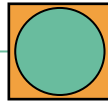


Video Tutorial: Interrupted Time Series

Part 3

Data for Impact

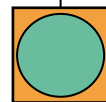




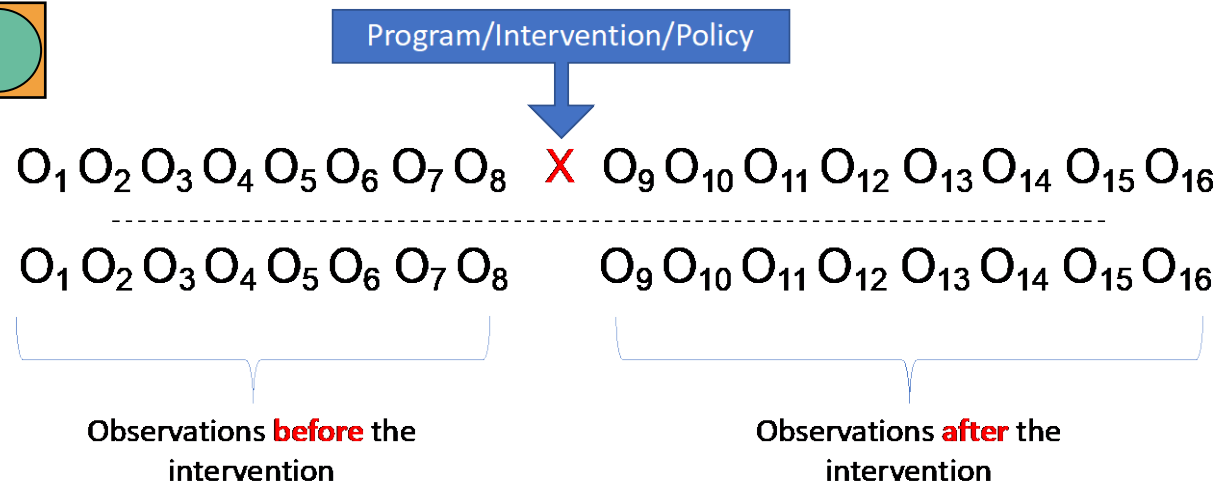
Overview

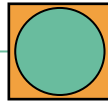
- Part 1:
 - Interrupted time series overview
 - Important considerations
 - Preparing the dataset
- Part 2:
 - Interrupted time series analysis: Single group
- Part 3:
 - Interrupted time series analysis: Multiple group

MULTIPLE GROUP ITS



ITSA with a control group



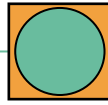


Single group vs. multiple group ITS

$$y_t = \beta_0 + \beta_1 T_t + \beta_2 X_t + \beta_3 X_t T_t + \varepsilon_t$$

versus

$$y_t = \beta_0 + \beta_1 T_t + \beta_2 X_t + \beta_3 X_t T_t + \beta_4 Z + \beta_5 Z T_t + \beta_6 Z X_t + \beta_7 Z X_t T_t + \varepsilon_t$$



Multiple group ITS

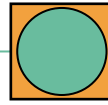
$$y_t = \beta_0 + \beta_1 T_t + \beta_2 X_t + \beta_3 X_t T_t + \beta_4 Z + \beta_5 Z T_t + \beta_6 Z X_t + \beta_7 Z X_t T_t + \varepsilon_t$$

Where,

- T = time since start of study
- X = program/intervention/policy
- Z = treatment or control
- ε = error term

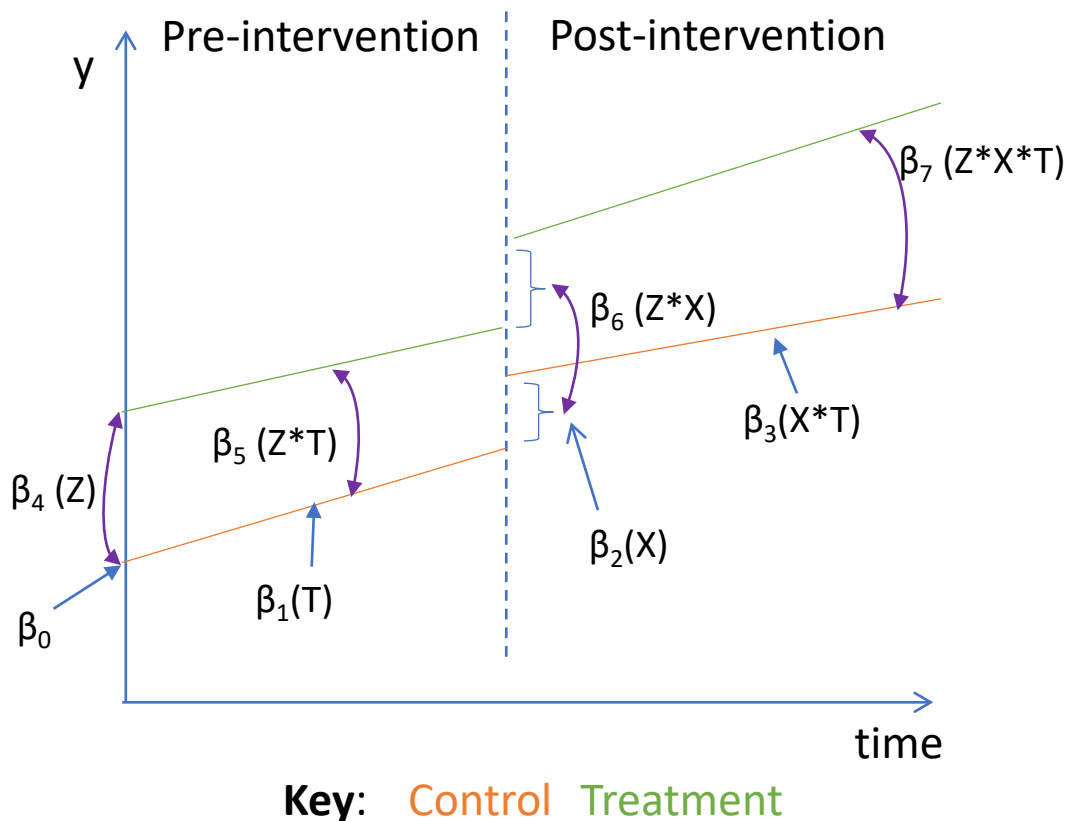
Interaction terms

- ZT = time for treatment
- ZX = study phase for treatment
- ZXT = time after interruption for treatment
- XT = time after the interruption



Multiple group ITS

$$y_t = \beta_0 + \beta_1 T_t + \beta_2 X_t + \beta_3 X_t T_t + \beta_4 Z + \beta_5 Z T_t + \beta_6 Z X_t + \beta_7 Z X_t T_t + \varepsilon_t$$



