Econometrics

Randomized Trials

Lec. **A1**

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Healthcare Issues in the U.S.

- ✔ The U.S. healthcare system is marked by **fragmentation**, lacking a unified approach.
- ✔ Despite allocating a significant portion of its GDP to healthcare, the U.S. experiences disparities in health outcomes compared to other developed nations.
- ✔ Unequal access to healthcare services persists, particularly for uninsured individuals who often resort to emergency departments for primary care.
- ✔ While programs like **Medicare** and **Medicaid** provide coverage for specific demographics, the absence of a universal health insurance scheme leaves gaps in coverage.
- ✔ Ongoing debates surround the need for a universal health insurance scheme to address disparities and ensure comprehensive coverage for all.

Affordable Care Act (ACA)

- ✔ The **Affordable Care Act (ACA or Obamacare)** is a policy innovation that requires Americans to buy health insurance, with a tax penalty for those who don't comply.
- ✔ But this plan proved to be controversial since:
  1. ACA's contentious mandate for compulsory health insurance and associated levies,
  2. controversies regarding the government's role in healthcare, including a lack of a universal health insurance scheme,
  3. disparities in healthcare spending and outcomes, fueling ongoing debates about the overall effectiveness of the ACA.

Posing a Cause-and-Effect Question

Q Does health insurance necessarily improve overall health status?

✔ Establishing a direct causal relationship between health insurance and health is multifaceted and complex.

- ✗ Observing individuals with and without insurance simultaneously and in the exact circumstances is practically challenging. (**counterfactual problem**)
- ✗ The self-selection process of choosing insurance can be problematic. (**selection bias**)

Counterfactual

Counterfactual refers to a **hypothetical and unobservable scenario** that contrasts with the observed reality. It represents the alternative situation or outcome that **would have occurred** if a specific condition, event, or exposure had not taken place.

Khuzdar & Maria's Insurance Case

- ✔ Consider two individuals, Khuzdar and Maria. They are faced with decisions regarding health insurance, and their choices may have implications for their overall health outcomes.

- ✔ Their choice is summarized by the following table: (Y denotes *health status*)

Outcomes and treatments for Khuzdar and Maria

i =	Khuzdar	, Maria
Potential outcome without insurance: Y_{0i}	3	5
Potential outcome with insurance: Y_{1i}	4	5
Treatment (insurance status chosen): D_i	1	0
Actual health outcome: Y_i	4	5
Treatment effect: $Y_{1i} - Y_{0i}$	1	0

- ✔ So based on the table, Khuzdar paid for insurance, but Maria didn't.

Khuzdar & Maria's Insurance Case (cont'd)

✔ The comparison between Khuzdar (K) and Maria's (M) choices is written by:

$$Y_K - Y_M = Y_{1,K} - Y_{0,M}$$

$$\xrightarrow{\pm Y_{0,K}} \underbrace{\left(Y_{1,K} - Y_{0,K}\right)}_{\text{c-effect on } K} + \underbrace{\left(Y_{0,K} - Y_{0,M}\right)}_{\textbf{selection bias}}$$

✔ To **generalize** the comparison mentioned above to a sample size of n (rather than just between two individuals), and assuming that individuals purchasing insurance are healthier by a factor of κ, we have:

$$Y_{1i} - Y_{0i} = \kappa \tag{1}$$

$$E\big(Y_{1i}|D_i = 1\big) - E\big(Y_{0i}|D_i = 0\big)$$

$$= \kappa + \underbrace{\Big(E\big(Y_{0i}|D_i = 1\big) - E\big(Y_{0i}|D_i = 0\big)\Big)}_{\textbf{selection bias}} \tag{2}$$

Comparison with NHIS Data

✔ Try to specify the average causal effect in this table. Why is it hard to do so?

