Ec140 - Randomized Controlled Trials

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07/05/2022

Housekeeping

- Midterm this Thursday at class time (8:10) in the this classroom. DSP accommodations at Evans ...
  - Material covered up to tomorrow. But questions on hypothesis testing will only measure general understanding of class material.
  - Everything else follow the practice test as a (very) close example of questions you will see in the midterm (and exam).
- Address question on how to interpret $Avg(Y_{0,i}|D_i = 1)$.

National Health Interview Survey, 2009 (MM, Ch1)

TABLE 1.1
Health and demographic characteristics of insured and uninsured couples in the NHIS

	Husbands			Wives		
	Some HI (1)	No HI (2)	Difference (3)	Some HI (4)	No HI (5)	Difference (6)
A. Health						
Health index	4.01 [.93]	3.70 [1.01]	.31 (.03)	4.02 [.92]	3.62 [1.01]	.39 (.04)
B. Characteristics						
Nonwhite	.16	.17	−.01 (.01)	.15	.17	−.02 (.01)
Age	43.98	41.26	2.71 (.29)	42.24	39.62	2.62 (.30)
Education	14.31	11.56	2.74 (.10)	14.44	11.80	2.64 (.11)
Family size	3.50	3.98	−.47 (.05)	3.49	3.93	−.43 (.05)
Employed	.92	.85	.07 (.01)	.77	.56	.21 (.02)
Family income	106,467	45,656	60,810 (1,355)	106,212	46,385	59,828 (1,406)
Sample size	8,114	1,281		8,264	1,131	

Notes: This table reports average characteristics for insured and uninsured married couples in the 2009 National Health Interview Survey (NHIS). Columns (1), (2), (4), and (5) show average characteristics of the group of individuals specified by the column heading. Columns (3) and (6) report the difference between the average characteristic for individuals with and without health insurance (HI). Standard deviations are in brackets; standard errors are reported in parentheses.

National Health Interview Survey, 2009 (MM, Ch1)

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Education	14.31	11.56	2.74 (.10)	14.44	11.80	2.64 (.11)
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Selection Bias in Simple Difference of Groups

$$\mathbb{E}(\textbf{Difference in group means}) = \kappa + \underbrace{\mathbb{E}(Y_{i0}|D_i = 1) - \mathbb{E}(Y_{i0}|D_i = 0)}_{\textbf{Selection bias}}$$

- How can we make selection bias disapear?
- How can we $\mathbb{E}(Y_{i0}|D_i = 1) = \mathbb{E}(Y_{i0}|D_i = 0)$
- What is the definition of independence we are using in this class?

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- How can we make selection bias disapear?
- How can we make $\mathbb{E}(Y_{i0}|D_i = 1) = \mathbb{E}(Y_{i0}|D_i = 0)$?
- We need D to be independent of the potential outcomes $(Y_0$ and $Y_1)$.
- We achieve this by randomly assigning intervention (D).

Randomized Experiments 1/2

- Often called **R**andomized **C**ontrolled **T**rials (RCT).
- The first known RCTs happen in 1731! Then mainly conducted in Medicine (18th and 19th century).
- In the beginning of the 20th century they were popularized by famous statisticians like **J. Neyman** or **R.A. Fisher**.
- Since then they have had a growing influence and have progressively become a reliable tool for public policy evaluation.
- As for economics, the **2019 Nobel Price in Economics** was awarded to three exponents of RCTs, Abhijit Banerjee, Esther Duflo and Michael Kremer, "for their

Randomized Experiments 2/2

- First **research design** tool that we use in class to measure causality (one of what MM calls the Furious Five)
- Simple in logic, very challenging in logistics
- Illustrate with three examples

Example 1: RAND Health Insurance Experiment (HIE)

- One of the first, and most influential, RCTs in social science.
- Intervention: different types of health insurance with varying degrees of generosity.
- Designed to measure how responsive is health care use to health care costs (aka elasticity of demand for healthcare).
- 1974 - 1982.
- N = ~4000 (3,958).
- Population between 14 - 61, non medicare, non medicaid, non military.
- 6 areas of the US.

The Importance of Logistics in the HIE

- Very expensive (Over $300 million in today dollars).
- Overly complex types of intervention threatend the validity of the study (14 type intervention).
- Control group: 95% coinsurance (individual pays 95%, insurance pays 5%) hits a limit of $1000 dollars (~4000 in today dollars).
- Understanding the control group is key when thinking about policies regarding the treatment and the population of interest (more on this in our external validity class).
- Not-so random assignment.
- Differential attrition between treatments and controls.
- With all these caveats, we can still see the power of randomization at work.