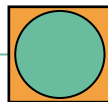
- $\beta_0 - \beta_3$ = Control Group
 - Intercept or existing level, β_0
 - Trend, trajectory or slope until intervention, β_1
 - Effect of intervention, level change, β_2
 - Trend change (difference in pre-and post-intervention slopes or trends), β_3
- $\beta_4 - \beta_7$ = Treatment Group
 - Difference in the level between trt and control before intervention, β_4
 - Difference in the trend/slope between trt and control before intervention, β_5
 - Difference in the level between trt and control immediately after the intervention, β_6
 - Difference between trt and control in the trend/slope after initiation of the intervention compared with preintervention, β_7

Exposed group

Year	Rate	T	X	XT	Z	ZT	ZX	ZXT
1999	30.001	1	0	0	1	1	0	0
2000	27.921	2	0	0	1	2	0	0
2001	20.739	3	0	0	1	3	0	0
2002	26.409	4	0	0	1	4	0	0
2003	30.834	5	0	0	1	5	0	0
2004	27.462	6	0	0	1	6	0	0
2005	25.635	7	0	0	1	7	0	0
2006	20.416	8	0	0	1	8	0	0
2007	29.888	9	0	0	1	9	0	0
2008	25.051	10	0	0	1	10	0	0
2009	29.559	11	1	1	1	11	1	1
2010	30.22	12	1	2	1	12	1	2
2011	26.707	13	1	3	1	13	1	3
2012	26.294	14	1	4	1	14	1	4
2013	23.768	15	1	5	1	15	1	5
2014	25.714	16	1	6	1	16	1	6
2015	30.057	17	1	7	1	17	1	7
2016	24.028	18	1	8	1	18	1	8

Unexposed group

1999	15.016	1	0	0	0	0	0	0
2000	18.476	2	0	0	0	0	0	0
2001	19.888	3	0	0	0	0	0	0
2002	25.095	4	0	0	0	0	0	0
2003	19.328	5	0	0	0	0	0	0
2004	20.902	6	0	0	0	0	0	0
2005	17.626	7	0	0	0	0	0	0
2006	25.589	8	0	0	0	0	0	0
2007	23.239	9	0	0	0	0	0	0
2008	18.760	10	0	0	0	0	0	0
2009	18.473	11	1	1	0	0	0	0
2010	21.703	12	1	2	0	0	0	0
2011	21.625	13	1	3	0	0	0	0
2012	19.723	14	1	4	0	0	0	0
2013	23.080	15	1	5	0	0	0	0
2014	16.717	16	1	6	0	0	0	0
2015	24.774	17	1	7	0	0	0	0
2016	24.929	18	1	8	0	0	0	0



Sample dataset

- Sample data is from a fictional country called Exile.
- In November 2017, Exile introduced a policy that eliminated fees at health facilities associated with maternity care services, with the aim of increasing utilization of health services.
- It was piloted in two constituencies, Gold-Coast IX and Gold-Coast XV. The policy was not piloted in North Troy XXVI.
- Dataset: Health facility data on the number of women who attended their 4th antenatal care (ANC) visits from 2017 to 2020

Treatment group

Gold Coast IX constituency

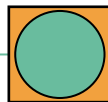
Control group

North Troy XXVI constituency

Dataset description

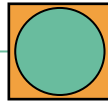
obs: 132
vars: 6
size: 3,168

variable name	storage type	display format	value label	variable label
id	float	%9.0g		Unique ID
region	long	%26.0g	de_region	Region
constituency	long	%35.0g	de_constituency	Constituency
nfac_cons	float	%9.0g		Number of health facilities in each constituency
mdate	float	%tm		Date
conANC4	float	%9.0g		4th ANC visit (constituency level)



Sample dataset

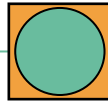
id	region	constituency	nfac_cons	mdate	conANC4
20	Gold Coast Region	Gold-C. IX	17	2017m1	.0012877
20	Gold Coast Region	Gold-C. IX	17	2017m2	.0013797
20	Gold Coast Region	Gold-C. IX	17	2017m3	.0012877
20	Gold Coast Region	Gold-C. IX	17	2017m4	.0013797
20	Gold Coast Region	Gold-C. IX	17	2017m5	.0016557
20	Gold Coast Region	Gold-C. IX	17	2017m6	.0015637
20	Gold Coast Region	Gold-C. IX	17	2017m7	.0016557
20	Gold Coast Region	Gold-C. IX	17	2017m8	.0014717
20	Gold Coast Region	Gold-C. IX	17	2017m9	.0015637
20	Gold Coast Region	Gold-C. IX	17	2017m10	.0015637
20	Gold Coast Region	Gold-C. IX	17	2017m11	.0016557
20	Gold Coast Region	Gold-C. IX	17	2017m12	.0027594
20	Gold Coast Region	Gold-C. IX	17	2018m1	.0039144
20	Gold Coast Region	Gold-C. IX	17	2018m2	.0040924
20	Gold Coast Region	Gold-C. IX	17	2018m3	.0047151
20	Gold Coast Region	Gold-C. IX	17	2018m4	.0056047
20	Gold Coast Region	Gold-C. IX	17	2018m5	.0047151
20	Gold Coast Region	Gold-C. IX	17	2018m6	.0056047
20	Gold Coast Region	Gold-C. IX	17	2018m7	.0055158
20	Gold Coast Region	Gold-C. IX	17	2018m8	.0072951
20	Gold Coast Region	Gold-C. IX	17	2018m9	.0070282
20	Gold Coast Region	Gold-C. IX	17	2018m10	.0065834
20	Gold Coast Region	Gold-C. IX	17	2018m11	.0054268
20	Gold Coast Region	Gold-C. IX	17	2018m12	.0072061
20	Gold Coast Region	Gold-C. IX	17	2019m1	.0111295
20	Gold Coast Region	Gold-C. IX	17	2019m2	.0095153
20	Gold Coast Region	Gold-C. IX	17	2019m3	.0072214
20	Gold Coast Region	Gold-C. IX	17	2019m4	.0103648
20	Gold Coast Region	Gold-C. IX	17	2019m5	.0088356
20	Gold Coast Region	Gold-C. IX	17	2019m6	.01011
20	Gold Coast Region	Gold-C. IX	17	2019m7	.0097701
20	Gold Coast Region	Gold-C. IX	17	2019m8	.0086657



Research question

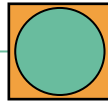
Research Questions

1. What was the impact of the policy on the utilization of ANC, specifically the 4th ANC visit of pregnant women, in Gold Coast IX?
2. What was the impact of the **policy** on the **utilization of ANC, specifically the 4th ANC visit of pregnant women**, in the intervention constituency, **Gold Coast IX**, compared to the control constituency, **North Troy XXVI**?



