(A) Read   ECG 753 → Lecture Slide 8 → Treatment → Pg 25 − DiD
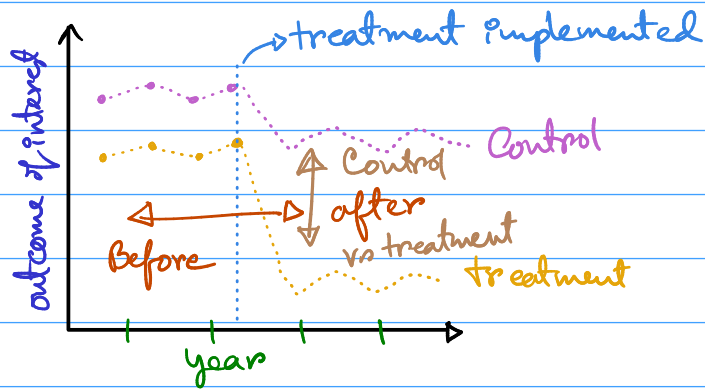
Stata →   **did regress** → cross sectional

xt did regress → panel (longitudinal) data

DiD → nonexperimental technique to estimate the ATET

↳ controls for unobservable time and group characteristics

DDD → adds a control group to the DiD framework to account for unobservable group

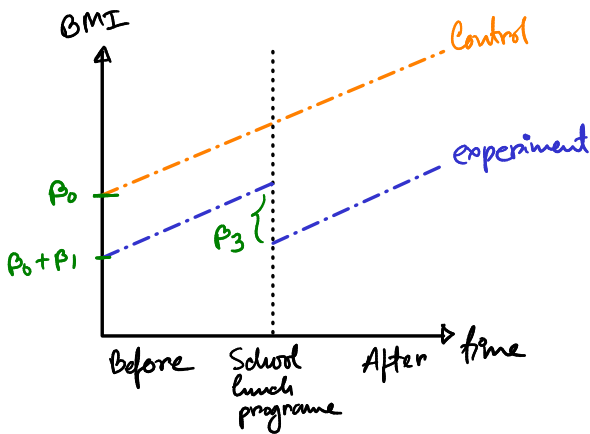| i	High School	College	TE	Obs. outcome
low ability	1.7 (observed)	1.9 (not obs)	0.2	1.7
High ~	2.8 (not obs.)	3.6 (obs)	0.8	3.6

— counterfactual

$$ATE = \frac{0.2 + 0.8}{2} = 0.5$$

$$ATET = 0.8 \quad [\text{change in outcome for the treated group}]$$

independence between treatment status and potential outcomes

↳ $ATE = ATET$

⊞ Differences in difference :-

$$BMI = \beta_0 + \beta_1\,time + \beta_2\,(experimental) + \beta_3\,(After * experimental)$$

Source: Ashley Hodgson (YouTube)

https://www.youtube.com/watch?v=XFqFH97bDy4

Source: an intuitive intro to DiD

Y	Pre	Post
Ctrl	30	70
Trt	20	90

		D_{post}	
		Pre	Post
D_{Tr}	Ctrl	β_0	$\beta_0 + \beta_1$
	Trt	$\beta_0 + \beta_2$	$\beta_0 + \beta_1 + \beta_2 + \beta_3$

$$DiD = (Y_{Tr,Po} - Y_{Tr,Pr}) - (Y_{e,Po} - Y_{e,Pr})$$
$$= (90-20) - (70-30)$$
$$= 40$$

$$y = \beta_0 + \beta_1 D_{post} + \beta_2 D_{Tr} + \beta_3 (D_{post} * D_{Tr})$$

