

FLS 6441 - Methods III: Explanation and Causation

Week 1 - Review

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Section 1

Explanation

Explanation

- What does it mean to explain something?

Explanation

- ▶ What does it mean to explain something?
- ▶ To give an account of what happens, *and why*
 - ▶ The 'chain of causation'

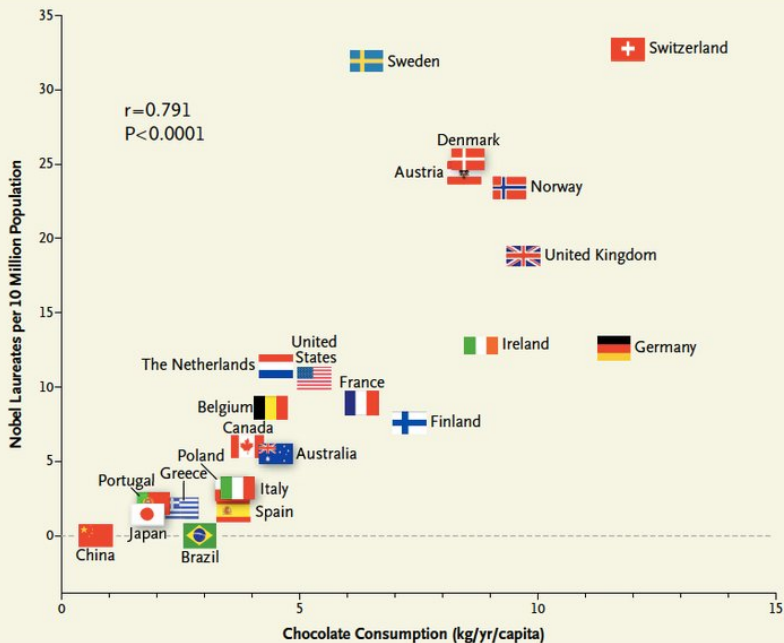


Figure 1 Correlation between Countries' Annual Per Capita Chocolate Consumption and the Number of Nobel

Explanation

- Why isn't correlation enough?

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 - ▶ For **prediction**, correlation is fine: If we know a country has chocolate consumption of 10kg/yr/capita we can reasonably predict it will have about 25 Nobel Laureates

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 - ▶ But for **intervention**, correlation does not help: forcing people to eat more chocolate does nothing on its own to produce more Nobel Laureates
 - ▶ For **explanation**, correlation also fails - it is no *explanation* to say that Switzerland has the most Nobel Laureates because it has the highest chocolate consumption

Explanation

- ▶ Two perspectives on explanation:

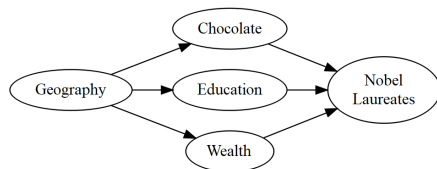
Explanation

- Two perspectives on explanation:

Causes of Effects	Effects of Causes
What caused Y?	Does D cause Y?
Why does Switzerland have so many Nobel laureates?	Does chocolate cause more Nobel laureates?

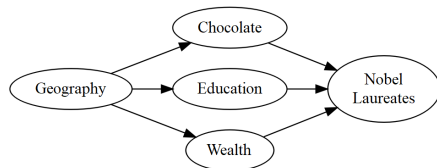
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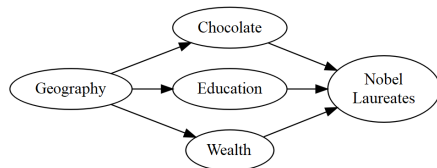
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- Identifying the source of **ALL** of the variation in Nobel Laureates

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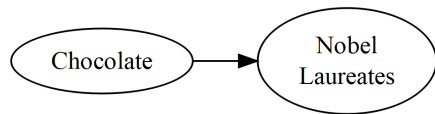
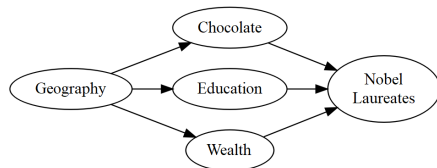
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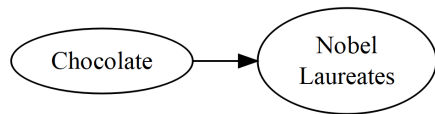
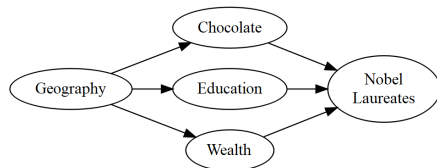
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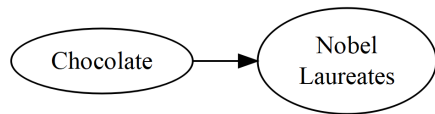
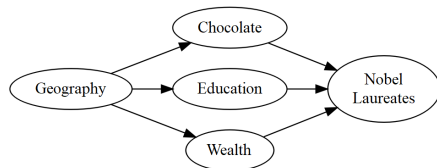
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Explanation

