Research Design for Causal Inference

MTS 525-0-20

Spring, 2015
Wed. 3-5:50pm
Location TBA

Aaron Shaw
aaronshaw@northwestern.edu
FSB 2-142
Office hours TBA

Course Description

This course is a Ph.D. seminar focused on analyzing, designing, and conducting empirical causal inference using quantitative methods. Inquiries into cause and effect lie at the heart of almost all social and behavioral research. For example: What are the effects of media exposure on children's educational attainment? Which kinds of outreach and incentives promote participation in voluntary organizations? Can social pressure increase political engagement? Answering these questions requires methods of analysis that identify the effects of particular causes.

Learning Objectives and Course Design

By the end of the quarter, students should be able to: (1) discuss and compare multiple research methods of causal inference; (2) assess causal identification strategies and claims in empirical research; (3) design research to address causal theories and questions; (4) manipulate and analyze empirical data sets to identify, estimate, and interpret causal effects; (5) identify and address threats to the validity of findings; and (6) apply methods of causal inference to empirical questions and data beyond those covered in course readings and assignments.

The course consists of two "units." The first unit focuses on the fundamentals of causal inference. Then, in the second unit, we will survey a variety of specific methodological approaches, such as field experiments, natural experiments, regression discontinuity designs, difference in differences, matching, and instrumental variable estimation. For each of these approaches, I recommend you read *at least* one text providing an instructional overview of the method as well as *at least* one empirical application of the method.

Every week, I will assign problem sets and in-class activities aimed at helping you cultivate practical experience applying the methods in question. In general, the problem sets will lag a week behind the readings so that you can get a feel for each approach before you apply it.

During the course, you will also develop two larger-scale projects. The first of these is a class exercise in which you will work (perhaps in a small team) over several weeks to plan, design, execute,

analyze, and report the results of a field experiment. The second is a planning document for an empirical research project that you plan to execute (or perhaps have already begun executing). The first assignment is intended to help you cultivate experience with the craft of designing, conducting, and writing up an empirical study to address a causal question. We will workshop these group projects throughout the quarter. The second assignment is intended to provide an opportunity to apply your skills and experiences from the class to the design of an independent project that directly advances your research interests. I especially encourage you to use this second assignment to pursue something bold and creative.

Prerequisites

There are no formal prerequisites for this course. However, you should be familiar with (i.e. have taken at least one graduate-level class on) social scientific research methods and should be comfortable with (i.e. have taken at least one graduate-level class on) quantitative analysis techniques including multivariate regression. Some experience conducting empirical research will be useful, but is not strictly necessary. Knowledge of some statistical software and/or programming will also prove very helpful, but is not required. If you have questions or concerns, please email me.

Requirements

The day-to-day course requirements consist in performing standard graduate seminar activities in a standard timely fashion: attending and participating in seminar meetings, as well as completing all assignments. I believe it is crucial for *all* participants of the seminar to do *all* of these things. If you believe you require some sort of exemption or exception from any of these activities, please negotiate with me before the end of the first week of the quarter.

Course Website and Materials

Most materials for the class (including a "live" version of the course schedule, readings, problem sets, datasets, and solution code) will be made available through the course website.

http://aaronshaw.org/teaching/2015/causal

Once the quarter begins, I will not issue revised PDF versions of the syllabus, so check the website! I may distribute some readings and materials via Canvas.

Assignments

There are four kinds of assignments for this class: readings, problem sets, your field experiment, and your research planning document. Along the way, I will also ask you to submit incremental portions of the two larger assignments (the field experiment and the planning document).

Any assignments you turn in must be submitted to me via Canvas no less than one day (24 hours) before the class meeting for that week. I strongly prefer PDFs and plain-text formats because they don't require special software. For problem sets, please include your (well-commented) code as well as the final output or answers. I will evaluate problem sets at random throughout the quarter.

Mostly, you are on your own recognizance as far as checking your solutions and following up when you do not understand any content.

Problem sets will encourage conceptual understanding, provide experience applying techniques, elicit analytical interpretation, and (to much a lesser extent) facilitate computational skill-building. I strongly encourage you to complete the problem sets in a small group (ideally no more than 2-3 people). If you work in a group, I also recommend that you (1) try to complete the work on your own first; (2) submit your work individually and acknowledge your collaborators by name.

Readings

During the first few weeks of the course we will use the following as a textbook:

Gerber, A. S. and Green, D. P. (2012). *Field Experiments: Design, Analysis, and Interpretation*. WW Norton, New York.

