Lecture 5. Mixing it all…

Complements on longitudinal data, Diff-in-Diff and Lag Dependent Variable

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Two areas of research

- 1. Dif-in-dif with panels

- 2. Panels and reverse causality

1. Dif and Diff- Reminders

- (Simplified) Design
  - Two periods:
    - pre-treatment
    - (post-)treatment
  - Two groups:
    - treated
    - control

- With a panel
  - We measure outcomes for the same individuals, before and after
  - We estimate evolution in outcomes

$\Delta y_i = \beta_0 + \beta_1 * TG + \varepsilon_i$ where *TG* is the treated group

- β_1 is the diff-in-diff estimator

- Without panel
  - Individuals before and after are not the same
  - $y_{it} = \beta_0 + \beta_1 * GT + \beta_2 * t + \beta_3 * t * TG + \varepsilon_{it}$
  - β_3 is the diff-in-diff estimator

More than 2 periods?

- Several periods before treatment
  - Enable to test for parallel evolution of treated and control groups before treatment
  - => Do treated and control already diverge before treatement?
  - If answer NO: Better causal proof
- Several periods after treatment
  - Enable to measure the duration of treatment effects

How to do it?

- If all treated units are treated on the same date
- Example periods between t=-2 to t=1 (treatment starts in t=0)

$y_{it} = \beta_0 + \beta_1 * TG$ # TG Dummy

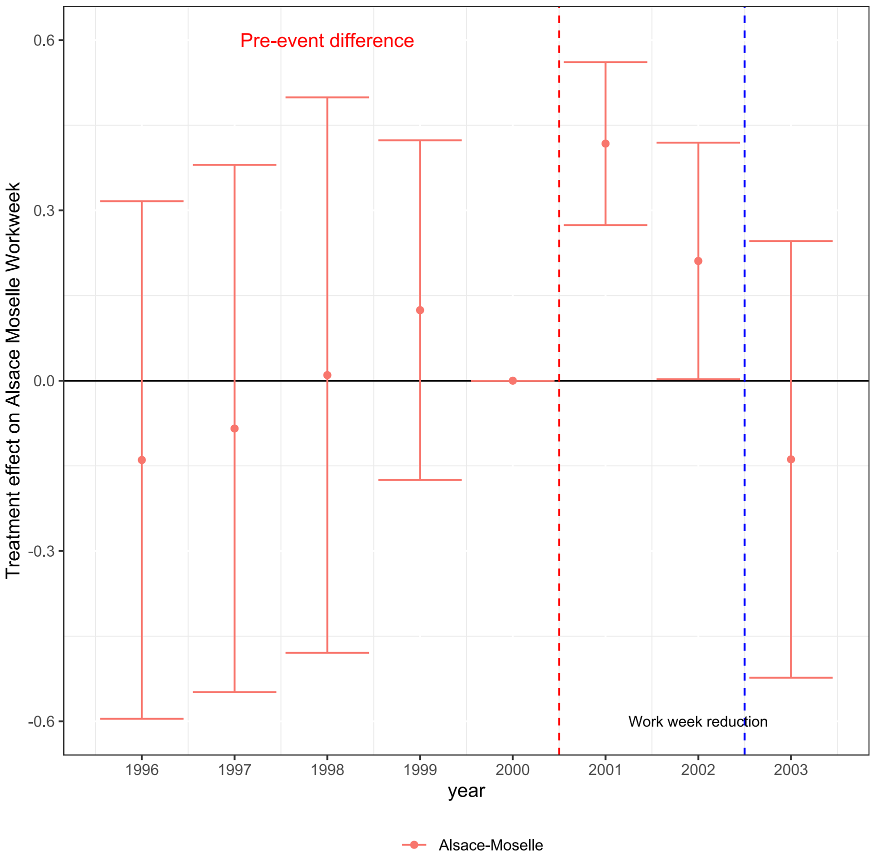
$+ \beta_{-2p} * t_{-2} + \beta_{0p} * t_0 + \beta_{1p} * t_1 +$ # Period Fixed effects