Steps needed to use ITS

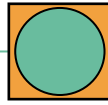
1. Determine time period(s)
2. Select the analytic cohort, if applicable
3. Determine outcomes of interest
4. Setup the data and visually inspect data
5. Preliminary analysis
6. Address autocorrelation, if applicable
7. Run final model
8. Plot results
9. Predict relative and absolute effects



Determine time period

$$y_t = \beta_0 + \beta_1 T_t + \beta_2 X_t + \beta_3 X_t T_t + \beta_4 Z + \beta_5 Z T_t + \beta_6 Z X_t + \beta_7 Z X_t T_t + \varepsilon_t$$

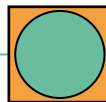
- **Y** : outcome, constituency rate of 4th ANC visits
- **T** : time since the start of the study
 - Each month is an observation, count the number of months since the start of the study (Jan 2017)
- **X** : dummy variable for pre and post policy period
 - Pre – period (Jan. – Oct. 2017) = 0
 - Post – period (Nov. 2017 – Aug. 2020) = 1
- **Z** : dummy variable for treatment and control
 - Control = 0
 - Treatment = 1



Determine time period

$$y_t = \beta_0 + \beta_1 T_t + \beta_2 X_t + \beta_3 X_t T_t + \beta_4 Z + \beta_5 Z T_t + \beta_6 Z X_t + \beta_7 Z X_t T_t + \varepsilon_t$$

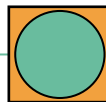
- **XT** : Time after the policy, number of months after start of policy (Nov. 2017). Pre-period=0
- **ZT** : Time for treatment, Control=0
- **ZX** : Study phase for treatment, Control=0
- **ZXT** : Time after the policy for treatment, Control=0



Variables

- Previously created
 - T – time
 - X – period
 - XT – posttime
- Additional variables
 - Z – cohort
 - ZT – trt_time
 - ZX – trt_period
 - ZXT – trt_posttime

constituency	mdate	time	period	posttime	cohort	trt_time	trt_period	treat_posttime
Gold Coast IX	2017m1	1	0	0	1	1	0	0
Gold Coast IX	2017m2	2	0	0	1	2	0	0
Gold Coast IX	2017m3	3	0	0	1	3	0	0
Gold Coast IX	2017m4	4	0	0	1	4	0	0
Gold Coast IX	2017m5	5	0	0	1	5	0	0
Gold Coast IX	2017m6	6	0	0	1	6	0	0
Gold Coast IX	2017m7	7	0	0	1	7	0	0
Gold Coast IX	2017m8	8	0	0	1	8	0	0
Gold Coast IX	2017m9	9	0	0	1	9	0	0
Gold Coast IX	2017m10	10	0	0	1	10	0	0
Gold Coast IX	2017m11	11	1	0	1	11	1	0
Gold Coast IX	2017m12	12	1	1	1	12	1	1
Gold Coast IX	2018m1	13	1	2	1	13	1	2
Gold Coast IX	2018m2	14	1	3	1	14	1	3
Gold Coast IX	2018m3	15	1	4	1	15	1	4
Gold Coast IX	2018m4	16	1	5	1	16	1	5
Gold Coast IX	2018m5	17	1	6	1	17	1	6
Gold Coast IX	2018m6	18	1	7	1	18	1	7
Gold Coast IX	2018m7	19	1	8	1	19	1	8
North Troy XXVI	2017m1	1	0	0	0	0	0	0
North Troy XXVI	2017m2	2	0	0	0	0	0	0
North Troy XXVI	2017m3	3	0	0	0	0	0	0
North Troy XXVI	2017m4	4	0	0	0	0	0	0
North Troy XXVI	2017m5	5	0	0	0	0	0	0
North Troy XXVI	2017m6	6	0	0	0	0	0	0
North Troy XXVI	2017m7	7	0	0	0	0	0	0
North Troy XXVI	2017m8	8	0	0	0	0	0	0
North Troy XXVI	2017m9	9	0	0	0	0	0	0
North Troy XXVI	2017m10	10	0	0	0	0	0	0
North Troy XXVI	2017m11	11	1	0	0	0	0	0
North Troy XXVI	2017m12	12	1	1	0	0	0	0
North Troy XXVI	2018m1	13	1	2	0	0	0	0
North Troy XXVI	2018m2	14	1	3	0	0	0	0
North Troy XXVI	2018m3	15	1	4	0	0	0	0
North Troy XXVI	2018m4	16	1	5	0	0	0	0
North Troy XXVI	2018m5	17	1	6	0	0	0	0
North Troy XXVI	2018m6	18	1	7	0	0	0	0
North Troy XXVI	2018m7	19	1	8	0	0	0	0



STATA Commands

Time

```
sort constituency mdate  
  
by constituency : gen time=_n  
  
label var time "Time points"
```

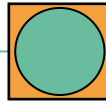
Period

```
. gen period=0 if time>=1 & time<=10  
(102 missing values generated)  
  
. replace period=1 if time>=11 & time<=45  
(102 real changes made)
```

Pre and post policy period	Freq.	Percent	Cum.
Pre-period	30	22.73	22.73
post-period	102	77.27	100.00
Total	132	100.00	

Posttime

```
. bysort constituency period : gen posttime=_n-1  
  
. replace posttime=0 if period==0  
(27 real changes made)  
  
. label var posttime "Time points after the policy"
```



STATA Commands

Cohort

```
. gen cohort=1 if constituency==20 | constituency==26  
(44 missing values generated)  
  
. replace cohort=0 if constituency==235  
(44 real changes made)  
  
. label var cohort "Control vs Treatment"
```

Trt_period

```
. by constituency:gen trt_period=0 if time>=1 & time<=10  
(102 missing values generated)  
  
. replace trt_period=1 if time>=11 & time<=45  
(102 real changes made)  
  
. replace trt_period=0 if constituency==235  
(34 real changes made)  
  
. label var trt_period "Pre and post policy period for the treatment group"
```

Trt_time

```
sort constituency mdate  
  
by constituency: gen trt_time=_n  
  
replace trt_time=0 if constituency==235  
44 real changes made)  
  
label var trt_time "Time since start of study for treatment group"
```

Trt_posttime

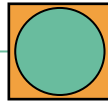
```
. bysort constituency period : gen trt_posttime=_n-1  
  
. replace trt_posttime=0 if period==0  
(27 real changes made)  
  
. replace trt_posttime=0 if constituency==235  
(33 real changes made)  
  
. label var trt_posttime "Time points after the policy for the treatment group"
```


