

# Lecture 6. Difference-in-Difference Estimates

Wei Jiang

## John Snow



Dr. John Snow

<b>Born</b>	15 March 1813 York, England
<b>Died</b>	16 June 1858
<b>Citizenship</b>	British
<b>Fields</b>	epidemiology
<b>Known for</b>	anaesthesia, locating source of a cholera outbreak, thus establishing the link between this infection and water as its vector

## Get to know John Snow

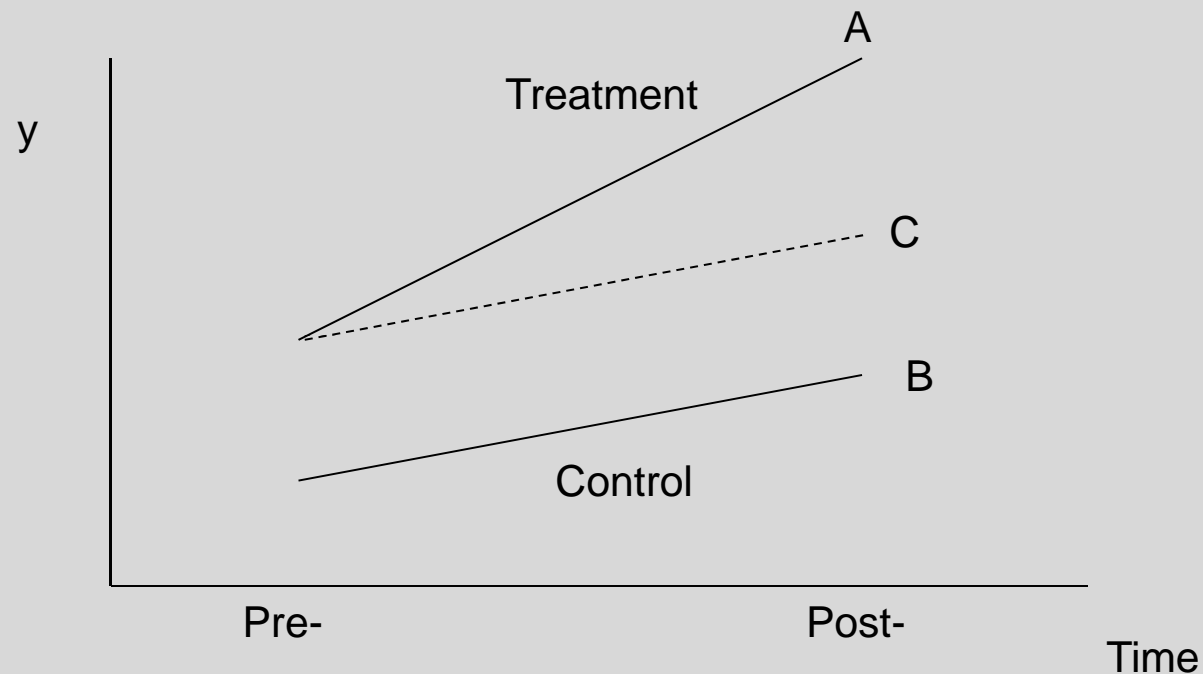
- Before Snow, people blame cholera or the Black Death to “bad air.”
- Snow established its relation to water supply in the 1854 cholera outbreak.
- He used a dif-in-dif method.
- A vegetarian, teetotaler, pure – water-only drinker, life-long celibate.

# The Grand Experiment

- In south London two main companies:
  - Lambeth Company (water supply from Thames Ditton, 22 miles upstream). Changed from Hungerford Bridge in 1852.
  - Southwark and Vauxhall Company (water supply from Battersea Park). In 1855 forced to move to Hampton.

	1849	1853/54	Difference
Lambeth	150	10	-140
Vauxhall and Southwark	125	150	25
Difference	-25	140	-165