- ▶ Two perspectives on explanation:



- ▶ Identifying the source of **ALL** of the variation in Nobel Laureates
- ▶ An infinite task!
- ▶ Identifying how much **ONE** variable causes variation in Nobel Laureates
- ▶ This we can do!

Explanation

- ▶ A focus on a single explanatory variable D requires a clear definition of '**Treatment**'
- ▶ AND to clearly define a '**Control**'
 - ▶ What is the opposite of investing \$1bn in education?
 - ▶ No investment, or investing it elsewhere?
- ▶ Define treatment:

$$D_i = \begin{cases} 1, & \text{if treated} \\ 0, & \text{if not treated} \end{cases}$$

Explanation

- ▶ Defining our outcome:
 - ▶ Is it the outcome we really care about? Or just what's easy to measure?
 - ▶ Tempting to look at many outcomes, but the risk of 'cherry-picking'
 - ▶ All outcomes are **probabilistic** (due to all the other factors we haven't accounted for)
 - ▶ If we study 20 outcomes, on average one will show a significant effect even with no real causal effect
 - ▶ So we also want a **single outcome** usually

Explanation

- ▶ What are the **units** of our analysis?
- ▶ Countries? Political Parties? Individuals?
- ▶ eg. How does electoral system affect attitudes to redistribution?
 - ▶ Treatment at the national level
 - ▶ Outcome at the individual level
 - ▶ Measurement needed at the lowest (individual) level
- ▶ Units are **time-specific**: the same person 10 minutes later is a different unit

Explanation

Deterministic Explanation

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Probabilistic Explanation

- ▶ If D happens, the **probability** of Y increases
- ▶ Treatment effects are a distribution, not a single value

Section 2

Causal Inference

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- ▶ This means comparing the **Potential Outcomes** for unit i :

$$Y_{Di} = \begin{cases} Y_{1i} & \text{Potential Outcome if unit } i \text{ treated} \\ Y_{0i} & \text{Potential Outcome if unit } i \text{ NOT treated} \end{cases}$$

- ▶ Individual Treatment Effect for unit $i = Y_{1i} - Y_{0i}$

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$$Y_{Di} = \begin{cases} Y_{1i} & \text{GDP Growth of Brazil in 2010 if a Democracy} \\ Y_{0i} & \text{GDP Growth of Brazil in 2010 if NOT a Democracy} \end{cases}$$

- ▶ Individual Treatment Effect for unit $i = Y_{1i} - Y_{0i}$

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 - ▶ Would World War I still have happened if Archduke Franz Ferdinand had not been assassinated in 1914?

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 - ▶ Would Brazil have won the 2014 World Cup if Neymar had not been injured?

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Causal Inference

Potential Outcomes are just another Variable

	GDP Growth if Democracy	GDP Growth if NOT Democ- racy	Treatment Effect
	Y_1	Y_0	$Y_1 - Y_0$
Brasil	4	2	2
Argentina	7	3	4
Bolivia	2	4	-2
Colombia	11	11	0
Peru	6	2	4

Causal Inference

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$$ATE = E(Y_1 - Y_0) = \frac{\sum_i (Y_{1i} - Y_{0i})}{N}$$

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Colombia	7	7	0
Peru	5	4	1
Average Treatment Effect	5	4	1

Causal Inference

The Fundamental Problem of Causal Inference

- ▶ No units can receive **both** treatment and control
- ▶ So we can never observe both Y_1 and Y_0 for the same unit
- ▶ *Individual* Treatment Effects are **Impossible to Estimate**

Causal Inference

Potential Outcomes Example

	Democracy?	GDP Growth if Democracy	GDP Growth if NOT Democracy	Treatment Effect
	D_i	Y_1	Y_0	$Y_1 - Y_0$
Brasil	1	4	2	2
Argentina	1	7	3	4
Bolivia	0	2	4	-2
Colombia	0	7	7	0
Peru	0	5	4	1

Causal Inference

Potential Outcomes Example

	Democracy?	GDP Growth if Democracy	GDP Growth if NOT Democracy	Treatment Effect
	D_i	Y_1	Y_0	$Y_1 - Y_0$
Brasil	1	4	?	?
Argentina	1	7	?	?
Bolivia	0	?	4	?
Colombia	0	?	7	?
Peru	0	?	4	?