Exposed group

constitu~y	mdate	conANC4	time	period	posttime	cohort	trt_time	trt_pe~d	trt_po~e
Gold-C. IX	2017m1	.0012877	1	Pre-period	0	1	1	0	0
Gold-C. IX	2017m2	.0013797	2	Pre-period	0	1	2	0	0
Gold-C. IX	2017m3	.0012877	3	Pre-period	0	1	3	0	0
Gold-C. IX	2017m4	.0013797	4	Pre-period	0	1	4	0	0
Gold-C. IX	2017m5	.0016557	5	Pre-period	0	1	5	0	0
Gold-C. IX	2017m6	.0015637	6	Pre-period	0	1	6	0	0
Gold-C. IX	2017m7	.0016557	7	Pre-period	0	1	7	0	0
Gold-C. IX	2017m8	.0014717	8	Pre-period	0	1	8	0	0
Gold-C. IX	2017m9	.0015637	9	Pre-period	0	1	9	0	0
Gold-C. IX	2017m10	.0015637	10	Pre-period	0	1	10	0	0
Gold-C. IX	2017m11	.0016557	11	post-period	0	1	11	1	0
Gold-C. IX	2017m12	.0027594	12	post-period	1	1	12	1	1
Gold-C. IX	2018m1	.0039144	13	post-period	2	1	13	1	2
Gold-C. IX	2018m2	.0040924	14	post-period	3	1	14	1	3
Gold-C. IX	2018m3	.0047151	15	post-period	4	1	15	1	4
Gold-C. IX	2018m4	.0056047	16	post-period	5	1	16	1	5
Gold-C. IX	2018m5	.0047151	17	post-period	6	1	17	1	6
Gold-C. IX	2018m6	.0056047	18	post-period	7	1	18	1	7
Gold-C. IX	2018m7	.0055158	19	post-period	8	1	19	1	8
Gold-C. IX	2018m8	.0072951	20	post-period	9	1	20	1	9
Gold-C. IX	2018m9	.0070282	21	post-period	10	1	21	1	10

Unexposed group

N-Troy XXVI	2017m1	.0015474	1	Pre-period	0	0	0	0	0
N-Troy XXVI	2017m2	.0018204	2	Pre-period	0	0	0	0	0
N-Troy XXVI	2017m3	.0021585	3	Pre-period	0	0	0	0	0
N-Troy XXVI	2017m4	.0025096	4	Pre-period	0	0	0	0	0
N-Troy XXVI	2017m5	.0019765	5	Pre-period	0	0	0	0	0
N-Troy XXVI	2017m6	.0016904	6	Pre-period	0	0	0	0	0
N-Troy XXVI	2017m7	.0017034	7	Pre-period	0	0	0	0	0
N-Troy XXVI	2017m8	.0013393	8	Pre-period	0	0	0	0	0
N-Troy XXVI	2017m9	.0014564	9	Pre-period	0	0	0	0	0
N-Troy XXVI	2017m10	.0014433	10	Pre-period	0	0	0	0	0
N-Troy XXVI	2017m11	.0015734	11	post-period	0	0	0	0	0
N-Troy XXVI	2017m12	.0013133	12	post-period	1	0	0	0	0
N-Troy XXVI	2018m1	.0015218	13	post-period	2	0	0	0	0
N-Troy XXVI	2018m2	.0017482	14	post-period	3	0	0	0	0
N-Troy XXVI	2018m3	.0017104	15	post-period	4	0	0	0	0
N-Troy XXVI	2018m4	.0016224	16	post-period	5	0	0	0	0
N-Troy XXVI	2018m5	.0016475	17	post-period	6	0	0	0	0
N-Troy XXVI	2018m6	.0015847	18	post-period	7	0	0	0	0
N-Troy XXVI	2018m7	.0010816	19	post-period	8	0	0	0	0
N-Troy XXVI	2018m8	.0016601	20	post-period	9	0	0	0	0
N-Troy XXVI	2018m9	.0011822	21	post-period	10	0	0	0	0

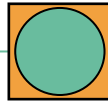


Declare data

- Declare data to be time series data
 - tsset panelvar timevar

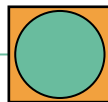
```
tsset constituency mdate  
  panel variable:  constituency (strongly balanced)  
    time variable:  mdate, 2017m1 to 2020m8  
          delta:    1 month
```

```
tsset constituency time  
  panel variable:  constituency (strongly balanced)  
    time variable:  time, 1 to 44  
          delta:    1 unit
```