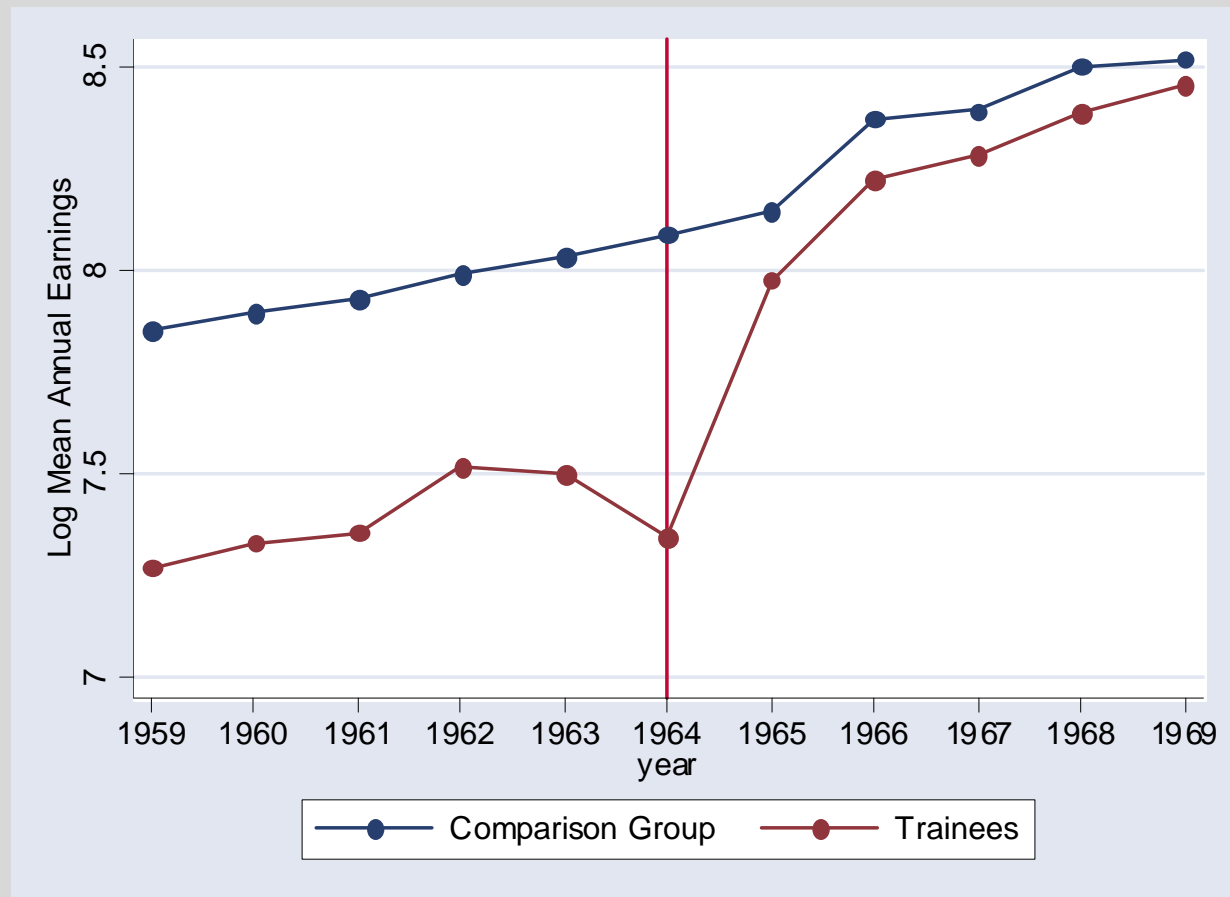
# A Graphical Representation



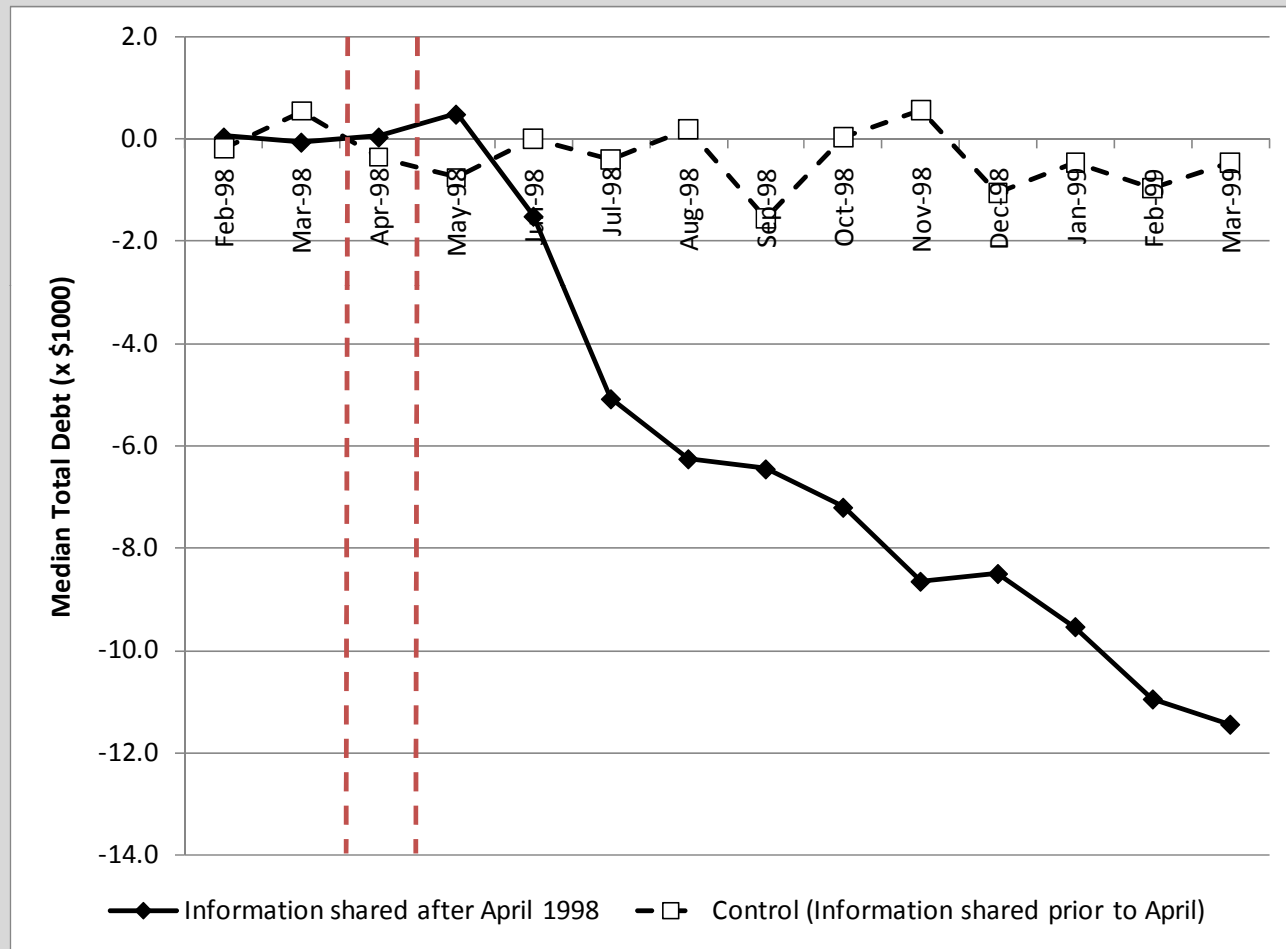
## Assumptions:

- Simple difference: 'treatment' and 'control' group are similar in every way except receipt of treatment.
- Dif-in-Dif: in absence of treatment, difference between 'treatment' and 'control' group is constant over time. How to test this?

# Ashenfelter (REStat, 1978)



# Hertzberg, Liberti, and Paravisini (2008)



# Application: Fan, Rui, and Zhao (2008, JCE)

- In emerging markets, political connections are often useful in getting firms favorable financing.
- In China, loans from state-owned banks represent subsidized financing. Long-term loans more so than short-term ones.
- Shocks to political connections: convicted corruption cases.
  - 846,150 people convicted for corruption during 1997-2002. 2422 at the high level (bureau chief/mayor or above), 98 at very senior level (minister/provincial governor or above).
  - But convictions are endogenous: many believe corruptions get prosecuted only *because* the person already lost political connection.
  - Need an extra layer to make the shocks exogenous.