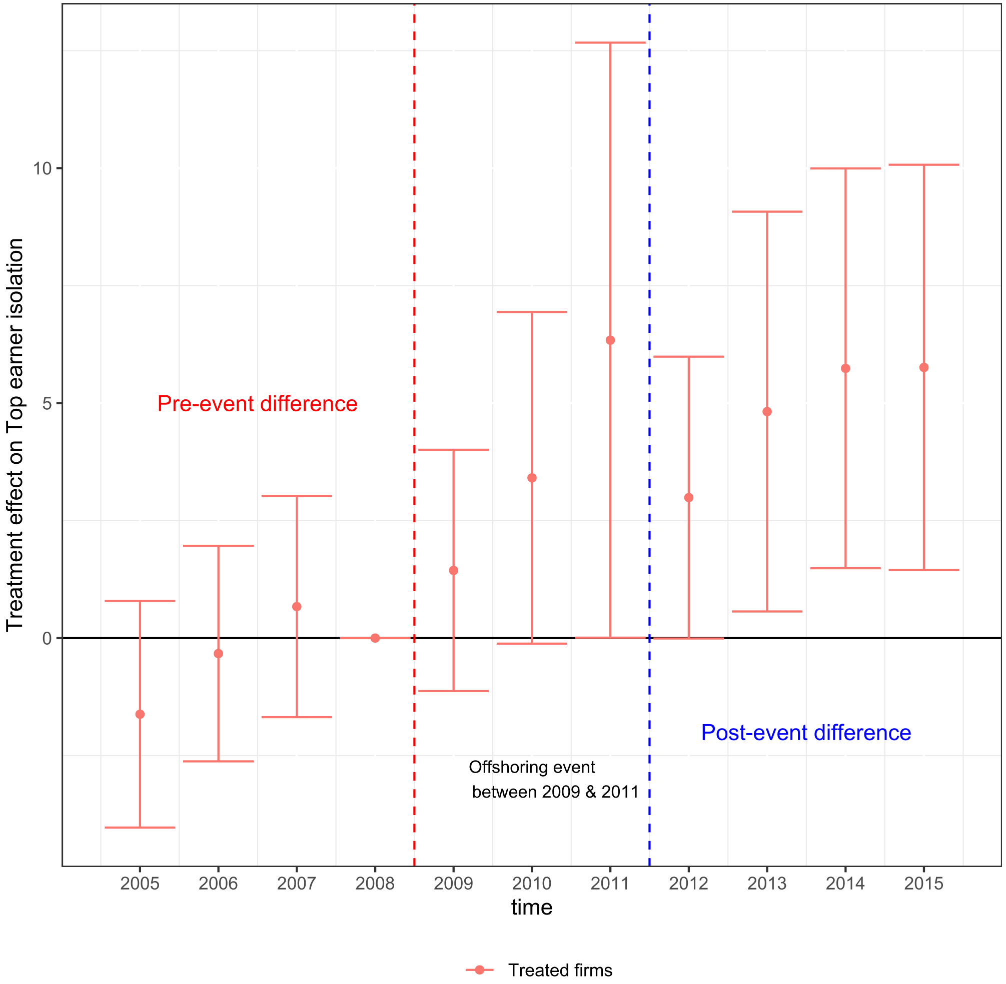
$+ \beta_{-2tg} * t_{-2} * TG$ # Before treatment difference

$+ \beta_{0tg} * t_0 * TG + \beta_{1tg} * t_1 * TG + (i +) \varepsilon_{it}$ # After treatment difference

- (i +) : If it's an individual panel, you can add individual fixed effects
  - Consequence: No treated group dummies
- (t-1) serves as reference period