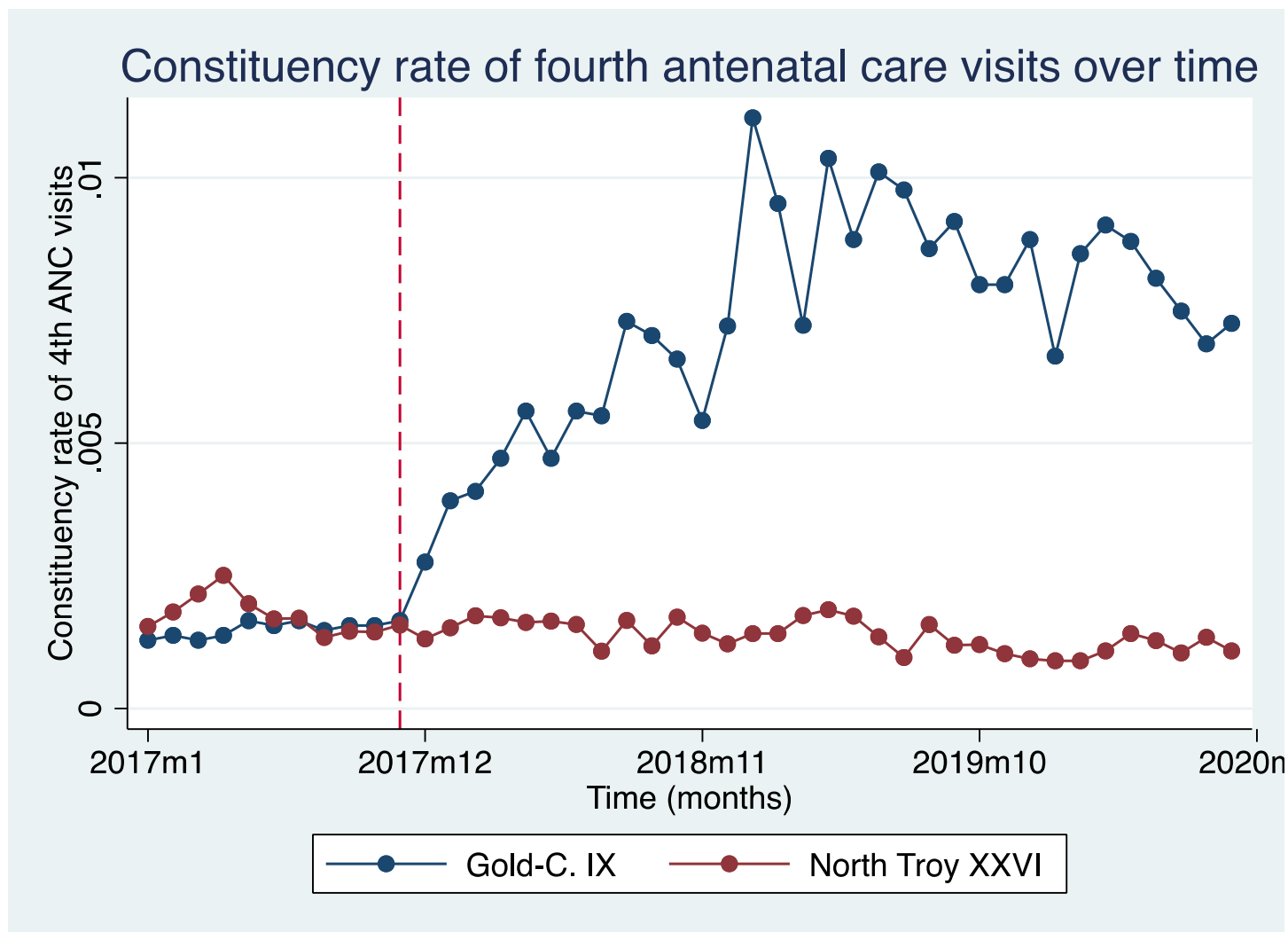


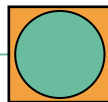
Visual Inspection

- Graph data of interest
 - STATA command:
 - `twoway connected (depvar invar) (depvar invar) , xline(year)`
 - `twoway line (depvar invar) (depvar invar) , xline(year)`
- Tutorial example: Policy implementation
 - Treatment/intervention constituency
 - Gold Coast IX (#20)
 - Control constituency
 - North Troy XXVI (#235)



STATA code: twoway (connected conANC4 time if constituency==20) (connected conANC4 time if constituency==235), xline(11, lpattern(dash)) xtitle(Time (months)) ytitle(4th ANC visit) title(Fourth ANC visit over time) xlabel(1(11)44, valuelabel) legend(label(1 "Gold-C. IX") label(2 "North Troy XXVI")) legend(order(1 2))





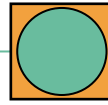
ITSA command

- Used for multiple group ITS

itsa *depvar* [*indepvars*] [*if*] [*in*] [*weight*], **trperiod**(*numlist*) [**treatid**(#)
contid(*numlist*) **lag**(#) **figure**[(*twoway_options*)] **replace**

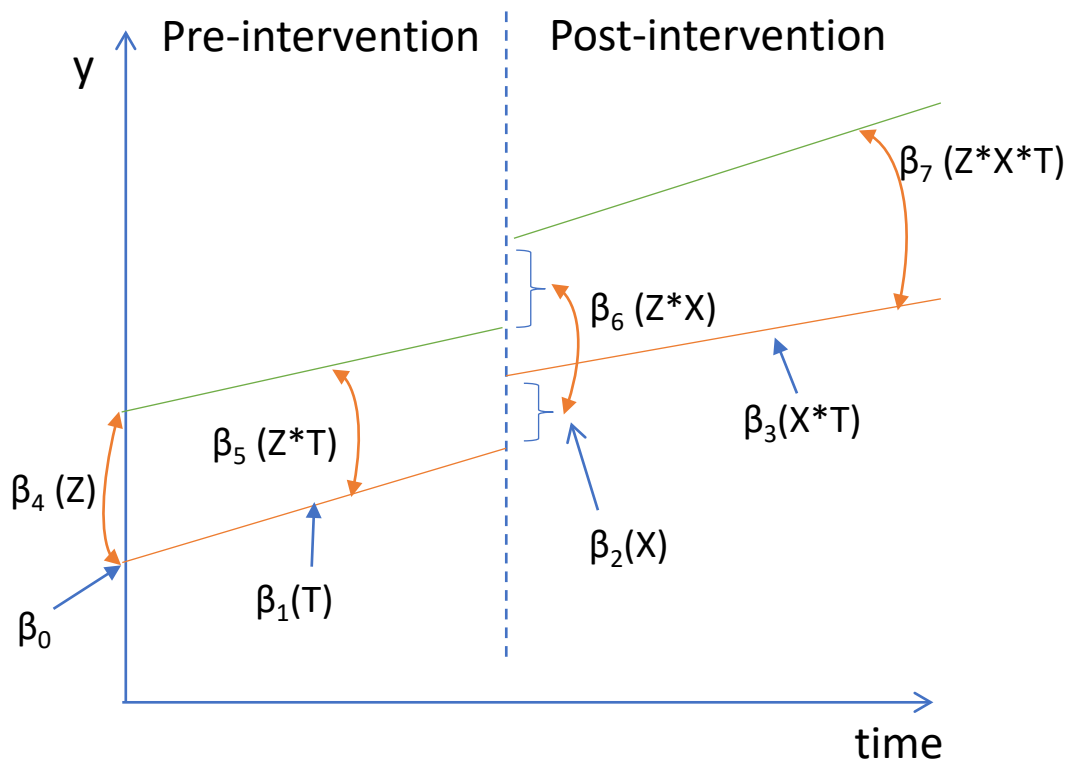
Component	Description
trperiod(numlist)*	Time period when the intervention begins
treatid(#)	Identifier of treatment cohort
contid(numlist)	Identifiers used as control units
lag(#)	# of lags to be considered in the autocorrelation structure
figure[(twoway_options)]	Produces a line plot of predicted dependent variable combined with a scatter plot
replace	Replaces variables created if they already exist

Tip : search "help itsa" for more information on the command

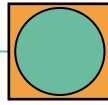


Recap: Multiple group ITS

$$y_t = \beta_0 + \beta_1 T_t + \beta_2 X_t + \beta_3 X_t T_t + \beta_4 Z + \beta_5 Z T_t + \beta_6 Z X_t + \beta_7 Z X_t T_t + \varepsilon_t$$



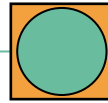
- $\beta_0 - \beta_3$: Control Group
 - Intercept or existing level, β_0
 - Trend, trajectory or slope until intervention, β_1
 - Effect of intervention, level change, β_2
 - Trend change (difference in pre-and post-intervention slopes or trends), β_3
- $\beta_4 - \beta_7$: Treatment Group
 - Difference in the level between trt and control before intervention, β_4
 - Difference in the trend/slope between trt and control before intervention, β_5
 - Difference in the level between trt and control immediately after the intervention, β_6
 - Difference between trt and control in the trend/slope after initiation of the intervention compared with preintervention, β_7



Research question

Research Questions

1. What was the impact of the policy on the utilization of ANC, specifically the 4th ANC visit of pregnant women, in Gold Coast IX?
2. What was the impact of the **policy** on the **utilization of ANC, specifically the 4th ANC visit of pregnant women**, in the intervention constituency, **Gold Coast IX**, compared to the control constituency, **North Troy XXVI**?