# High-profile convicted corruptions

Name	Position	Event Day	Sentence Day	Sentence
Wang Huizhong	Vice-Province Governor	20010407	20031229	Death penalty
Liu Jinbao	CEO of Bank Of China (HK)	20030525	20050812	Suspended death penalty
Wang Xuebin	CEO of China Construction Bank	20020111	20031210	12 years of imprisonment
Chen Xitong	CPC Secretary	19950426	19980731	16 years of imprisonment
Xu Penghang	Vice chairman of national defense technology commission	20001011	20001011	Dismissal from the service
Shi Zhaobin	Vice-CPC Secretary	19990818	20010927	Dismissal from the service and CPC
Xu Binsong	Vice-Chairman of Municipality	19980523	19990827	Life imprisonment
Chen Kejie	Chairman of Municipality	20000111	20000731	Death penalty
Liu Zhibin	Vice-Chairman of Municipality	20000319	20020624	15 years of imprisonment
Wang Qinglu	Vice-Chairman of PPCC	20010222	20010222	Dismissal from the service and CPC
Liu Changgui	Vice-Province Governor	20030417	20040430	11 years of imprisonment
Liu Fangren	CPC Secretary & PC Chairman	20030422	20040629	Life imprisonment
Xin Yejiang	Vice-PC Chairman	19961227	19980526	5 years of imprisonment
Jiang Dianwu	Vice-PC Chairman	19971101	19981207	10 years of imprisonment
Chen Weigao	CPC Secretary & PC Chairman	20000301	20030809	Dismissal from CPC
Cong Fukui	Vice-Province Governor	20000627	20010518	Dismissal from the service and CPC
Li Daqiang	Vice-Province Governor	20000925	20000925	Dismissal from the service and CPC
Meng QingPing	Vice-Province Governor	19980410	19991201	10 years of imprisonment
Hu Changqing	Vice-Province Governor	19990808	20000215	Death penalty
Mu TuoXing	Vice-Province Governor	20010321	20011113	Death penalty
Aman.Haji	Vice-Province Governor	20031015	N/A	N/A (Still under investigation)
Li Jiating	Vice CPC Secretary & Province Governor	20010620	20030509	Death penalty
Xu Yunhong	Vice-Province Governor	19990922	20001017	10 years of imprisonment

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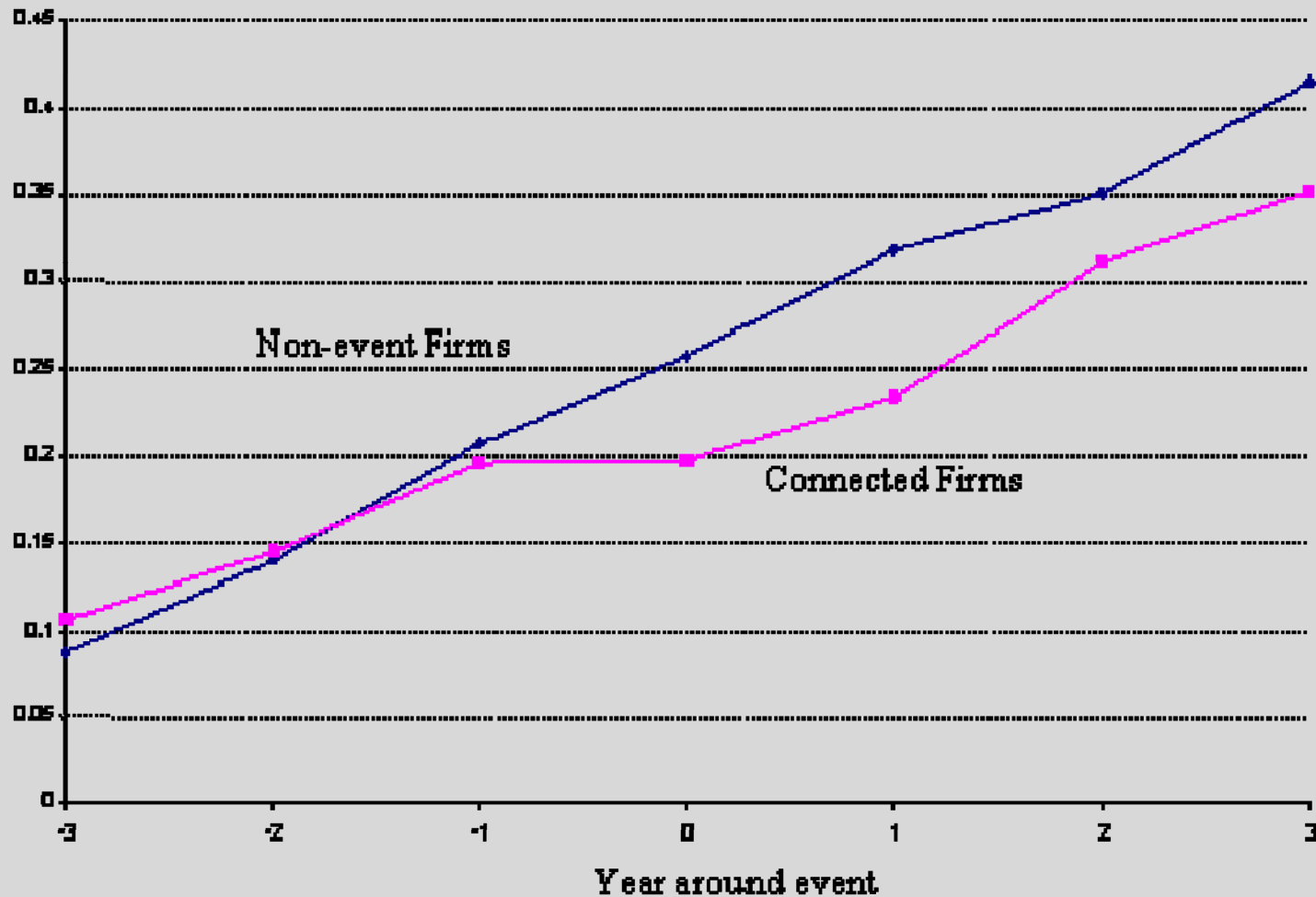