Causal Inference

Potential Outcomes Example

	Democracy?	GDP Growth if Democracy	GDP Growth if NOT Democracy	Observed GDP Growth
	D_i	Y_1	Y_0	Y
Brasil	1	4	?	4
Argentina	1	7	?	7
Bolivia	0	?	4	4
Colombia	0	?	7	7
Peru	0	?	4	4

Causal Inference

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Bolivia	0	?	4	4
Colombia	0	?	7	7
Peru	0	?	4	4
Average Treatment		5.5	5	0.5

Causal Inference

- ▶ We can't even look at the change in countries that switch to a PR system
 - ▶ What if **all** countries had started to invest more in education at the same time, for different reasons?
 - ▶ The potential outcome for Country X in time 1 is different to at time 2
- ▶ So we need to consider the **counterfactual** - what would have happened if the country had **not** switched to a PR system?
- ▶ So we can only estimate the effect by comparing **across** units
- ▶ That is why we are doing causal **inference**, not causal proof

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Causal Inference

- ▶ To compare across units we need counterfactuals: **control** units that do not receive treatment
- ▶ Control units can never be perfect substitutes
- ▶ Causal Inference is all about identifying a **plausible counterfactual**
 - ▶ Plausible means that the potential outcomes of the control unit are the same as those of the treated unit

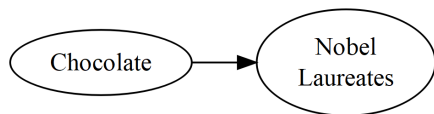
Causal Inference

- ▶ Why wasn't regression enough for explanation?
 1. Omitted Variables
 2. Reverse Causation
 3. Selection Bias
 4. Measurement Bias
 5. Lack of Overlap
- ▶ In all of these cases the values in our data hid the real causal relationship

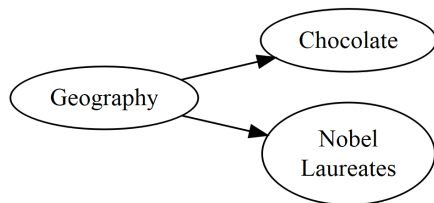
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► Omitted Variables

A real causal relationship:



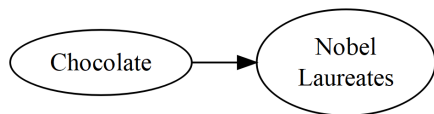
Being misled by omitted variable bias:



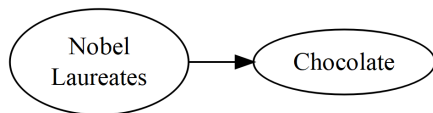
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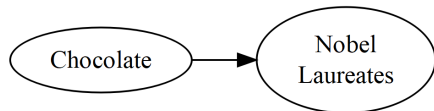
Being misled by reverse causation:



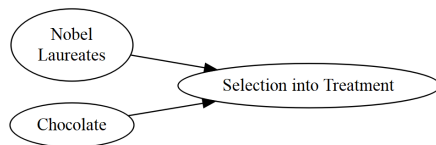
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- ▶ **Selection Bias** - the Swiss *choose* to eat a lot of chocolate because they know it will be really effective at producing Nobel Laureates
- ▶ Messy treatment assignment mechanisms are why basic regression is no use for explanation
 - ▶ It means our control cases are really misleading
 - ▶ South Africa is our counterfactual for Switzerland
 - ▶ What would happen if the 'untreated' units got treated?