This book provides a clear, practically-oriented introduction to the potential outcomes framework for causal inference focused on field experiments. I recommend that you get a copy.

For all subsequent topics I will assign at least one instructional reading along with at least one empirical reading. I assign several instructional readings about natural and quasi-expermental methods from:

Murnane, R. J. and Willett, J. B. (2011). *Methods Matter: Improving Causal Inference in Educational and Social Science Research*. Oxford University Press, Oxford ; New York.

These authors emphasize conceptual understanding and examples over formal math. If their approach works for you (and it may not!), get a copy of this book too. If Murnane & Willett does not work, I still recommend that you acquire a "textbook" treatment that covers all of the methods we talk about in a consistent way. All of the following are widely used:

Angrist, J. D. and Pischke, J.-S. (2008). *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton University Press.

Morgan, S. L. and Winship, C. (2007). *Counterfactuals and Causal Inference: Methods and Principles for Social Research*. Cambridge University Press, New York.

Imbens, G. and Rubin, D. B. (2014). *Causal inference for statistics, social, and biomedical sciences: an introduction*. Cambridge University Press, New York.

Shadish, W. R., Cook, T. D., and Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Wadsworth, Belmont, CA.

Depending on your training and aspirations, you may prefer these other approaches and you should feel free to substitute corresponding selections for instructional readings throughout the latter half of the quarter.

For each topic, I have also listed additional, "optional" readings that you may find useful. If you have trouble locating any of the readings, please let me know.

Last, if you want to revisit some of the statistical foundations of the material covered in this course (e.g. Regression, Probability, Linear Algebra), I recommend the following textbooks:

Freedman, D. (2005). *Statistical Models: Theory And Practice*. Cambridge University Press.

Wooldridge, J. (2012). *Introductory Econometrics: A Modern Approach*. Cengage Learning, 5th edition edition (earlier editions are also good).

Verbeek, M. (2012). *A Guide to Modern Econometrics*. John Wiley & Sons, 4th edition edition.

Statistical Computing

You will need to use statistical computing software in this class. You are welcome to use any statistical software you like (Stata, SPSS, Python, etc.); however, I will use (heavily commented) R for all in-class examples and solutions to the problem sets.

I do all of my statistical computing and analysis in R (http://r-project.org), which is free software available for use on any operating system and extremely powerful for just about any kind of statistical application. If you have not yet invested heavily in another statistical computing language/environment (and sometimes even if you have) I highly recommend learning R and using it to complete assignments for this class. I'll say more during the first class session.

Major Projects

You are required to complete two major projects in this course: (1) a field experiment and (2) a final project consisting of a detailed research planning document for another project. The field experiment provides an opportunity to design, plan, execute, and write-up a research project estimating a causal effect. The final project provides an opportunity to apply the course material to a research design that will lead to a major research product (e.g. journal/conference submission, qualifying paper, dissertation chapter, replication study, research proposal). I will provide additional details about my requirements and expectations for each project early in the quarter.

Field experiments are due via Canvas by May 20, 2015 at 5pm, CDT.
Final projects are due via Canvas by June 9, 2015 at 5pm, CDT.

Evaluation

Your final grade for the course will be based on my evaluation on your engagement with the material in class (25%) as well as the successful and timely completion of the field experiment project (25%), final project (25%), and all other assignments throughout the quarter (25%).

Course Policies

Confidentiality of Peers' Work

You will be receiving, reading and commenting on classmates' writing. These writing assignments are for class use only. You may not share them with anybody outside of class without explicit written permission from the document's author pertaining to the specific piece.

Confidentiality of In-Class Discussions

It is essential to the success of this class that all participants feel comfortable sharing questions, ideas, fears, reservations, apprehensions, and confusions about works-in-progress, writing, the research process, and related experiences during discussions. Therefore, you may not create any audio or video recordings during class time nor share verbatim comments with those not in class nor are you allowed to share using other methods – e.g., social media – comments linked to people's identities unless you get a person's permission.

Academic Integrity

You are responsible for reading and abiding by the Northwestern University Principles Regarding Academic Integrity as well as the applicable school-specific academic integrity policies. The bottom line: make sure to document all of your work and acknowledge the ideas and work of others. When in doubt, err on the side of giving more credit to the original source rather than less. The sanctions for violations of these principles are severe. Feel free to ask me (the instructor) for clarification about related matters.

Deadlines, Absences, etc.