Looking for Balance in HIE

TABLE 1.3
Demographic characteristics and baseline health in the RAND HIE

	Means	Differences between plan groups			
	Catastrophic plan (1)	Deductible – catastrophic (2)	Coinsurance – catastrophic (3)	Free – catastrophic (4)	Any insurance – catastrophic (5)
A. Demographic characteristics					
Female	.560	−.023	−.025	−.038	−.030
		(.016)	(.015)	(.015)	(.013)
Nonwhite	.172	−.019	−.027	−.028	−.025
		(.027)	(.025)	(.025)	(.022)
Age	32.4	.56	.97	.43	.64
	[12.9]	(.68)	(.65)	(.61)	(.54)
Education	12.1	−.16	−.06	−.26	−.17
	[2.9]	(.19)	(.19)	(.18)	(.16)
Family income	31,603	−2,104	970	−976	−654
	[18,148]	(1,384)	(1,389)	(1,345)	(1,181)
Hospitalized last year	.115	.004	−.002	.001	.001
		(.016)	(.015)	(.015)	(.013)
B. Baseline health variables					
General health index	70.9	−1.44	.21	−1.31	−.93
	[14.9]	(.95)	(.92)	(.87)	(.77)
Cholesterol (mg/dl)	207	−1.42	−1.93	−5.25	−3.19
	[40]	(2.99)	(2.76)	(2.70)	(2.29)
Systolic blood pressure (mm Hg)	122	2.32	.91	1.12	1.39
	[17]	(1.15)	(1.08)	(1.01)	(.90)
Mental health index	73.8	−.12	1.19	.89	.71
	[14.3]	(.82)	(.81)	(.77)	(.68)
Number enrolled	759	881	1,022	1,295	3,198

Notes: This table describes the demographic characteristics and baseline health of subjects in the RAND Health Insurance Experiment (HIE). Column (1) shows the average for the group assigned catastrophic coverage. Columns (2)–(5) compare averages in the deductible, cost-sharing, free care, and any insurance groups with the average in column (1). Standard errors are reported in parentheses in columns (2)–(5); standard deviations are reported in brackets in column (1).

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Looking for Balance in HIE

- Differences are smaller in magnitude than NHIS.
- They are also non-systematic.
- But how can we tell more precisely when the differences between two groups are due to sample variation or true underlying differences?
  - We need statistical inference for this. Will do a brief review of the starting point of statistical inference, hypothesis testing, next class.
- For now let's just go with the -dangerous but commonly used- rule of thumb of the difference being greater than 2 times their standard errors (will explain its rationale and dangers next class).

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Example #2: Balancing Observables and Unobservables

- Let's first split the class into two groups, front of the class (F) and back of the class (B).
- Now let's look at some demographics: gender (1 female, 0 non-female). From CA, not from CA (including international).
- Now each of you draw a die, two groups: "3 or less" and the "4 or more". Check for the same demographics.

- The LLN applies to **all** variables, observable and unobservable.
- For example I could ask which fraction of each group hates this class. I do not know that fraction (as I do not know much of the other things that I would like to be equal, represented by Y_0).
- What I do know, is that this fraction is the same in each group (as n grows large).

- Two reasons why this might not work:

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- Two reasons why this might not work: (1) Small n, or (2) students seat in an "almost random fashion"

Back to the Results of the HIE

TABLE 1.4
Health expenditure and health outcomes in the RAND HIE

	Means	Differences between plan groups			
	Catastrophic plan (1)	Deductible – catastrophic (2)	Coinsurance – catastrophic (3)	Free – catastrophic (4)	Any insurance – catastrophic (5)
A. Health-care use					
Face-to-face visits	2.78 [5.50]	.19 (.25)	.48 (.24)	1.66 (.25)	.90 (.20)
Outpatient expenses	248 [488]	42 (21)	60 (21)	169 (20)	101 (17)
Hospital admissions	.099 [.379]	.016 (.011)	.002 (.011)	.029 (.010)	.017 (.009)
Inpatient expenses	388 [2,308]	72 (69)	93 (73)	116 (60)	97 (53)
Total expenses	636 [2,535]	114 (79)	152 (85)	285 (72)	198 (63)
B. Health outcomes					
General health index	68.5 [15.9]	−.87 (.96)	.61 (.90)	−.78 (.87)	−.36 (.77)
Cholesterol (mg/dl)	203 [42]	.69 (2.57)	−2.31 (2.47)	−1.83 (2.39)	−1.32 (2.08)
Systolic blood pressure (mm Hg)	122 [19]	1.17 (1.06)	−1.39 (.99)	−.52 (.93)	−.36 (.85)
Mental health index	75.5 [14.8]	.45 (.91)	1.07 (.87)	.43 (.83)	.64 (.75)
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Notes: This table reports means and treatment effects for health expenditure and health outcomes in the RAND Health Insurance Experiment (HIE). Column (1) shows the average for the group assigned catastrophic coverage. Columns (2)–(5) compare averages in the deductible, cost-sharing, free care, and any insurance groups with the average in column (1). Standard errors are reported in parentheses in columns (2)–(5); standard deviations are reported in brackets in column (1).