β_3 = DiD estimate

when, 1st box, (Ctrl, Pre) ⟹ $D_{post}=0$, $D_{Tr}=0$ ⟹ β_0

when, 2nd box, (Ctrl, Post) ⟹ $D_{post}=1$, $D_{Tr}=0$ ⟹ $\beta_0 + \beta_1$

when 3rd box, (trt, Pre) ⟹ $D_{post}=0$, $D_{Tr}=1$ ⟹ $\beta_0 + \beta_2$
$$⟹ \beta_0 + \beta_1 + \beta_2 + \beta_3$$

https://www.youtube.com/watch?v=J7q2H8aB8bQ

DDD :- Source Gruber 1994

treatment group (Married woman 20-40) $treat_i = 1$

D_{Tr}		Pre ($\tau_t=0$)	Post ($\tau_t=1$)	Time difference for location
	Trt ($\delta_j=1$)	110 — $\beta_3\ \beta_4\ \beta_7$	111 — $\beta_2\ \beta_3\ \beta_4\ \beta_5\ \beta_6\ \beta_7\ \beta_8$	$\beta_2\ \beta_5\ \beta_6\ \beta_8$
	Ctrl ($\delta_j=0$)	100 — β_4	101 — $\beta_2\ \beta_4\ \beta_6$	$\beta_2\ \beta_6$
Location difference at a point in time		$\beta_3\ \beta_7$	$\beta_3\ \beta_5\ \beta_7\ \beta_8$	

$$DiD_{i=1} = \beta_5 \quad \beta_8$$

Control group (over 40 & single male 20-40) $treat_i = 0$

D_{Tr}		Pre ($\tau_t=0$)	Post ($\tau_t=1$)	Time difference for location
	Trt ($\delta_j=1$)	010 — β_3	011 — $\beta_2\ \beta_3\ \beta_5$	$\beta_2\ \beta_5$
	Ctrl ($\delta_j=0$)	000 — ∅	001 — β_2	β_2
Location difference at a point in time		β_3	$\beta_3\ \beta_5$	

$$DiD_{i=0} = \beta_5$$

$$W = \alpha + \beta_1 x_{ijt} + \beta_2 \tau_t + \beta_3 \delta_j + \beta_4\,Treat_i$$
$$+ \beta_5 (\delta_j \cdot \tau_t) + \beta_6 (\tau_t \cdot Treat_i) + \beta_7 (\delta_j \cdot Treat_i)$$
$$+ \beta_8 (\delta_j \cdot \tau_t \cdot Treat_i)$$

i = individual
j = states (treatment / control)
t = time (before / after)
W = log real hourly wage

treat = dummy treatment group
δ_j = fixed state effect
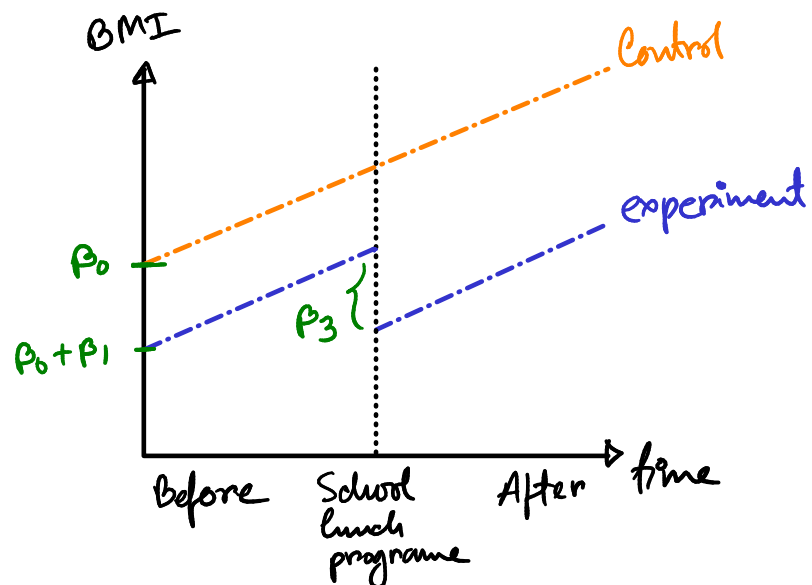τ_t = fixed year effect

$$DDD = DiD_{i=1} - DiD_{i=0} = \beta_8$$

time = monthly data = r_t
treat$_i$ = procedure =
ratio = outcome of interest = w