	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	

This table reports average characteristics for insured and uninsured married couples in the 2009 National Health Interview Survey (NHIS)

Random Assignment

Randomized Trials

Randomized trials are experimental studies that randomly assign participants to treatment and control groups. This randomization helps **eliminate selection bias**, ensuring groups are comparable.

✔ By assessing outcomes between groups, researchers aim to establish causal relationships and measure the treatment's effectiveness.

Q But what is the root of randomized trials magic?

A It is originated from the **Law of Large Numbers (LLN)**.

The Law of Large Numbers (LLN)

The LLN characterizes the behavior of sample averages in relation to sample size. Specifically, the LLN says that a sample average can be brought as close as we like to the average in the population from which it is drawn simply by enlarging the sample.

Random Assignment (cont'd)

- ✔ Because randomly assigned treatment and control groups come from the same underlying population, they are the same in every way. Meaning:

$$E(Y_{0i}|D_i = 1) = E(Y_{0i}|D_i = 0) \tag{3}$$

- ✔ So, based on equations (2) and (3), it could be derived that:

$$E(Y_{1i}|D_i = 1) - E(Y_{0i}|D_i = 0) = \kappa \tag{4}$$

- ✔ Thus, the effect of selection bias has been neutralized.
- ✔ Also, always check whether treatment and control groups indeed look similar. (**checking for balance**)

Comparison with RAND HIE Data

- ✔ Try to check for balance between groups in this table.
- ✔ Do the same for the NHIS table. What did you find out?

	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

This table describes the demographic characteristics and baseline health of subjects in the RAND Health Insurance Experiment (HIE)

RAND HIE v.s. OHP

- ✔ The **RAND Health Insurance Experiment (HIE)** was a large-scale experiment conducted from 1974 to 1982, aiming to assess the impact of different health insurance plans on healthcare costs and health outcomes. It involved middle-class families and randomly assigned participants to various insurance plans with different coverage levels, including comprehensive care and catastrophic coverage.

- ✔ The **Oregon Health Plan (OHP)** Lottery, conducted in 2008, was not originally designed for research but provided a unique opportunity to study the effects of expanding **Medicaid** through random assignment. Approximately 75,000 low-income individuals entered the lottery, with 30,000 (treatment) randomly selected as winners who could apply for OHP coverage.

OHP Data: Likelihood of Insurance

Q Are OHP lottery winners more likely to end up insured as a result of winning based on the following table?

	Oregon		Portland area	
Outcome	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			

This table reports estimates of the effect of winning the Oregon Health Plan (OHP) lottery on insurance coverage and use of health care

OHP Data: Health Effects

Q Was the health effect of lottery winners statistically significant?

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	

This table reports estimates of the effect of winning the Oregon Health Plan (OHP) lottery on health indicators and financial health

Results

- ✔ The RAND and Oregon findings are remarkably similar.
- ✔ Two ambitious experiments targeting substantially different populations.
- ✔ The use of health-care services increases sharply in response to insurance coverage, while neither experiment reveals much of an insurance effect on physical health.
- ✔ These studies suggest that subsidized public health insurance should not be expected to yield a dramatic health dividend.

Wrap-Up

MASTER JOSHWAY: In a nutshell, please, Grasshopper.

GRASSHOPPER: Causal inference compares potential outcomes, descriptions of the world when alternative roads are taken.

MASTER JOSHWAY: Do we compare those who took one road with those who took another?

GRASSHOPPER: Such comparisons are often contaminated by selection bias, that is, differences between treated and control subjects that exist even in the absence of a treatment effect.

MASTER JOSHWAY: Can selection bias be eliminated?

GRASSHOPPER: Random assignment to treatment and control conditions eliminates selection bias. Yet even in randomized trials, we check for balance.

MASTER JOSHWAY: Is there a single causal truth, which all randomized investigations are sure to reveal?

GRASSHOPPER: I see now that there can be many truths, Master, some compatible, some in contradiction. We therefore take special note when findings from two or more experiments are similar.

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