

# Economics, CCU

## Weekly Seminar

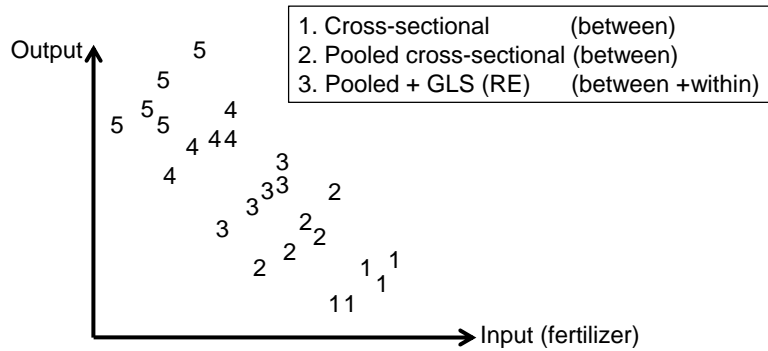
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### Outlines

- Panel Data
- Treatment Effects
- Examples

## Panel Data

- An example: Mundlak (1961)



- Yair Mundlak, 1961, "Empirical Production Function Free of Management Bias," *Journal of Farm Economics* 43(1): 44-56.

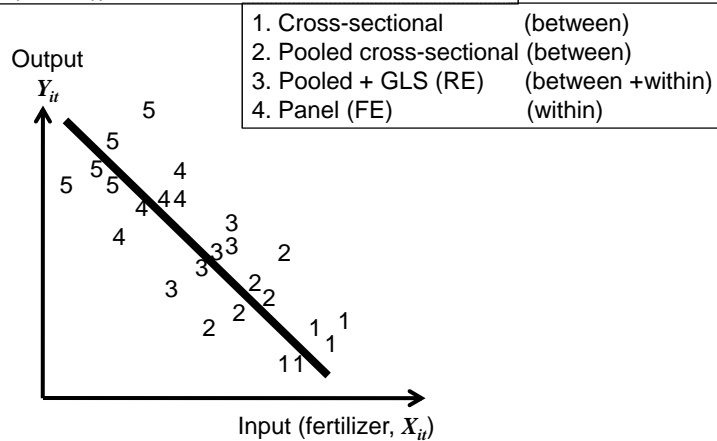
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3

## Mundlak (1961)

$$Y_{it} = \mathbf{x}_{it}\beta + c_i + \varepsilon_{it} \quad i = 1 \dots N; t = 1 \dots T$$



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4

$$E(\mathbf{x}_{it}\varepsilon_{it}) = 0, \text{ or}$$

$$E(\mathbf{x}_{it} (c_i + \varepsilon_{it})) = 0$$

- |                           |                   |
|---------------------------|-------------------|
| 1. Cross-sectional        | (between)         |
| 2. Pooled cross-sectional | (between)         |
| 3. Pooled + GLS (RE)      | (between +within) |
| 4. Panel (FE)             | (within)          |

1.  $Y_i = \mathbf{x}_i\beta + c_i + \varepsilon_i, i = 1, \dots, N$
2.  $Y_{it} = \mathbf{x}_{it}\beta + c_i + \varepsilon_{it}, i = 1, \dots, N; t = 1, \dots, T$
3.  $Y_{it} = \mathbf{x}_{it}\beta + c_i + \varepsilon_{it}, i = 1, \dots, N; t = 1, \dots, T$
4.  $Y_{it} = \mathbf{x}_{it}\beta + c_i + \varepsilon_{it}, i = 1, \dots, N; t = 1, \dots, T$

Examples: $y$	$x$	$c_i$
outputs	fertilizer	soil quality
grades	attendance	motivation

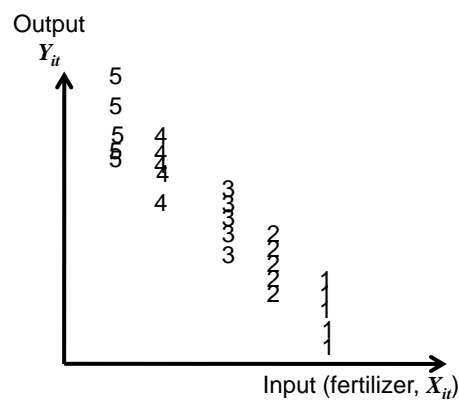
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5

## Fixed or Random Effects?

- Hausman test
- Economic theory
- No variation in  $X_{it}$  (i.e. gender...)?
- RE results are better?



