Counterfactuals, Clones, and Cool Regression Stuff

Econ 140, Section 2

Jonathan Old

Roadmap

1. Selection bias
2. Potential outcomes
3. RCTs
4. A non-mathematical intro to OLS – OR: standard errors, t-statistics, and hypothesis tests: What is that all about? Your choice

Any questions?

… Remember – Every question is useful!

Selection bias

How to think about Selection Bias

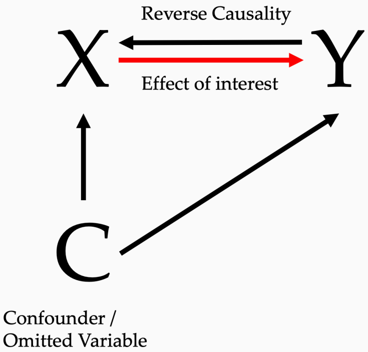


Figure 1: Selection bias

Dissecting Bad Causal Claims III

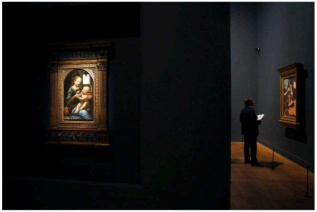
Discuss in groups of 2: Why is this statement problematic?

The New York Times

Another Benefit to Going to Museums? You May Live Longer

Researchers in Britain found that people who go to museums, the theater and the opera were less likely to die in the study period than those who didn't.

Give this article



Leonardo da Vinci's "The Virgin and Child" at the Louvre in Paris. A British study found that people who engaged with the arts had a lower likelihood of dying during the study period than those who did not. Thibault Camus/Associated Press

Figure 2: Museums and longevity (Source)

Potential outcomes

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Our main challenge: We **NEVER** observe an individual at more than one status at the same time!

Potential outcomes: Notation

We write the potential outcomes as:

$$\left.\begin{aligned} Y_{i0} &= \text{Outcome of individual } i \text{ with "status" } 0 \\ Y_{i1} &= \text{Outcome of individual } i \text{ with "status" } 1 \end{aligned}\right\} \begin{array}{r} \text{Counterfactual} \\ \text{Outcomes} \end{array}$$

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”Status” can be anything

- Treatment assignment: 0 or 1
- Actual treatment: 0 or 1
- Drinking expensive whiskey or not
- Can also be: Multi-valued (number of children) or continuous (hours studied)

Potential outcomes: Notation

- We are often interested in the expected (think: average) potential outcome of a group of individuals with a given status.
- We write the group behind a conditional sign: $\mathrm{E}\left[\text{Score}_{i0} \mid \text{iPad}_i = 0\right]$ gives the potential outcome of a group of people that had no iPad, in the ”parallel universe” where they don’t have an iPad.
- Then, $\mathrm{E}\left[\text{Score}_{i1} \mid \text{iPad}_i = 0\right]$ gives the potental outcome of the same group (that currently have no iPad), in the ”parallel universe” where they do have an iPad.

Estimating the effect of iPads on grades

Let us start with a difference-in-means comparison:

$$\Delta = E[\text{Grade}_i|\text{iPad}_i = 1] - E[\text{Grade}_i|\text{iPad}_i = 0]$$

Add and subtract $E[\text{Grade}_i(0)|\text{iPad}_i = 1]$:

$$= E[\text{Grade}_i(1)|\text{iPad}_i = 1] - E[\text{Grade}_i(0)|\text{iPad}_i = 1] \quad +$$

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Selection bias: Students with and without iPad have different potential grades: **even if they both *had* iPads, they would be different**.

Selection Bias revisited

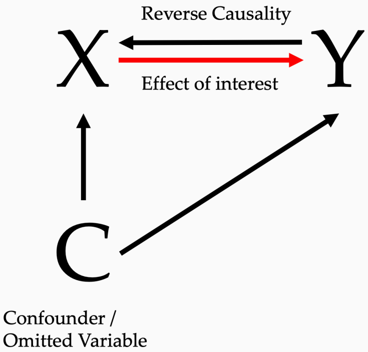

Figure 3: Selection bias

RCTs

RCTs solve selection bias

We had:

$$\Delta = E[\text{Grade}_i(1) - \text{Grade}_i(0)|\text{iPad}_i = 1] \quad + \\ E[\text{Grade}_i(0)|\text{iPad}_i = 1] - E[\text{Grade}_i(0)|\text{iPad}_i = 0]$$

- The second line was selection bias: The potential grade of individuals with and without iPad is different
- If the treatment (iPad) is independent of the potential outcomes, then:

$$\text{iPad}_i \perp (\text{Grade}_i(1), \text{Grade}_i(0)) \\ \Rightarrow E[\text{Grade}_i(0)|\text{iPad}_i = 1] = E[\text{Grade}_i(0)|\text{iPad}_i = 0]$$

and selection bias will be zero.

Remaining issues with RCTs

RCTs solve the selection bias problem by **randomly assigning treatment** to different groups.

Discuss in groups:

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- External validity (Generalizability)

RCTs have revolutionized economics

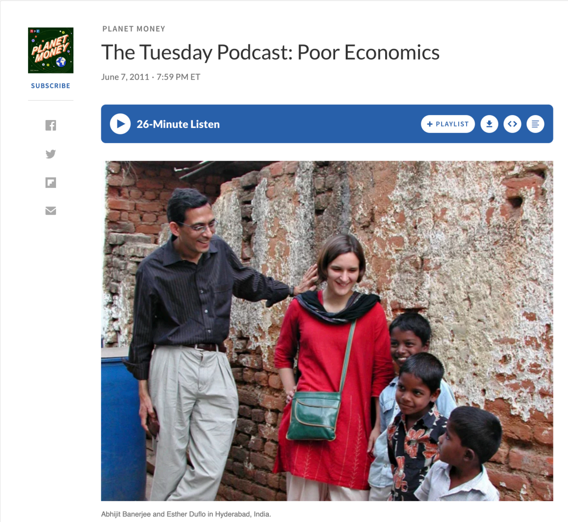

Figure 4: Abhijeet Banerjee and Ester Duflo. (Source)

OLS or hypothesis tests: Your choice

See this hilarious example

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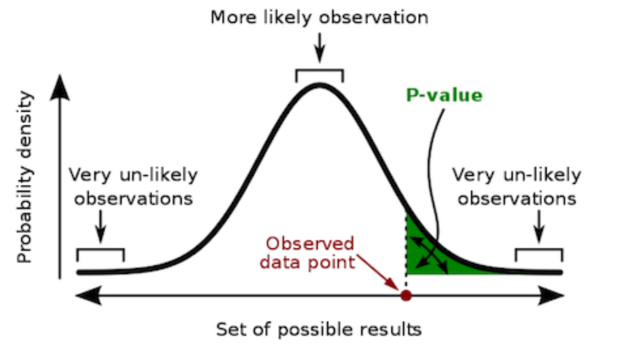
- We assume that the null hypothesis is true and then see how plausible results are, given that null hypothesis is true.
- If they are implausible – we reject the null hypothesis! Otherwise: Fail to reject.

It’s all connected



A **p-value** (shaded green area) is the probability of an observed (or more extreme) result assuming that the null hypothesis is true.