Stata 17

>>> webuse hospdd
>>> did regress (ratio) (procedure), group(hospital) time(month)

$\underbrace{\text{ratio}}_{W}$ $\underbrace{\text{procedure}}_{\text{treat}_i}$ $\underbrace{\text{hospital}}_{\delta_j}$ $\underbrace{\text{month}}_{r_t}$

⊞ Differences in difference :-

BMI

β_0

$\beta_0 + \beta_1$

Control

experiment

β_3 {

Before   School lunch programme   After   time

$$BMI = \beta_0 + \beta_1 \, time + \beta_2 \, (experimental)$$
$$+ \beta_3 \, (After * experimental)$$

Source: Ashley Hodgson (YouTube)

Source: an intuitive intro to DiD

Y	Pre	Post
Ctrl	30	70
Trt	20	90

$$DiD = (Y_{Tr, Po} - Y_{Tr, Pr}) -$$
$$(Y_{c, Po} - Y_{c, Pr})$$
$$= (90 - 20) -$$
$$(70 - 30)$$
$$= 40$$

		D_{post}	
		Pre	Post
D_{Tr}	Ctrl	β_0	$\beta_0 + \beta_1$
	Trt	$\beta_0 + \beta_2$	$\beta_0 + \beta_1 + \beta_2 + \beta_3$

$$y = \beta_0 + \beta_1 D_{post} + \beta_2 D_{Tr}$$
$$+ \beta_3 (D_{post} * D_{Tr})$$

$\beta_3 = $ DiD estimate

when, 1st box, (Ctrl, Pre) $\Rightarrow D_{post} = 0, D_{Tr} = 0 \Rightarrow \beta_0$

when, 2nd box, (Ctrl, Post) $\Rightarrow D_{post} = 1, D_{Tr} = 0 \Rightarrow \beta_0 + \beta_1$

when 3rd box, (trt, Pre) $\Rightarrow D_{post} = 0, D_{Tr} = 1 \Rightarrow \beta_0 + \beta_2$
$$\Rightarrow \beta_0 + \beta_1 + \beta_2 + \beta_3$$

DDD :-

treatment group (Married woman 20-40)
$treat_i = 1$

		D_{post}		
		Pre $\tau_{t=0}$	Post $\tau_{t=1}$	Time difference for location
D_{Tr}	Trt $\delta_j=1$	110 β_3 β_4 β_7	111 β_2 β_3 β_4 β_5 β_6 β_7 β_8	β_2 β_5 β_6 β_8
	Ctrl $\delta_j=0$	100 β_4	101 β_2 β_6 β_4	β_2 β_6
Location difference at a point in time		β_3 β_7	β_3 β_5 β_7 β_8	

$DID_{i=1} = \beta_5 \qquad \beta_8$

Control group (over 40 & single male 20-40)
$treat_i = 0$

		D_{post}		
		Pre $\tau_{t=0}$	Post $\tau_{t=1}$	time difference for location
D_{Tr}	Trt $\delta_j=1$	010 β_3	011 β_2 β_3 β_5	β_2 β_5
	Ctrl $\delta_j=0$	000 $\emptyset$	001 β_2	β_2
Location difference at a point in time		β_3	β_3 β_5	

$DiD_{i=0} = \beta_5$

$$W = \alpha + \beta_1 x_{ijt} + \beta_2 \tau_t + \beta_3 \delta_j + \beta_4 Treat_i$$
$$+ \beta_5 (\delta_j \cdot \tau_t) + \beta_6 (\tau_t \cdot Treat_i) + \beta_7 (\delta_j \cdot Treat_i)$$
$$+ \beta_8 (\delta_j \cdot \tau_t \cdot Treat_i)$$

i = individual
j = states (treatment / control)
t = time (before/after)
W = log real hourly wage

treat = dummy treatment group
δ_j = fixed state effect
τ_t = fixed year effect

$$DDD = DiD_{i=1} - DiD_{i=0} = \beta_8$$