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## Treatment Effects

- A treatment (i.e. drugs, job training program, marriage, college education, class attendance, ..., etc)
- $w$ : treatment (1 or 0)
- Outcomes
  - $Y_1$ : with treatment, and
  - $Y_0$ : without treatment
  - The effect =  $Y_1 - Y_0$
  - Only observe one outcome ( $Y_1$  or  $Y_0$ ) for each subject; missing data, or counterfactual

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7

## Treatment Effects

- The effect =  $Y_1 - Y_0$  is a random variable
- Average treatment effects  
(random experiment effect)  $E(Y_1 - Y_0)$
- Average treatment effects on the treated  
(treatment on the treated effect)  $E(Y_1 - Y_0 | w = 1)$ , or  $E(Y_1 - Y_0 | w = 0)$
- Estimation
  - The key is to obtain some *reasonable* counterfactuals
  - IV's
  - Panel (and difference-in-difference)
  - Matching
  - Propensity score matching
  - Randomized experiments
  - ...

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8

## Examples

- Class attendance effects (Chen & Lin, 2008)
- Recorded lectures effects (Chen & Lin, 2009)

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9

## Class Attendance Effects

- What is the average attendance effect for students who have chosen to attend lectures?
- Find the counterfactuals for attendees (their grades what if they have not attended the lectures)

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10

## Attendance Effects

- Average treatment effects

$$E(Y_1) - E(Y_0)$$

- Average treatment effects on the treated

$$E(Y_1 | d = 1) - E(Y_0 | d = 1)$$

$$E(Y_1 | d = 0) - E(Y_0 | d = 0)$$

$Y_i$ : grade outcomes associated with attending the lecture  
 $Y_o$ : grade outcomes associated with not attending the lecture  
 $d = 1$ , attending the lecture;  $d = 0$ , not attending the lecture

## Literature

- Romer (1993)
- Anikeeff (1954), Schmidt (1983), Jones (1984), Buckalew et al. (1986), Brocato (1989), Park & Kerr (1990), Van Blerkom (1992), Gunn (1993), Durden & Ellis (1995), Devadoss & Foltz (1996), Marburger (2001), Bratti & Staffolani (2002), Dolton (2003), Kirby & McElroy (2003)
- Rodgers (2001), Stanca (2004), Chen (2005), Lin & Chen (2006)

## How to Estimate the Attendance Effects

- Average treatment effects on the treated

$$E(Y_1 | d = 1) - E(Y_0 | d = 1)$$

$$- E(Y_1 | d = 1) - E(Y_0 | d = 0)$$

- IV's
- Panel (and difference-in-difference)
- Matching
- Propensity score matching
- Randomized experiments
- ...

## The Experiment

- $E(Y_1 | d = 1) - E(Y_0 | d = 1)$
- The key: randomly deny the access to the treatments
  - When students come to the door, randomly select some students to come in and ask the rest to leave

## The Experiment (continued)

- Tamkang University
- Industrial Economics Major
- Public Finance
- Spring 2005
- Junior (required course)
- 12 weeks, 2 hours per week

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15

## The Experiment (continued)

- 114 students in 2 sections (67, 47)
- 107 multiple choice questions
- Sample size
  - All sample = 12,028
  - Samples (with Actual Attendance = 1) = 10,919
- Students' exam grades are linked to their attendance records