If something causes you to miss a deadline or a class, please contact me. If you request, and obtain, an incomplete for the course and/or an extension on the final project (note: I strongly discourage this!), please allow at least 1 month (4 weeks) after you submit your completed work for me to submit a grade. Keep this in mind if you will need the grade in order to receive your fellowship/diploma/visa/etc. by a particular date.

Students with Disabilities

Any student requesting accommodations related to a disability or other condition is required to register with AccessibleNU (accessiblenu@northwestern.edu; 847-467-5530) and provide professors with an accommodation notification from AccessibleNU, preferably within the first two weeks of class. All information will remain confidential.

Sexual Harassment

All participants in this class are bound by the Northwestern University sexual harassment policies. Please note that the core of the policy states, "no member of the Northwestern community may sexually harass any other member of the community." Review the policy and speak to me (or some other appropriate person) if you have any questions or concerns.

Course Outline

As described above, all readings and assigned tasks are due *prior* to the class alongside which they are listed. Items listed in the "Additional Readings" subsection for each week are not required. I may adjust the list of readings or the schedule as needed throughout the quarter, so please consult the online version of the schedule for the most up-to-date information.

April 1 – Introductions & Causality

Readings

Gerber and Green – Chapter 1.

Tasks

Describe three research questions addressing some causal relationship relevant to your research interests. Write the research questions down for the first class meeting and be prepared to discuss at least one of them.

Make sure you have a satisfactory setup for statistical computing. If you are working with R, Download & install it. You will also want to pick and install a development environment for R: I recommend Rstudio unless you use Emacs already, in which case Emacs Speaks Statistics (ESS) may be more appealing.

Learn (or review) statistical computing basics: R users: if you're completely new, take the Try R course. Also, this Getting Started with R page from York University contains a variety of tutorials, tips, and instructional resources. You may also want to check out the startR resources page that I created for this course.

Optional: Attend an "Intro to R" session that I will lead on **Friday, April 3, 2:00-4:00pm in Frances Searle 2-378**. We'll cover basic data input and manipulation; some operators and mathematical functions; as well as writing loops and simple functions of your own.

Additional Readings

Hidalgo, F. D. and Sekhon, J. (2011). Causality. In Badie, B., Berg-Schlosser, D., and Morlino, L., editors, *International Encyclopedia of Political Science*, pages 204–211. Sage Publications, Inc, Thousand Oaks, CA. [Available from sekhon.berkeley.edu]

Murnane and Willett – Chapters 1-2, 13.

Morgan and Winship – Chapters 1-2.

Watch Ned Hall and L.A. Paul discuss causation on Philosophy TV.

April 8 – Causal Inference & Experimentation

Readings

Gerber and Green – Chapter 2; Appendix B.

Tasks

Complete Problem Set 1.

Complete (if you have not done so already) the required CITI training for human subjects research through the Northwestern Institutional Review Board (IRB).

Additional Readings

Holland, P. W. (1986). Statistics and Causal Inference. *Journal of the American Statistical Association*, 81(396):945–960. [Available via JSTOR]

Little, R. J. and Rubin, D. B. (2000). Causal Effects in Clinical and Epidemiological Studies Via Potential Outcomes: Concepts and Analytical Approaches. *Annual Review of Public Health*, 21:121–145. [Available via Annualreviews.org]

April 15 – Sampling Distributions, Inference, & Hypothesis Testing

Readings

Gerber and Green – Chapter 3.

Bowers, J. and Panagopoulos, C. (2012). Do Newspaper Ads Raise Voter Turnout? *Unpublished working paper*. [Available via jakebowers.org]

Tasks

Complete Problem Set 2.

Complete Field Experiment Assignment 1.

Additional Readings

Rosenbaum, P. R. (2010). *Design of Observational Studies*. Springer series in statistics. Springer, New York – Chapter 2, through section 2.3.2. [Available via Springer]

Splawa-Neyman, J. (1990). On the Application of Probability Theory to Agricultural Experiments. Essay on Principles. Section 9. *Statistical Science*, 5(4):465–472. [Available via JSTOR]

Fisher, S. R. A. (1935). *The Design of Experiments*. Oliver and Boyd, Edinburgh and London. Chapters 1-2. [Available online]

Bowers, J. and Panagopoulos, C. (2011). Fisher's Randomization Mode of Statistical Inference, Then and Now. *Unpublished working paper*. [Available via jakebowers.org]

Rubin, D. B. (1990). Comment: Neyman (1923) and Causal Inference in Experiments and Observational Studies. *Statistical Science*, 5(4):472–480. [Available via JSTOR]

April 22 – Covariates in Experimental Design & Analysis

Readings

Gerber and Green – Chapter 4 (& skim Chapter 9).

