Causal Inference: Instrumental Variables

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Part 5

Overview

Previous three parts were about "selection-on-observables": how to estimate treatment effects by controlling for all relevant covariates, and exploiting variation in time and units in a "difference-in-differences" .

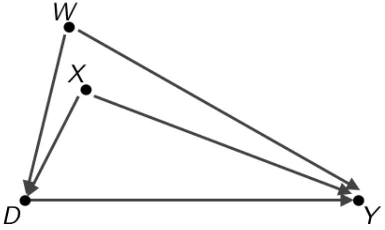
This time we consider situations where:

- Treatment depends on unobservables, i.e. CIA does not hold
- **But** treatment also depends on an as-if random variable Z_i that only affects the outcome through treatment (at least conditional on covariates).

This special variable Z_i is an **instrument**: it changes D_i, and we can use this change to measure the effect of D_i.

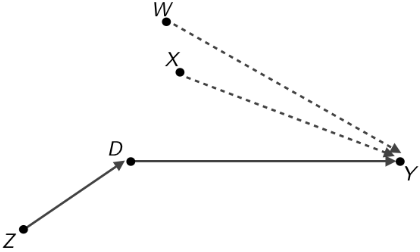
Graphical overview: selection on observables

To estimate the effect of D on Y, we must observe and control for X and W.



Graphical overview: randomized experiment

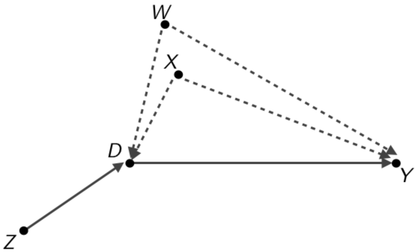
If D is completely determined by a randomization process Z, so we can measure the effect of D on Y, even if X and W are **not** observed.



Graphical overview: instrumental variables

If D is partly determined by random Z, and Z does not affect Y in any other way, we can measure the effect of D on Y. This is the case even if X and W are not observed (through IV techniques).

In this case, we call Z the instrument.



IV Assumptions

Four assumptions are crucial:

- Exclusion restriction (Z_i affects Y_i only through D_i)
- Random assignment of Z_i

Applications of IV

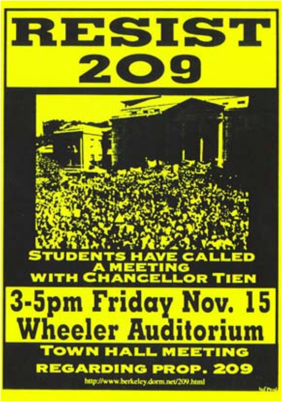
IV methods can be seen as a remedy for a **broken experiment**, i.e. failure to obtain 100% compliance.

More positively, **IV methods can be used as part of the design of using natural experiments** in which some random variation in Z_i creates some variation in D_i and then (given exclusion restriction) measures effect of D_i on some outcome Y_i.

Encouragement design example

Proposition 209: 1996 ballot proposition to end race-based preferences (affirmative action) in California government policies

Research question (Albertson and Lawrence 2009): Could watching a TV program affect citizens' attitudes toward Prop. 209?



Albertson and Lawrence 2009: Design

- Representative sample of households in Orange County, CA, interviewed by phone in October 1996
- All respondents told there will be a follow-up interview after the election
- Random subset of respondents told to watch upcoming TV debate on Prop. 209
- In follow-up, asked if they watched the debate; supported Prop. 209; felt knowledgeable about Prop. 209

In this design:

- What are Z_i, D_i, Y_i?
- What is the exclusion restriction?

Martin and Yurukoglu (2017) on impact of Fox News in USA

- **Question**: "how much does consuming slanted news, like the Fox News Channel, change individuals' partisan voting preferences?"
- **Treatment**: Minutes spent watching Fox News Channel, based on surveys
- **Outcome**: Voting in presidential election, based on aggregate zip code-level results

To consider:

- What about just regressing outcome on treatment?
- What covariates might remove the bias in that regression?
- How might an IV approach help?

Martin & Yurukoglu (2)

Instrument: channel position of Fox News on the cable lineup

Evaluate:

- **Independence** (exogeneity, ignorability): instrument unrelated to potential outcomes, conditional on covariates
- **Exclusion restriction**: instrument only affects outcome through treatment, conditional on covariates
- **Monotonicity**: instrument's effect on treatment is weakly positive or weakly negative for all units

Why we should be skeptical of most IV designs

IV designs must convince us of two key untestable assumptions:

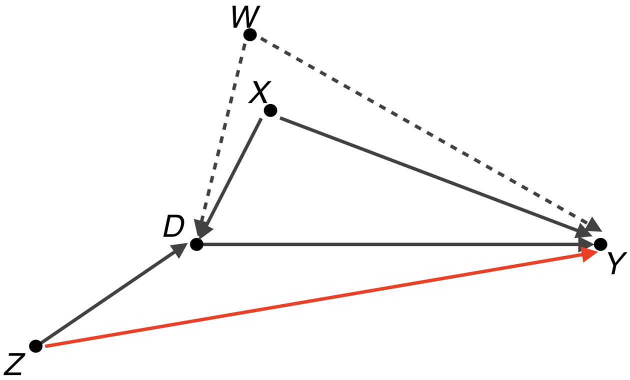
- The instrument Z_i satisfies **independence**, i.e. the CIA is met with respect to D_i and Y_i, e.g. because Z_i is random
- The instrument Z_i satisfies **exclusion**, i.e. it only affects Y_i through D_i

When Z_i is randomly determined in an experiment, it's easier to accept **independence** and think hard and discuss the **exclusion** assumption.

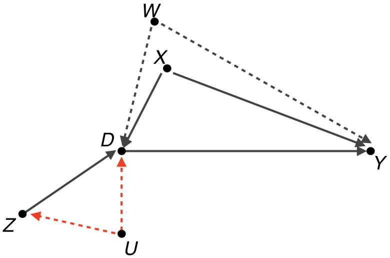
In an observational study, one should be skeptical about both.

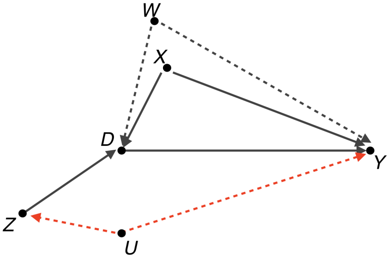
- Is the CIA really satisfied in the reduced form?
- Is D_i really the only channel through which Z_i affects Y_i?

Exclusion restriction violation DAG



Independence violations DAGs





(where U is an unobserved covariate)