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16



## Possible Estimation Methods and the Results

- Probit model
  - Without individual effects (OLS)
  - With individual effects (FE)
- Results:
  - $E(Y_1) - E(Y_0) = 5\%$
  - $E(Y_1 | d = 1) - E(Y_0 | d = 1) = 9\% \text{ to } 18\%$

$$y_{ij}^* = \eta r_{ij} + \alpha_i + \gamma_j + \varepsilon_{ij}, \quad \text{and}$$
$$y_{ij} = \begin{cases} 1 & \text{if } y_{ij}^* \geq 0 \\ 0 & \text{if } y_{ij}^* < 0 \end{cases}, \quad i = 1, 2, \dots, I, j = 1, 2, 3, \dots, J.$$

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17

## Online Recorded Lectures

- An example
- Research questions:
  - Do students watch online recorded lectures?
  - What is the relationship between students' individual characteristics and their use of online recorded lectures?
  - When do they use these videos? (right after the lecture, right before exams...)
  - Does watching online recorded lectures improve students' examination performance?

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18

## Online Recorded Lectures

- Average treatment effects
- Previous research:
  - Internet enhancements: Agarwal and Day (1998)
  - Traditional and online courses: Brown and Liedholm (2002)
  - Supplemental online recorded lectures: Flores and Savage (2007) and Savage (2009)
- Fixed effects model

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19

## The Data

- National Chengchi University
- Intermediate Microeconomics (3 classes)
- Fall 2007, Spring 2008
- Most of them are sophomores
- 12 weeks, 3 hours per week
- 312 students
- Sample size 13,490

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20

## Key Variables

- Grades: the percentage of correctness
- Times: the number of times the student accessed recorded lectures
- Watch Video: whether or not the student had accessed online recorded files
- Total minutes: total time, in minutes, the student spent watching recorded lectures
- Before examination: whether or not the student had accessed recorded lectures less than a week before examination
- After lecture: whether or not the student had accessed recorded lectures within a week after a lecture.

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21

**Table 1: Average Class Attendance and Semester Grades**  
(by Number of Times Watching Online Recorded Lectures)

Number of Times	Number of Students	Class Attendance	Semester Grades
0	211	0.6777	72.25
1 - 5	33	0.7273	68.14
6 - 10	22	0.6364	62.33
11 - 15	25	0.6000	70.97
16 - 20	14	0.5714	69.16
21+	7	0.4286	62.15
Total	312		

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22

Table 2: Summary Statistics

Variables	N	Mean	Standard Deviation	Minimum	Maximum
Full Sample					
Attendance	13490	0.7599	0.4272	0.0000	1.0000
Grades	13490	0.6736	0.4212	0.0000	1.0000
Male	13490	0.4098	0.4918	0.0000	1.0000
Times	13490	0.3202	0.7893	0.0000	7.0000
Watch Video	13490	0.1834	0.3870	0.0000	1.0000
Total Minutes	13490	26.722	79.790	0.0000	1053.0
Before the Exam	13490	0.1645	0.3707	0.0000	1.0000
After the Lecture	13490	0.0634	0.2437	0.0000	1.0000
Attendance = 0					
Attendance	3239	0.0000	0.0000	0.0000	0.0000
Grades	3239	0.6300	0.4390	0.0000	1.0000
Male	3239	0.5536	0.4972	0.0000	1.0000
Times	3239	0.4594	0.9510	0.0000	7.0000
Watch Video	3239	0.2485	0.4322	0.0000	1.0000
Total Minutes	3239	40.577	104.40	0.0000	834.00
Before the Exam	3239	0.2186	0.4134	0.0000	1.0000
After the Lecture	3239	0.1099	0.3128	0.0000	1.0000
Attendance = 1					
Attendance	10251	1.0000	0.0000	1.0000	1.0000
Grades	10251	0.6874	0.4145	0.0000	1.0000
Male	10251	0.3644	0.4813	0.0000	1.0000
Times	10251	0.2762	0.7254	0.0000	7.0000
Watch Video	10251	0.1628	0.3692	0.0000	1.0000
Total Minutes	10251	22.345	69.680	0.0000	1053.0
Before the Exam	10251	0.1474	0.3545	0.0000	1.0000
After the Lecture	10251	0.0487	0.2152	0.0000	1.0000