Causal Inference

- ▶ The comparability of treatment and control units depends on how they got to be treated
 - ▶ On the **treatment assignment mechanism**
- ▶ If we 'treated' an outlier like Búzios in Rio, could we find a comparable control unit?
- ▶ Comparisons are easier where the **treatment assignment mechanism is independent of potential outcomes**
 - ▶ This makes it more likely that potential outcomes are 'balanced' and comparable

Section 3

Rest of the Course

Causal Inference

- ▶ The rest of the course is mostly about the types of treatment assignment mechanisms that **avoid these biases** and provide plausible counterfactuals

Causal Inference

1. **Controlled Experiments** where we **control** the treatment assignment
 - ▶ Field Experiments
 - ▶ Survey Experiments
 - ▶ Lab Experiments

Causal Inference

2. **Natural Experiments** where the assignment mechanism creates balanced potential outcomes

- ▶ Randomized natural experiments
- ▶ Regression Discontinuities
- ▶ Instrumental Variables

Causal Inference

3. **Observable Studies:** What if no suitable treatment assignments are available?
- ▶ No historical examples of natural experiments
 - ▶ Not feasible or ethical to run a field experiment
- ▶ Remember the purpose of using these specific treatment assignment mechanisms is to achieve **comparable potential outcomes**
- ▶ One alternative way of making potential outcomes comparable is to **selectively use Observable Data**
- ▶ Difference-in-Differences
 - ▶ Controlling for confounding variables
 - ▶ Matching

Causal Inference

Analysis Types and Assumptions

Week	Assumption:	Researcher Controls Treatment Assignment?	Treatment Assignment Independent of Potential Outcomes	SUTVA	Additional Assumptions
	Controlled Experiments				
1	Field Experiments	✓	✓	✓	
2	Survey and Lab Experiments	✓	✓	✓	Controlled Environment for treatment exposure
	Natural Experiments				
3	Randomized Natural Experiments	X	✓	✓	
4	Instrumental Variables	X	✓	✓	First stage and Exclusion Restriction (Instrument explains treatment but not outcome)
5	Regression Discontinuity	X	✓	✓	Continuity of covariates; No manipulation; No compounding discontinuities
	Observational Studies				
6	Difference-in-Differences	X	X	✓	No Time-varying confounders; Parallel Trends
7	Controlling for Confounding	X	X	✓	Blocking all Back-door paths
8	Matching	X	X	✓	Overlap in sample characteristics

Causal Inference

4. **Small-N studies:** Some research questions have few units available
- ▶ How do we learn about the political economy of development with few units?
 - ▶ We can at least avoid some key biases:
 - ▶ Comparative Case Studies
 - ▶ Process Tracing

Causal Inference

- ▶ But **how much** can we learn from a causal analysis?
- ▶ Is this an accurate representation of what would happen in the real-world?
 - ▶ What was the policy problem (/academic question) you were trying to solve?
 - ▶ What details differ? Eg. context of how treatment was applied
- ▶ Generalizability to other units (External validity)
 - ▶ Would the same thing happen in another country? Next year?
 - ▶ Look out for variation in treatment, context, spillovers, learning etc.
- ▶ Any generalization requires assumptions

Causal Inference

- ▶ We will try to identify abstract, portable processes
 - ▶ **Causal Mechanisms**
- ▶ **Portable:** If the weather affects election turnout ONLY in Acre, is that a useful causal mechanism?
- ▶ **Abstract:** If unions are good at mobilizing support, but so are churches, the mechanism is collective action, not union organization
- ▶ We still need to define the **scope conditions** in which we think this causal mechanism will operate as expected

Causal Inference

- ▶ Examples of Causal Mechanisms:
 - ▶ Citizens
 - ▶ Electoral Accountability
 - ▶ Client Power
 - ▶ Collective Action
 - ▶ Social Trust/Sanctioning
 - ▶ Wealth Effects
 - ▶ Elites
 - ▶ Violence/Coercion
 - ▶ Brokerage/Patronage
 - ▶ Persuasion/Framing
 - ▶ Incumbency Power
 - ▶ Institutions
 - ▶ Power Devolution/Median Voter
 - ▶ Network Effects
 - ▶ Evolutionary Selection
 - ▶ Conversion/Layering/Drift/Replacement

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 - ▶ Citizens
 - ▶ Electoral Accountability - [Class 5](#)
 - ▶ Client Power - [Class 6](#)
 - ▶ Collective Action - [Class 11](#)
 - ▶ Social Trust/Sanctioning - [Class 4](#)
 - ▶ Wealth Effects
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 - ▶ Violence/Coercion - [Class 8](#)
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 - ▶ Institutions
 - ▶ Power Devolution/Median Voter - [Class 3](#)
 - ▶ Network Effects
 - ▶ Evolutionary Selection
 - ▶ Conversion/Layering/Drift/Replacement - [Class 12](#)