Causal Inference, 2 Days Workshop

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Information: "Correlation is not causation". You must have heard this warning many times. But, what then is causation, and how can we identify the causal effect of political messages, policies or programmes? This module introduces students to the ideal of the randomized experiment, and starting from there, to other common methods of causal inference using quasi-experimental data.

Aims: The module provides an introduction to the design-based approach to causal inference. Instead of using fancy modelling approaches to correct post-hoc for potential biases, the module encourages students to think about challenges to causal inference at the design stage of a study. Published work will be evaluated based on how it addresses three key assumptions underlying causal inference: independence, excludability, and non-interference. The module will cover identification strategies for a variety of causal research questions in Political Science. After introducing participants to the design-based approach to causal inference in general, the module will cover the Regression Discontinuity Design, the Difference-in-Differences Design and the Synthetic Control Method, three methods that allow design-based inference with quasi-experimental data, in detail. The module is taught as a combination of lectures and applied computer labs in R.

Prerequisites: The only pre-requisite is any course covering linear regression. There is relatively little assumed knowledge, and the aim is to build the statistical foundations from the ground up. If you have conducted a hypothesis test of any kind, you probably have the requisite skills.

Learning Outcomes: Participants will understand the potential outcomes framework, and the key assumptions underlying causal inference, and will be able to choose appropriate methods for a variety of research questions posing different identification challenges. Moreover, they will gain the practical skills of applying these insights and the statistical knowledge to their own research ideas.

Course Dropbox: Some readings and code files are available from the course dropbox.

Required textbooks

Bauer, Paul C. and Denis Cohen. *Applied Causal Inference with R*. 2020. https://bookdown.org/paul/applied-causal-analysis/

Cunningham, Scott. *Causal Inference: The Mixtape*, Yale University Press, 2020. https://mixtape.scunning.com

Recommended textbooks

Angrist, Joshua and Joern-Steffen Pischke. *Mostly Harmless Econometrics: An Empiricist's Companion*, Princeton: Princeton University Press, 2009.

Bueno de Mesquita, Eitan, and Anthony Fowler. *Thinking Clearly in a Data-Driven Age*, 2019: available via course dropbox.

Dunning, Thad. *Natural Experiments in the Social Sciences. A Design-Based Approach*, Cambridge: Cambridge University Press, 2012.

Gerber, Alan and Donald P. Green. *Field Experiments: Design, Analysis, and Interpretation*, New York: W.W. Norton, 2012.

Imbens, Guido W. and Donald B. Rubin. *Causal Inference for Statistics, Social and Biomedical Sciences: An Introduction.* Princeton: Princeton University Press, 2015.

Software: R Studio will be used throughout this module.

Workshop Outline

1. Monday, 9.00-10.00: Introduction to causal inference
2. Monday, 10.00-11.30: Potential Outcomes Framework and ATE
3. Monday, 12.30-14.30: Regression Discontinuity Design (RDD): Foundations
4. Monday, 15.00-17.00: Regression Discontinuity Design (RDD): Application
5. Tuesday, 9.00-10.30: Difference-in-Differences Design (DiD): Foundations
6. Tuesday, 11.00-12.30: Difference-in-Differences Design (DiD): Application
7. Tuesday, 13.30-15.30: Synthetic Control Method (SCM): Foundations & Application
8. Tuesday, 16.00 - 17.30: Advice on students' research designs

Introduction

Reading

Bauer and Cohen:
https://bookdown.org/paul/applied-causal-analysis/introconcepts.html

Bauer and Cohen:
https://bookdown.org/paul/applied-causal-analysis/assumptions.html

Cunningham:
https://mixtape.scunning.com/introduction.html

Gerber and Green: Chapters 1 and 2

Gelman, Forward Causal Inference

Content

- *What is causal inference?*
- *Unobserved heterogeneity*
- *Experiments and quasi-experiments*
- *Random and quasi-random assignment*

- *Potential outcomes notation*
- *The three core assumptions*

Fundamental problem of causal inference and the ATE

Reading

Cunningham:
https://mixtape.scunning.com/potential-outcomes.html#potential-outcomes

