Methods of Causal Inference for the Social Sciences

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Course Description

This course provides students with a core set of causal inference tools for social science research. It is aimed at upper-division undergraduates with a background in basic probability and statistics and graduate students in political science, sociology, public policy or economics.

We begin the course with a discussion of causality, randomization and experimental design and move on to quasi-random designs for causal inference using panel and cross-sectional data. Upon successful completion of this course students will be able to design their own experiments, understand and apply causal inference techniques such as regression discontinuity designs and instrumental variables and utilize linear regression techniques for panel data such as fixed effects and difference-in-difference models. Students will learn to apply these techniques using real data with software packages such as **R** and **Stata**.

Prerequisites

A course dealing with multiple regression, basic probability and statistics.

Evaluation

- A series of data-analysis and problem solving homework assignments (50% of grade).
- A final project utilizing at least one of the methods learned (40% of grade).
- Class participation (10% of grade).

Required Texts

Angrist, Joshua D. and Jörn-Steffen Pischke. *Mostly Harmless Econometrics: An Empiricist's Companion.* Princeton: Princeton University Press. 2009. ISBN: 0691120358.

D.A. Freedman. *Statistical Models: Theory and Practice.* Cambridge University

Press (2005). ISBN: 0521743850.

Woolridge, Jeffrey. *Introductory Econometrics: A Modern Approach.* Mason, OH: South-Western CENGAGE Learning. 2012. ISBN: 1111531048.

Course Outline

1. Review of Probability and Statistics.
    - Basic probability.
    - Random variables, probability distributions and conditional expectation.
    - Review of linear algebra.
2. Introduction to Causality: Experiments v. Observational Studies.
    - The Rubin Causal Model.
    - Experiments, randomization and the fundamental problem of causal inference.
    - Effects of causes v. causes of effects.
3. OLS and "Biased Regression Coefficients"
    - Review of OLS and the conditional expectation function.
    - When and how should OLS be used?
    - *Applications: Survey experiments, predicting success in college.*
4. Matching Designs: Propensity Score and Genetic Matching.
    - Matching and the Rubin Causal Model.
    - Defining treatment and control, ATE, ATT.
    - Propensity score matching and genetic matching.
    - Limitations of matching designs for causal inference: SUTVA, selection on observables.
    - *Applications: What is the effect of neighborhood on school performance? HUD's "Move-to-Opportunity" program.*
5. Panel Data Methods I: Fixed Effects and Random Effects.
    - Fixed-effects v. random-effects regression using panel data.
    - Assumptions and limitations, choosing the correct standard errors.
    - *Applications: Gun control and crime: How effective is federal gun control legislation? Assessing the Brady Assault Weapons Ban.*
6. Panel Data Methods II: Differences-in-Differences and Synthetic Controls for Case Studies.

- Differences-in-differences v. fixed- and random-effects.
- Introduction to synthetic controls methods.
- *Applications: Gun control and crime: How effective is state and local gun control legislation?*

7. Selection on Unobservables I: Instrumental Variables Designs.

   - Introduction to IV for causal inference: LATE and the Exclusion Restriction.
   - Reduced form and 2SLS.
   - Assessing instrument strength.
   - Multiple instruments
   - *Applications: Does greater voter turnout tend to help Republicans of Democrats?*

8. Selection on Unobservables II: Regression Discontinuity Designs.

   - Introduction to Regression Discontinuity Designs (RDDs) for causal inference.
   - Sharp and Fuzzy RDDs.
   - The Density Test and RD assumptions.
   - *Applications: Do female House candidates increase female voter turnout?*