Preliminary Model

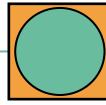
STATA command: itsa conANC4,
treatid(20) contid(235) trperiod(11)
lag(0) figure(xlabel(1(10)44,
value label) xtitle(Time (months))
title(ANC (4th) visits over time))
replace

Regression with Newey-West standard errors
maximum lag: 0

Number of obs = 88
F(7, 80) = 64.77
Prob > F = 0.0000

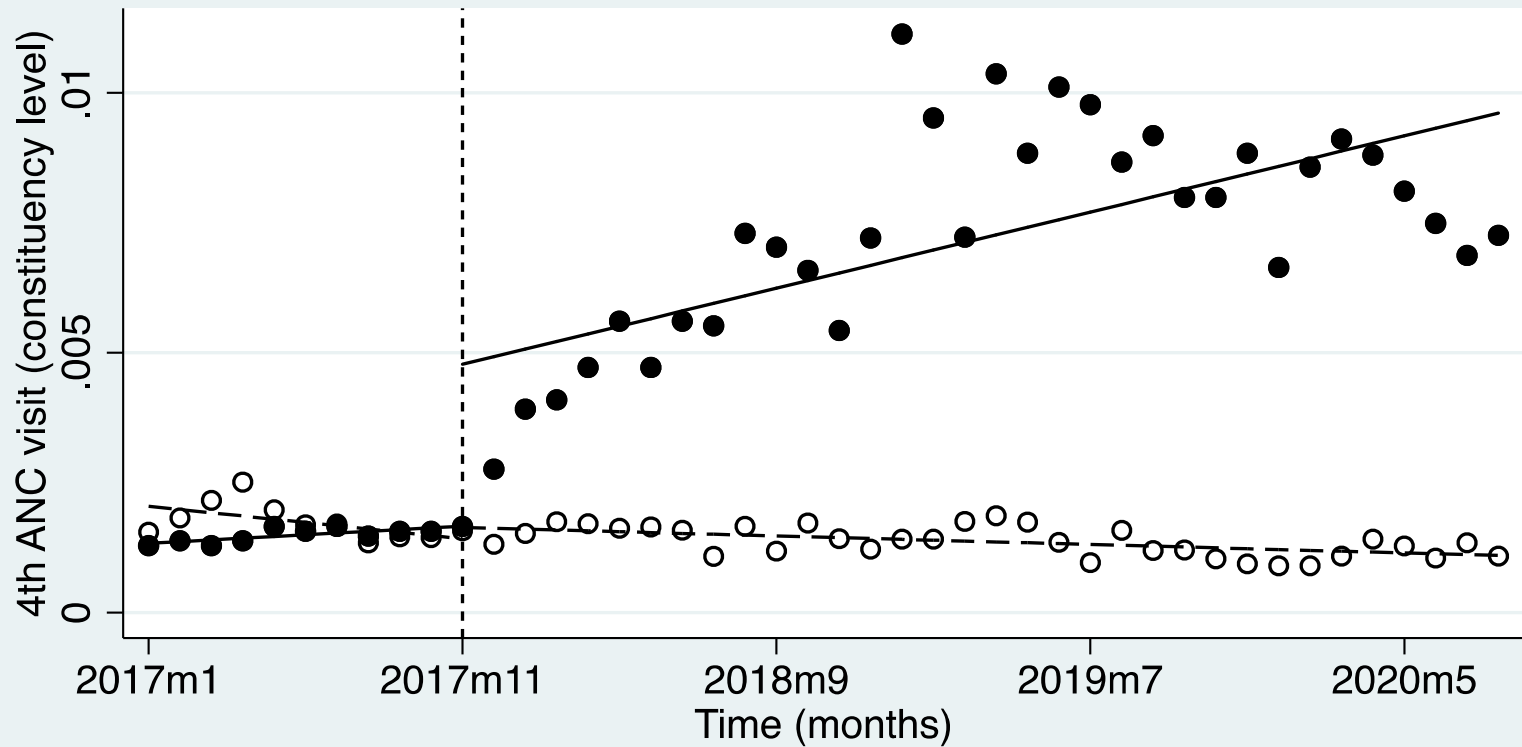
conANC4	Newey-West		t	P> t	[95% Conf. Interval]	
	Coef.	Std. Err.				
_t	-.0000623	.0000342	-1.82	0.072	-.0001304	5.76e-06
_z	-.0007121	.000238	-2.99	0.004	-.0011858	-.0002385
_z_t	.0000952	.000035	2.72	0.008	.0000256	.0001648
_x11	.0002158	.0001535	1.41	0.164	-.0000897	.0005214
_x_t11	.000046	.0000344	1.34	0.185	-.0000224	.0001144
_z_x11	.0028987	.0006157	4.71	0.000	.0016733	.004124
_z_x_t11	.0000676	.0000468	1.44	0.153	-.0000256	.0001607
_cons	.002045	.0002339	8.74	0.000	.0015796	.0025105

Variable	Explanation	Coefficient	P> t	[95% Conf. Interval]
_t	Pre-existing trend in control (β_1)	-0.0000623	0.072	[-0.0001304, 5.76 x 10 ⁻⁶]
_z	Pre-existing difference in level/intercept between trt and ctrl (β_4)	-0.0007121	0.004	[-0.0011858, -0.0002385]
_z_t	Pre-existing differential trend/slope between trt and ctrl (β_5)	0.0000952	0.008	[0.0000256, 0.0001648]
_x11	Level change in control (β_2)	-0.0002158	0.164	[-0.0000897, 0.0005214]
_x_t_11	Trend/slope change in control (β_3)	0.0000460	0.185	[-0.0000224, 0.0001144]
_z_x11	Differential change in level of trt relative to the ctrl (β_6)	0.0028987	0.000	[0.0016733, 0.0041240]
_z_x_t11	Differential change in trend/slope of trt relative to the ctrl (β_7)	0.0000676	0.153	[-0.0000256, 0.0001607]
_cons	Pre-existing level/intercept in control (β_0)	0.0020450	0.000	[0.0015796, 0.0025105]



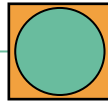
ANC (4th) visits over time

Intervention starts: 11



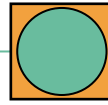
Gold-C. IX:	● Actual	— Predicted
Controls average:	○ Actual	- - - Predicted

Regression with Newey-West standard errors - lag(0)



Preliminary analysis

- Assess for autocorrelation using
 - Cumby-Huizinga test for autocorrelation
 - **STATA command:** `actest varname`
- Why?
 - Biased estimates in our errors



Cumby-Huizinga test for autocorrelation

Postestimation command : `actest, lags(10)`

Cumby-Huizinga test for autocorrelation

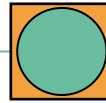
H0: variable is MA process up to order q

HA: serial correlation present at specified lags >q

H0: q=0 (serially uncorrelated) HA: s.c. present at range specified				H0: q=specified lag-1 HA: s.c. present at lag specified			
lags	chi2	df	p-val	lag	chi2	df	p-val
1 - 1	30.286	1	0.0000	1	30.286	1	0.0000
1 - 2	30.859	2	0.0000	2	8.670	1	0.0032
1 - 3	34.038	3	0.0000	3	8.086	1	0.0045
1 - 4	34.082	4	0.0000	4	4.377	1	0.0364
1 - 5	35.877	5	0.0000	5	5.091	1	0.0241
1 - 6	36.730	6	0.0000	6	1.805	1	0.1791
1 - 7	37.610	7	0.0000	7	0.041	1	0.8401
1 - 8	37.621	8	0.0000	8	0.021	1	0.8861
1 - 9	40.441	9	0.0000	9	2.003	1	0.1570
1 - 10	41.934	10	0.0000	10	1.038	1	0.3083