# The extra layer

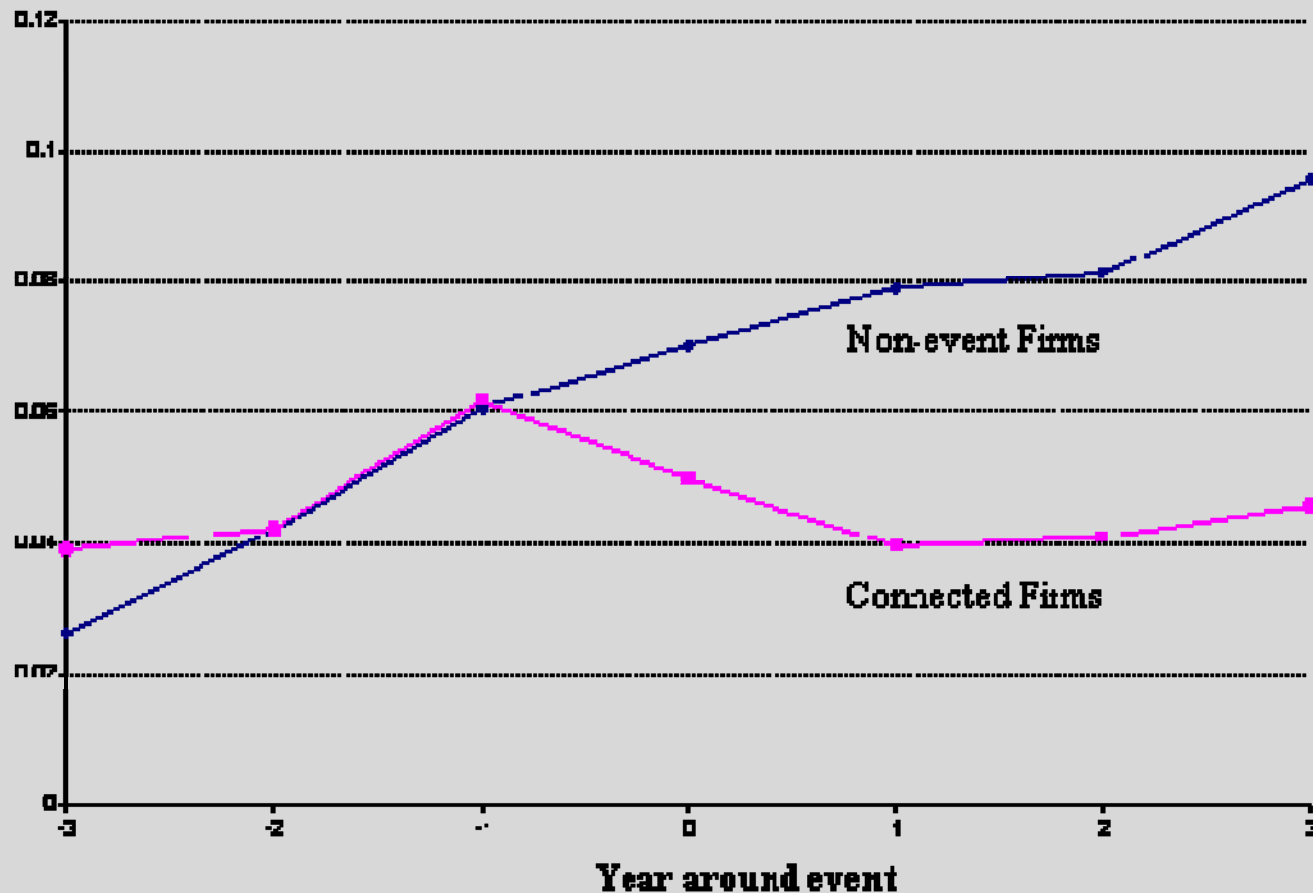
- Event firms:
  - Bribing firms: engaged in bribing the convicted officials.
  - Connected firms: whose senior managers, directors, or large shareholders have prior job affiliation or family relationship with the corrupted bureaucrats. For this group, conviction is a shock.
- Benchmark firms: non-event firms.
  - Firms with similar size with the event firms, geographically located outside the corrupted bureaucrats' jurisdictions.