Figures matter





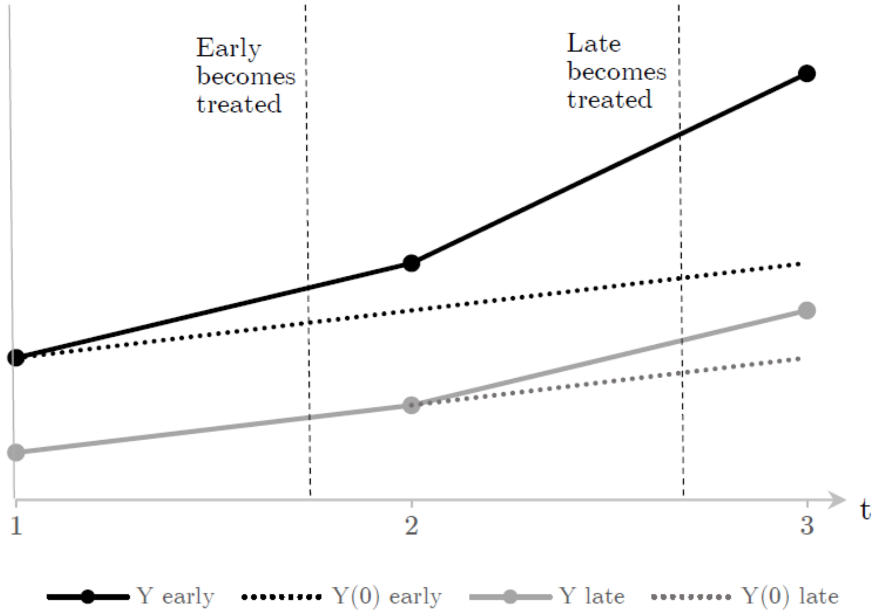
Staggered events

- What happen when the event does not happen at the same period?
- TWFE estimates :
  - Period fixed effects
  - Group (or individual) fixed effects
- Average causal treatment effect: correctly estimated if the treatment effect is **homogeneous** (The same at each period cf. Chaisemartin & D'Haultfoeuille, 2022)

Staggered design and forbidden comparisons

- If heterogeneity in treatment,
- The TWFE estimates can flip sign

Figure 1. A numerical example with three periods, an early and a late treated group

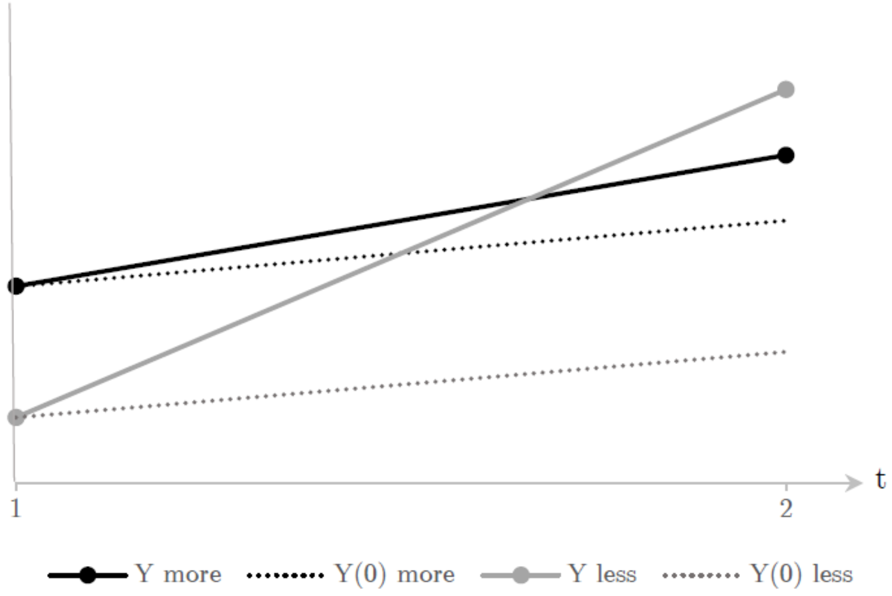


Intensity variation and forbidden comparison

- If heterogeneity in treatment,
- The TWFE estimates can flip sign

TWFE and DID with Heterogeneous Treatment Effects 11

Figure 2. A numerical example with two periods, a more- and a less-treated group



Solution to staggered events

- Stacked regression
  - Cengiz, Dube, Lindner, Zipperer (2019)
- Borusyak et al. (2021)
  - R package: did_imputation
- de Chaisemartin and D'Haultfoeuille (2021a)
  - R package: did_multiplegt
- Other solutions:
  - Sun & Abraham (2021), Callaway & Sant'Anna (2021)

Example

- Ajdacic (*SER*, 2022).
  - Impact of recruitment from alternative finance executives on CEO pays in banks