Test allows predetermined regressors/instruments

Test requires conditional homoskedasticity



Final Model

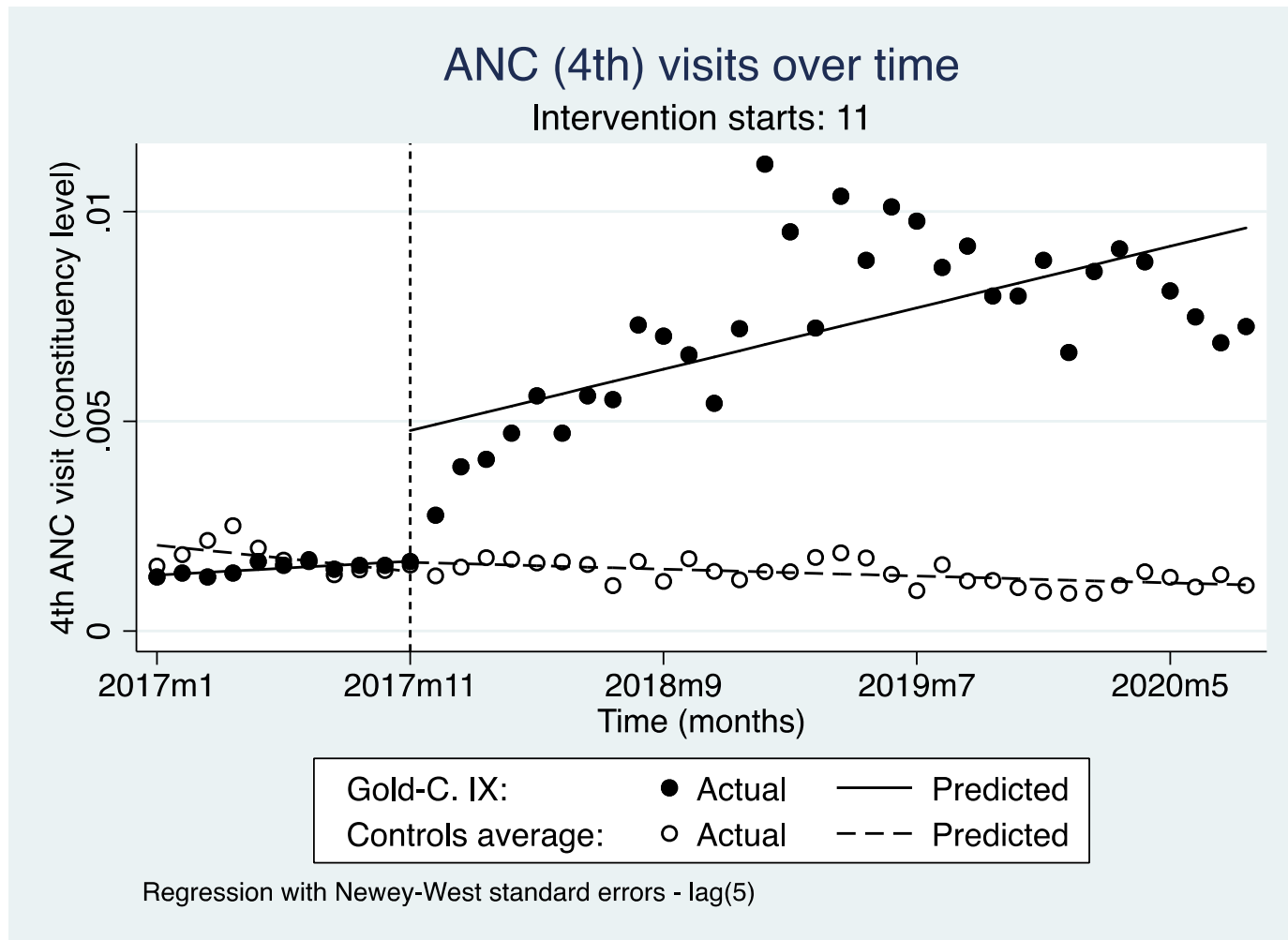
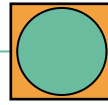
STATA command: itsa conANC4,
treatid(20) contid(235) trperiod(14)
lag(5) figure(xlabel(1(10)44,
value label) xtitle(Time (months))
title(ANC (4th) visits over time))
replace

Regression with Newey-West standard errors
maximum lag: 5

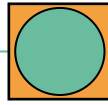
Number of obs = 88
F(7, 80) = 24.06
Prob > F = 0.0000

conANC4	Newey-West		t	P> t	[95% Conf. Interval]	
	Coef.	Std. Err.				
_t	-.0000623	.0000321	-1.94	0.056	-.0001262	1.52e-06
_z	-.0007121	.0001956	-3.64	0.000	-.0011015	-.0003228
_z_t	.0000952	.0000331	2.88	0.005	.0000294	.0001611
_x11	.0002158	.0001554	1.39	0.169	-.0000934	.0005251
_x_t11	.000046	.0000327	1.41	0.163	-.000019	.000111
_z_x11	.0028987	.0009761	2.97	0.004	.0009562	.0048411
_z_x_t11	.0000676	.0000638	1.06	0.293	-.0000594	.0001945
_cons	.002045	.0001913	10.69	0.000	.0016644	.0024256

Variable	Explanation	Coefficient	P> t	[95% Conf. Interval]
_t	Pre-existing trend in control (β_1)	-0.0000623	0.056	[-0.0001262, 1.52×10^{-6}]
_z	Pre-existing difference in level/intercept between trt and ctrl (β_4)	-0.0007121	0.000	[-0.0011015, -0.0003228]
_z_t	Pre-existing differential trend/slope between trt and ctrl (β_5)	0.0000952	0.005	[0.0000294, 0.0001611]
_x11	Level change in control (β_2)	-0.0002158	0.169	[-0.0000934, 0.0005251]
_x_t_11	Trend/slope change in control (β_3)	0.0000460	0.163	[-0.0000190, 0.0001110]
_z_x11	Differential change in level of trt relative to the ctrl (β_6)	0.0028987	0.004	[0.0009562, 0.0048411]
_z_x_t11	Differential change in trend/slope of trt relative to the ctrl (β_7)	0.0000676	0.293	[-0.0000594, 0.0001945]
_cons	Pre-existing level/intercept in control (β_0)	0.0020450	0.000	[0.0016644, 0.0024256]

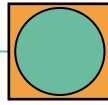


Interpretation: After the policy change in Gold Coast IV, there was a sustained increase in the constituency rate of 4th ANC visits of about 0.29% relative to the change in North Troy XXVI. There was an increase in the trend of about 0.0067% per month afterward, but this was not significant.