# Mean Total Debt/Assets

(The connected firms and the non-event firms)



# Mean Long Term Debt/Assets (The connected firms and the non-event firms)



# Notations

- Define:  $\mu_{it} = E(y_{it})$   
where  $i=0$  is control group,  $i=1$  is treatment  
where  $t=0$  is pre-period,  $t=1$  is post-period
- Standard differences estimate of causal effect is:  $\mu_{11} - \mu_{01}$ .
- Dif-in-Dif estimate of causal effect is:  $(\mu_{11} - \mu_{01}) - (\mu_{10} - \mu_{00})$ .
- Equivalent regression:

$$y_{it} = \beta_0 + \beta_1 \text{Treat}_i + \beta_2 \text{Post}_{i,t} + \beta_3 \text{Treat}_i \cdot \text{Post}_{i,t} + \gamma X + \varepsilon_{i,t}$$

$$p \lim \hat{\beta}_0 = \mu_{00}$$

$$p \lim \hat{\beta}_1 = \mu_{10} - \mu_{00}$$

$$p \lim \hat{\beta}_2 = \mu_{01} - \mu_{00}$$

$$p \lim \hat{\beta}_3 = (\mu_{11} - \mu_{01}) - (\mu_{10} - \mu_{00})$$

# Caveat 1: “Unnatural experiments”

- Intervention/treatment is purposeful , anticipating responses.
- Example 1: state takeover law change.  
Treatment effects under-estimated.
- Example 2: loan covenants violation.  
Treatment effects over-estimated.
- Very much need the “treatment” to be an exogenous shock.
  - A weaker assumption: selection only on the level but not on the slope. But such a scenario is difficult to verify.
- Otherwise, a Heckman correction is still needed.

$$\Delta Y_i = \beta \Delta X_i + \gamma Treat_i + \delta \lambda(\hat{\mu}Z) + \varepsilon_i$$

$$Treat_i^* = \mu Z_i + \eta_i$$

## Caveat 2: Control groups

- Control groups are “otherwise” equals:
  - Match along major dimensions.
  - Match by “propensity scores.”
  - Equalizing on pre-treatment outcome levels is often desirable.
- Selection on the observables vs. selections on the unobservables.
  - Outcome = propensity + residual
  - Conditional on outcome, the two components are *negatively* correlated.

## Content of the exam

- Conduct empirical tests to show whether hedge fund activism affects firm performance (you define).
- Must take into account the attrition.
- Methods we have covered so far are adequate for the purpose.
- Data given should allow a meaningful analysis, but you are welcome to retrieve more data from public sources.
- Be very clear about what the possible selection effects are, and how you correct the bias.
- No need to repeat any test in Brav, et al. (2008). The paper did not answer this question.

## Procedure of the exam

- Write up the project as if you are writing a short paper: Abstract, Introduction, Data and Empirical Specification, Results, Conclusion.
- The page limit is 10 pages, double spaced, including tables and charts.
- Conditional on the same content, the shorter, the better!
- Email your course TA everything: write-up (pdf), final data, and codes.
- The codes must be ready to generate the tables reported in your paper, and must be adequately commented.



# Grading rule

- (10) Format of the write-up.
- (10) Motivation and summary of results.
- (20) Formulation of hypothesis.
- (20) Empirical design.
- (20) Empirical execution.
- (10) Interpretation of results.
- (10) Readability of codes.
- The procedure and analysis, but not the particular results, will affect your grade.

# Honor code

- No help from anyone of any type. Except:
  - Seeking help from STATA/SAS/MATLAB professional regarding generic programming questions.
  - Seeking help from the TA for data variable clarification.
- No late submission will be accepted.