Gerber and Green: Chapter 2

Holland, Fundamental Problem of Causal Inference

Content

- Fundamental problem of causal inference
- Potential and realised outcomes
- The switching equation
- Difference-in-means estimator of the ATE
- Unbiasedness of ATE estimator
- Sampling distribution of the ATE

Regression Discontinuity Design (RDD)

Reading - basics

Bauer and Cohen:
https://bookdown.org/paul/applied-causal-analysis/rdd-regression-discontinuity-design.html

Cunningham:
https://mixtape.scunning.com/regression-discontinuity.html#regression-discontinuity

Cattaneo, Matias D., Nicolás Idrobo, and Rocío Titiunik. A practical introduction to regression discontinuity designs: Foundations. Cambridge University Press, 2019. Foundations: https://cattaneo.princeton.edu/books/Cattaneo-Idrobo-Titiunik_2019_CUP-Vol1.pdf

Campbell, Donald T. 1969. Reforms as experiments. American Psychologist 24(4): 409-429.

Reading - advanced

Imbens, Guido W., and Thomas Lemieux. 2008. "Regression discontinuity designs: A guide to practice." *Journal of econometrics* 142(2): 615-635.

Caughey, Devin, and Jasjeet S. Sekhon. 2011. "Elections and the regression discontinuity design: Lessons from close US house races, 1942–2008." Political Analysis 19(4): 385-408.

Dunning, chapters 1 and 3

Keele, Luke, and Rocio Titiunik. 2016. "Natural experiments based on geography." *Political Science Research and Methods* 4(1): 65-95.

Content

- What is a quasi-experiment
- RDD assumptions
- The running and assignment variables
- Polynomial estimation
- Different bandwidth estimators
- Robustness checks: Balance tests, density tests, placebo outcomes
- Fuzzy RDD
- Spatial RDD
- rdrobust https://cran.r-project.org/web/packages/rdrobust/rdrobust.pdf
- rdpower https://cran.r-project.org/web/packages/rdpower/rdpower.pdf

Difference-in-differences design (DiD)

Reading - basics

Bauer and Cohen:
https://bookdown.org/paul/applied-causal-analysis/difference-in-differences.html

Cunningham:
https://mixtape.scunning.com/difference-in-differences.html#difference-in-differences

Reading - advanced

Angrist and Pischke, chapter 5

Imai, chapter 2

Callaway, Brantly, and Pedro HC Sant'Anna. Introduction to DiD with Multiple Time Periods https://bcallaway11.github.io/did/articles/multi-period-did.html

Content

- *Basics*
- *Parallel trends assumption*
- *No compound treatment assumption*

- *Extension to multiple groups and treatment periods*
- *Examples: The Sun and Euroscepticism (Foos and Bischof 2021); Craigslist and Violence against Women (Cunningham 2019)*

Synthetic Control Method (SCM)

Reading - basics

Cunningham:
https://mixtape.scunning.com/synthetic-control.html?panelset2=r-code3#synthetic-control

Abadie, Alberto, Alexis Diamond, and Jens Hainmueller. 2010. "Synthetic control methods for comparative case studies: Estimating the effect of California's tobacco control program." Journal of the American Statistical Association 105(490: 493-505.

Abadie, Alberto, Alexis Diamond, and Jens Hainmueller. 2011. "Synth: An R Package for Synthetic Control Methods in Comparative Case Studies." J*ournal of Statistical Software* 42(13): 1-17.

Reading - advanced

Abadie, Alberto, Alexis Diamond, and Jens Hainmueller. 2015. "Comparative politics and the synthetic control method." *American Journal of Political Science* 59(2): 495-510.

Abadie, Alberto, and Javier Gardeazabal. 2003. "The economic costs of conflict: A case study of the Basque Country." *The American Economic Review* 93(1): 113-132.

Content

- Basics
- RMSE
- P-values
- Synth https://cran.r-project.org/web/packages/Synth/Synth.pdf
- MSCMT https://cran.r-project.org/web/packages/MSCMT/MSCMT.pdf