Predicted changes

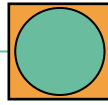
- Impact of policy 1 years later
 - *Absolute change = fitted – counterfactual*
 - *Relative change = $\frac{\text{fitted} - \text{counterfactual}}{\text{counterfactual}}$*



Predicted changes

$$y_t = \beta_0 + \beta_1 T_t + \beta_2 X_t + \beta_3 X_t T_t + \beta_4 Z + \beta_5 Z T_t + \beta_6 Z X_t + \beta_7 Z X_t T_t + \varepsilon_t$$

- 1 year (12 months) after policy
 - T: time since study start = 11 + 12 = 23
 - XT: time since policy start = 12
 - ZT: time since study start in treatment group=23
 - ZXT: time since policy start in treatment group=12



Predicted changes

- Predict counterfactual value at 1 year
 - $X = 1, T = 23, XT = 12, Z = 0, ZX = 0, ZT = 0, ZXT = 0$

$$y_t = \beta_0 + \beta_1 T_t + \beta_2 X_t + \beta_3 X_t T_t + \beta_4 Z + \beta_5 Z T_t + \beta_6 Z X_t + \beta_7 Z X_t T_t + \varepsilon_t$$

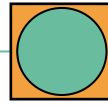
$$y_t = \beta_0 + (\beta_1 \times 23) + (\beta_2 \times 1) + (\beta_3 \times 1 \times 12) + (\beta_4 \times 0) + (\beta_5 \times 0) + (\beta_6 \times 0) + (\beta_7 \times 0)$$

$$y_t = \beta_0 + (\beta_1 \times 23) + \beta_2 + (\beta_3 \times 12)$$

```
. lincom _b[_cons] + (_b[_t]*23) + (_b[_x11]*1) + (_b[_x_t11]*12)
```

```
( 1) 23*_t + _x11 + 12*_x_t11 + _cons = 0
```

conANC4	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
(1)	.0013793	.0000558	24.71	0.000	.0012682	.0014903



Predicted changes

- Predict fitted value at 1 year
 - $X = 1, T = 23, XT = 12, Z = 1, ZX = 1, ZT = 23, ZXT = 12$

$$y_t = \beta_0 + \beta_1 T_t + \beta_2 X_t + \beta_3 X_t T_t + \beta_4 Z + \beta_5 Z T_t + \beta_6 Z X_t + \beta_7 Z X_t T_t + \varepsilon_t$$

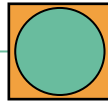
$$y_t = \beta_0 + (\beta_1 \times 23) + (\beta_2 \times 1) + (\beta_3 \times 1 \times 12) + (\beta_4 \times 1) + (\beta_5 \times 23) + (\beta_6 \times 1) + (\beta_7 \times 12)$$

$$y_t = \beta_0 + (\beta_1 \times 23) + \beta_2 + (\beta_3 \times 12) + \beta_4 + (\beta_5 \times 23) + \beta_6 + (\beta_7 \times 12)$$

```
. lincom _b[_cons]+ (_b[_t ]*23) + (_b[_x11]*1) + (_b[_x_t11]*12) + _b[_z] + (_b[_z_t]*23) + (_b[_z_x11]*1) + (_b[_z_x_t11]*12)
```

```
( 1) 23*_t + _z + 23*_z_t + _x11 + 12*_x_t11 + _z_x11 + 12*_z_x_t11 + _cons = 0
```

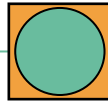
conANC4	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
(1)	.0065666	.0005676	11.57	0.000	.0054371	.0076961



Predicted changes

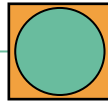
- Impact of policy 1 year later
 - *Absolute change* = *fitted* – *counterfactual*
= 0.0065666 – 0.0013793
= 0.0051873
 - *Relative change* = $\frac{0.0065666 - 0.0028573}{0.0028573}$
= 3.7608207

Interpretation: In the 1st year after the policy, the constituency rate of 4th ANC visits was 0.52% more than would have been expected if the policy was not implemented. This represents a 376-percentage point increase.



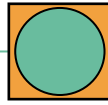
Additional capabilities of ITSA

- Multiple treatment/policy/intervention periods
 - `trtperiod(14 20 30)`
- Multiple treatment groups
 - `treatid(20 12)`
- Multiple control groups
 - `contid(8 4)`
- Account for autocorrelation in the initial command
 - Add “`prais`” and delete “`lag(#)`” specification
 - Note the output is not comparable to the `itsa` command without `prais`
- Control for independent variables



What should you report?

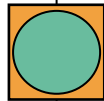
- Autocorrelation, non-stationarity, and seasonality considerations
- Intervention timepoints and lag periods
- Number of data points pre-intervention, post-intervention
- Statistical regression methods and the appropriateness of a linear model when applied
- Intervention impact (absolute and/or relative changes from baseline) with significance.



What should you report?

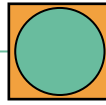
- Additional things to report or present
 - Present results graphically with clearly defined time point(s)
 - Present the minimum number of observations per data point, data variability

Resources



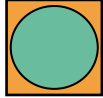
- Background information sheet
 - Overview of time series and interrupted time series
 - List of useful resources
 - Summary of studies using interrupted time series analysis
- PowerPoint presentation
- Sample dataset*
- Sample do file*

* Resources are available for Part 2 and 3 of the ITS video tutorial only



References

- Baum, C.F., Schaffer, M.E. 2013. `actest`: Stata module to perform Cumby-Huizinga general test for autocorrelation in time series. <http://ideas.repec.org/c/boc/bocode/s457668.html>
- Bernal, J. L., Cummins, S., & Gasparrini, A. (2017). Interrupted time series regression for the evaluation of public health interventions: A tutorial. *International Journal of Epidemiology*, 46(1), 348–355. <https://doi.org/10.1093/ije/dyw098>
- Cochrane Effective Practice and Organisation of Care (EPOC). (2017). Interrupted time series (ITS) analyses: EPOC Resources for review authors. <https://www.coursehero.com/file/74328642/interrupted-time-series-analysesdocx/>
- Law, M. Policy Analysis Using Interrupted Time Series. University of British Columbia. <https://www.edx.org/course/policy-analysis-using-interrupted-time-series>
- Linden, A. (2015). Conducting interrupted time-series analysis for single- and multiple-group comparisons. *The Stata Journal*, 15(2), 480-500. <https://www.stata-journal.com/article.html?article=st0389>
- Penfold, R. B., & Zhang, F. (2013). Use of interrupted time series analysis in evaluating health care quality improvements. *Academic pediatrics*, 13(6 Suppl), S38–S44. <https://doi.org/10.1016/j.acap.2013.08.002>



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www.data4impactproject.org