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Back to the Results of the HIE

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Back to the Results of the HIE

- Read results: show how increasing coverage increases expenses. Link back to definition of conditional expectations.
- Explain how evidence shows that expenses went up, in a consistent way with our intuitions: cheaper healthcare led to more consumption of it, and response was bigger among outpatients than inpatient.

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Back to the Results of the HIE (Notes)

- Increasing coverage increases expenses. Link back to definition of conditional expectations.
- Evidence shows that expenses went up, in a consistent way with our intuitions: cheaper healthcare led to more consumption of it, and response was bigger among outpatients than inpatient.
- The HIE provides credible evidence that highly subsidized HI leads to more utilization but not to better health *in a population representative of Americans 14-61, mostly not poor, not military, in the early 80s, that do have catastrophic health insurance, between 3-5 years after enrollment.*
- Ideally today we could measure the effects of HI over a much better health indicator, like life expectancy, unfortunately the follow up records were destroyed after a few years, due to an agreement with the survey company (NORC) probably related to issues of confidentiality. This again highlights the importance of logistics in an RCT (they forgot to think about 40 years in the future in 1979!)
- **Today's uninsured (in the US) are younger, less educated, poorer, and less likely to be working than the population of**

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Example #3: Orengon Health Plan (OHP) RCT 1/2

- How about a population that is more relevant to current policy debates (in the US)?
- Expanding Medicaid leads to less costs? Does it improve health?
- Oregon implemented an RCT unintentionally when they decided to expand Medicaid to a broader population.
- This expansion of the Oregon Health Plan (OHP) was later studied to learn about use of medical services and health outcomes.

Example #3: Orengon Health Plan (OHP) RCT 2/2

- Year: 2008
- Population:
  - Residents of Oregon
  - Under the poverty line and not eligible for Medicaid (non-disabled, non-children, non-pregnant)
  - $n = 75,000$; $30,000$ into an "invitation" treatment.

Results from the OHP RCT

TABLE 1.5
OHP effects on insurance coverage and health-care use

Outcome	Oregon		Portland area	
	Control mean (1)	Treatment effect (2)	Control mean (3)	Treatment effect (4)
A. Administrative data				
Ever on Medicaid	.141	.256 (.004)	.151	.247 (.006)
Any hospital admissions	.067	.005 (.002)		
Any emergency department visit			.345	.017 (.006)
Number of emergency department visits			1.02	.101 (.029)
Sample size	74,922		24,646	
B. Survey data				
Outpatient visits (in the past 6 months)	1.91	.314 (.054)		
Any prescriptions?	.637	.025 (.008)		
Sample size	23,741			

Notes: This table reports estimates of the effect of winning the Oregon Health Plan (OHP) lottery on insurance coverage and use of health care. Odd-numbered columns show control group averages. Even-numbered columns report the regression coefficient on a dummy for lottery winners. Standard errors are reported in parentheses.

Results from the OHP RCT

TABLE 1.6

OHP effects on health indicators and financial health

Outcome	Oregon		Portland area	
	Control mean (1)	Treatment effect (2)	Control mean (3)	Treatment effect (4)
A. Health indicators				
Health is good	.548	.039 (.008)		
Physical health index			45.5	.29 (.21)
Mental health index			44.4	.47 (.24)
Cholesterol			204	.53 (.69)
Systolic blood pressure (mm Hg)			119	−.13 (.30)
B. Financial health				
Medical expenditures >30% of income			.055	−.011 (.005)
Any medical debt?			.568	−.032 (.010)
Sample size	23,741		12,229	

Notes: This table reports estimates of the effect of winning the Oregon Health Plan (OHP) lottery on health indicators and financial health. Odd-numbered columns show control group averages. Even-numbered columns report the regression coefficient on a dummy for lottery winners. Standard

Results from the OHP RCT (Notes)

- First: not all who won the lottery got insurance. So the first thing to look at is the effect of winning the lottery on getting insurance (Medicaid).
- Second, the results show higher utilization of healthcare ss. Problematically, one of the most expensive ones, like emergency visits. After a couple of years since the invitation. It also shows improvements on health, particularly on mental health.
- Both the HIE and OHP suggest no causal effect of HI on physical health in the short run. Both show more utilization. OHP shows improvements on mental health and financial stability (also in the short run). Two, or more, studies finding similar results are much more persuasive than any single study showing a particular result.
- One final issue with the second RCT is that not everybody who was invited ended up receiving the most relevant treatment (HI). Hence the effect of winning on utilization and health are basically pooling a bunch of zeros for those invited that did not get HI, and a larger effect (both in emergency use and in mental health) over those invited that did receive the health insurance treatment. We will learn how to separate these two effects once we study Regression and Instrumental Variables.

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