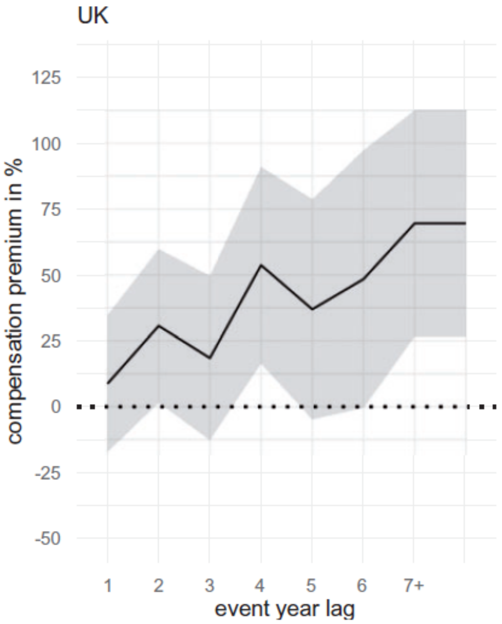


Table 2 Estimations of event effect on compensation levels for the UK

	M1: FE Year		M2: TWFE		M3: S&A DID		M4: Callaway DID	
Predictors	Est.	SE	Est.	SE	Est.	SE	Est.	SE
−6	–	–	–	–	−0.19	0.210	0.16	0.080
−5	–	–	–	–	0.17	0.170	0.09	0.070
−4	–	–	–	–	0.08	0.130	−0.19	0.160
−3	–	–	–	–	0.08	0.080	−0.14	0.140
−2	–	–	–	–	0.21†	0.120	0.06	0.090
−1	–	–	–	–	–	–	−0.22	0.160
0	–	–	–	–	0.28†	0.150	0.31	0.220
1	0.02	0.173	0.08	0.125	0.17	0.140	0.26	0.170
2	0.27	0.179	0.27†	0.139	0.46*	0.200	0.79*	0.250
3	0.34†	0.179	0.17	0.148	0.28	0.220	0.35	0.310
4	0.62**	0.212	0.43*	0.174	0.53†	0.310	0.84	0.550
5	0.50*	0.222	0.31	0.193	0.26	0.300	1.27	0.640
6	0.57*	0.262	0.39†	0.223	–	–	–	–
7+	0.68***	0.163	0.53**	0.198	–	–	–	–
CEO in year	−0.16	0.137	−0.22*	0.086	–	–	–	–
Multiple arrivals	0.25***	0.056	–	–	–	–	–	–
Insurance	0.67***	0.126	–	–	–	–	–	–
Investment companies	−0.24†	0.131	–	–	–	–	–	–
Speciality finance	0.35**	0.114	–	–	–	–	–	–
log(AuM)	0.31***	0.009	–	–	–	–	–	–
N:	933	–	933	–	961	–	961	–
R^2	0.64	–	0.02	–	0.90	–	–	–

2. Panel and reverse causality

- Two-ways FE turn a “level” regression into an “evolution” regression.
  - Accounts for time invariant unobserved heterogeneity
  - Evolution explains evolution
  - Endogeneity still possible
    - Time variant unobserved heterogenity
    - Reverse causality:
      - evolution of dependent variable y could account for evolution of independent variable x

Lagged dependent variable & the Nickell bias

- Idea for taking into account reverse causality: lag dependent variable
- But bias

$y_{it} = \beta_1 + \varrho y_{i,t-1} + X_{it}\,\beta_2 + a_i + u_{it}$ (1)

- We calculate first difference to wipe out a_i

$\Delta y_{it} = \varrho \Delta y_{i,t-1} + \Delta X_{it}\,\beta_2 + \Delta u_{it}$ (2)

- $\Delta y_{i,t-1}$ is not independent from Δu_{it}.
  - $\Delta u_{it} = (u_{it} - \boldsymbol{u_{i,t-1}})$
  - $\Delta y_{it-1} = \varrho \Delta y_{i,t-2} + \Delta X_{it-1}\,\beta_2 + (\boldsymbol{u_{i,t-1}} - u_{i,t-2})$
  - They both depend on $\boldsymbol{u_{i,t-1}}$

Solution to the bias

- Solution 1: Ignore. If T large (>30), Nickell bias converges to 0
  - Cross country panel regression with more that 30 years
- Solution 2: Instrument
  - Estimate first difference regressions
  - Instrument lag dependent variable evolution $(\Delta y_{i,t-1})$ with lag dependent variable past levels $(y_{i,t-2})$