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23

Table 3: Pearson Correlation Coefficients for Attendance, Grades, Online Video Usage, and Other Variables

Variables	Attendance	Grades	Male	Times	Watch Video	Total Minutes	Before the Exam	After the Lecture
Attendance	1							
Grades	0.0582**	1						
Male	-0.1643**	-0.0423**	1					
Times	-0.0991**	-0.0007	0.0164**	1				
Watch Video	-0.0946**	-0.0142*	0.0165**	0.8559**	1			
Total Minutes	-0.0976**	-0.0121	-0.0139	0.7531**	0.7059**	1		
Before the Exam	-0.0820**	-0.0198**	0.0319**	0.7892**	0.9362**	0.6508**	1	
After the Lecture	-0.1073**	-0.0666**	-0.0051	0.4171**	0.5489**	0.3599**	0.4935**	1

Note: Number of observations: 13,490. \*\*\* at 5% and \*\* at 10% significant level.

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24

Table 4: The Effects of Supplemental Online Recorded Lectures

Independent Variable	OLS							Fixed Effects						
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)
(1) Attendance	0.0591** (0.0077)	0.0616** (0.0078)	0.0611** (0.0078)	0.0672** (0.0086)	0.0655** (0.0082)	0.0706** (0.0088)	0.0709** (0.0088)	0.0151* (0.0092)	0.0170* (0.0092)	0.0159* (0.0092)	0.0189* (0.0099)	0.0192** (0.0096)	0.0212** (0.0101)	0.0217** (0.0101)
(2) Watch video		0.0235** (0.0105)							0.0389** (0.0118)					
(3) Watch video right after lecture			0.0319* (0.0177)	0.0351* (0.0086)	0.0631** (0.0251)	0.0272 (0.0770)	0.0392 (0.0278)			0.0007 (0.0171)	0.0019 (0.0173)	0.0218 (0.0238)	-0.0017 (0.0173)	0.0126 (0.0267)
(4) Watch video right before exam			0.0042 (0.0114)	0.0229 (0.0156)	0.0041 (0.0114)	0.0407** (0.0185)	0.0353* (0.0203)			0.0340** (0.0125)	0.0421** (0.0159)	0.0336** (0.0125)	0.0531** (0.0191)	0.0468** (0.0213)
(5) Interaction Term (1)*(2)				-0.0289* (0.0165)							-0.0130 (0.0166)			
(6) Interaction Term (1)*(3)					-0.0495* (0.0279)		-0.0181 (0.0321)					-0.0338 (0.0268)		-0.0218 (0.0309)
(7) Interaction Term (1)*(4)						-0.0484** (0.0194)	-0.0414* (0.0222)						-0.0254 (0.0196)	-0.0173 (0.0226)
R-squared	0.2763	0.2766	0.2766	0.2768	0.2768	0.2770	0.2770	0.3596	0.3602	0.3601	0.3601	0.3602	0.3602	0.3602
Sample Size	13,490	13,490	13,490	13,490	13,490	13,490	13,490	13,490	13,490	13,490	13,490	13,490	13,490	13,490

Note: Dependant variable is percentage correctly answer the question. The exam question dummies are included in all regressions. \*\*\*\* is significant at 5% and \*\*\* is significant at 10% type I error level. White (1980) robust standard errors are in parentheses.

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## Results

- Males, and all students who skip relatively more classes, are more likely to use online recorded lectures
- Most students access online recorded lectures just before examinations, rather than just after the lectures
- Fixed effects model shows a significant and positive effect of using online recorded lectures on students' learning outcomes

## Conclusions and Future Research

- Panel data method is useful, and the concept of treatment is important
- Future research
  - More courses
  - e-learning
  - Other suggestions...