Anderson-Hsiao (1982) solution

- 2SLS instrumental variable
  - 1^{st} *stage:* $\Delta y_{i,t-1} = y_{i,t-2} + \Delta X_{i,t}\, \beta'_2 + \Delta u_{i,t-1}$
  - 2^{nd} *stage:* $\Delta y_{it} = \varrho(\Delta y_{i,t-1})^* + \Delta X_{it}\, \beta_2 + \Delta u_{it}$
- Replacing the endogeneous variable with first stage estimates "solve" the bias $u_{i,t-1}$ is not in $y_{i,t-2}$
- Limits
  - Strong exogeneity hypothesis
    - $y_{i,t-2}$ impacts Δy_{it} only through its impact on $\Delta y_{i,t-1}$
  - We spoil one year ==> first year per individual can not be instrumented and is dropped
  - We don't use a lot of information to instrument

Arellano-Bond (1991) Solution

- Framework similar to Anderson Hsiao
  - $\Delta y_{it} = \varrho(\Delta y_{i,t-1})^* + \Delta X_{it}\, \beta_2 + \Delta u_{it}$
- Different estimation techniques :
  - Moment method
  - More lags used (up to all lags)
  - Possibility to also use $X_{i,t-k}$ to instrument ΔX_{it}
- Limits
  - "Too many instruments" problem
  - Unstable
- Further developments: Bond-Blundell (1998)

Example

- Goldstein, Adam. "Revenge of the managers: Labor cost-cutting and the paradoxical resurgence of managerialism in the shareholder value era, 1984 to 2001." American Sociological Review 77.2 (2012): 268-294.

Table 3. Dynamic GMM Estimates of Managerial Employment Growth

	(log) Number of Managerial Employees in Industry			
	(5)	(6)	(7)	(8)
	1986 to 2001	1986 to 2001	1990 to 2001	1992 to 2001
Constant	.552*	3.619***	3.304***	3.770***
	(.2400)	(.3770)	(.4920)	(.5960)
Controls				
Lagged Number of Managers	.671***	.471***	.425***	.409***
	(.0194)	(.0249)	(.0293)	(.0392)
Profit to Asset Ratio	.00439***	.00316*	.00428**	.00785***
	(.0013)	(.0014)	(.0016)	(.0020)
Lagged Profit to Asset Ratio	.00072	.00127	.000944	–.000438
	(.0014)	(.0014)	(.0016)	(.0020)
Managerial Education	–.00949	–.012	–.0182*	–.0353**
	(.0063)	(.0077)	(.0091)	(.0115)
Proportion Female Managers	.225***	.197***	.185***	.0887
	(.0359)	(.0367)	(.0436)	(.0525)
Total Industry Employment (FTE)	–.161**	–.0402	.0826	.220*
	(.0490)	(.0502)	(.0710)	(.0897)
Industry Output (GDP)	.381***	.223***	.221***	.0738
	(.0446)	(.0488)	(.0619)	(.0750)
Industry Growth Rate (GDP)	.196***	.100	.0423	–.191*
	(.0509)	(.0538)	(.0627)	(.0826)
Lag Weighted Avg. Firm Size (empl.)			.000132*	.000254***
			(.0001)	(.0001)
Theoretical Variables				
Lagged Mergers		.000118*	.0000965	.000123
		(.00006)	(.00006)	(.00007)
Lagged Log Computer Investment		.0400***	.0311***	.0901***
		(.0082)	(.0092)	(.0152)
Lagged % Emp. in Corp. Firms		.0922*	.122*	.150*
		(.0414)	(.0528)	(.0678)
Lagged Union Coverage Rate		–.00970***	–.00920***	–.00571**
		(.0011)	(.0014)	(.0019)
% Holdings Institutional Investors		.0817**	.0991***	.0615
		(.0257)	(.0300)	(.0355)
Lagged Layoff Announcements		.000852	.000736	
		(.0012)	(.0015)	
Lagged Job Displacement Rate				.561*
				(.2520)
Observations	857	857	668	502

Note: Standard errors are in parentheses.
$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$ (two-tailed tests).

References

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- Anderson, Theodore Wilbur, and Cheng Hsiao. "Formulation and estimation of dynamic models using panel data." *Journal of econometrics* 18.1 (1982): 47-82.
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