Wantchekon, L. (2003). Clientelism and Voting Behavior: Evidence from a Field Experiment in Benin. *World Politics*, 55(3):399–422. [Available via JSTOR]

Tasks

Complete Problem Set 3.

Additional Readings

Rosenbaum, P. R. (2010). *Design of Observational Studies*. Springer series in statistics. Springer, New York – Chapter 2, section 2.3.3-end. [Available via Springer]

Bloom, H. S. (2006). The Core Analytics of Randomized Experiments for Social Research. *MDRC Working Papers on Research Methodology*. [Available via MDRC]

Howell, W. G., Wolf, P. J., Campbell, D. E., and Peterson, P. E. (2002). School vouchers and academic performance: results from three randomized field trials. *Journal of Policy Analysis and Management*, 21(2):191–217. [Available via Wiley]

Krueger, A. B. and Zhu, P. (2004). Another Look at the New York City School Voucher Experiment. *American Behavioral Scientist*, 47(5):658–698. [Available via Sage]

Myers, D. E. and Mayer, D. P. (2003). Comments On "Another Look at the New York City Voucher Experiment". Mathematica Policy Research, Inc. [Available online]

Freedman, D. A. (2008). Randomization Does Not Justify Logistic Regression. *Statistical Science*, 23(2):237–249. [Available via Project Euclid]

Rosenbaum, P. R. (2002). Covariance Adjustment in Randomized Experiments and Observational Studies. *Statistical Science*, 17(3):286–327. [Available via Project Euclid]

April 29 – Validity: Planning, Executing, & Archiving Research Effectively

Readings

Gerber and Green. Chapter 13.

Gelman, A. and Loken, E. (2013). The garden of forking paths: Why multiple comparisons can be a problem, even when there is no "fishing expedition" or "p-hacking"and the research hypothesis was posited ahead of time. [Available via Gelman's website]

Tasks

Complete Problem Set 4.

Complete Mid-quarter course assessment (distributed in class).

Additional Readings

Inter-university Consortium for Political and Social Research (ICPSR) (2009). Guide to Social Science Data Preparation and Archiving. [Available from ICPSR website]

Boutron, I., John, P., and Torgerson, D. J. (2010). Reporting Methodological Items in Randomized Experiments in Political Science. *The ANNALS of the American Academy of Political and Social Science*, 628(1):112–131. [Available from Sage]

Stodden, V. and Miguez, S. (2013). Best Practices for Computational Science: Software Infrastructure and Environments for Reproducible and Extensible Research. SSRN Scholarly Paper ID 2322276, Social Science Research Network, Rochester, NY. [Available from SSRN]

2008. MDRC. Program Design and Evaluation Strategy for Opportunity NYC-Family Rewards. [Available from FEDAI website]

Miller, C., Riccio, J., and Smith, J. (2009). A Preliminary Look at Early Educational Results of the Opportunity NYC—Family Rewards Program: A Research Note for Funders. *New York: MDRC*. [Available from MDRC]

Casey, K., Glennerster, R., and Miguel, E. (2012). Reshaping Institutions: Evidence on Aid Impacts Using a Preanalysis Plan*. *The Quarterly Journal of Economics*, 127(4):1755–1812. [Both the paper and online supplement available via Oxford Journals]

Gerber and Green. Chapter 11.

May 6 – Natural Experiments

Readings

Murnane and Willett – Chapter 8.

Blattman, C. and Annan, J. (2010). The Consequences of Child Soldiering. *Review of Economics and Statistics*, 92(4):882–898. [Available via MIT Press]

Tasks

Complete Problem Set 5.

Complete Field Experiment Assignment 2 (Submit Planning Document for your field experiment).

Additional Readings

Dunning, T. (2008). Improving Causal Inference Strengths and Limitations of Natural Experiments. *Political Research Quarterly*, 61(2):282–293. [Available via Sage]

Zhang, X. M. and Zhu, F. (2010). Group size and incentives to contribute: A natural experiment at Chinese Wikipedia. *American Economic Review*, 101:1601–1615. [Available via mikezhang.com]

DellaVigna, S. and Kaplan, E. (2007). The Fox News Effect: Media Bias and Voting. *The Quarterly Journal of Economics*, 122(3):1187–1234. [Available via Oxford Journals]

Angrist, J. D. and Lavy, V. (1999). Using Maimonides' Rule to Estimate the Effect of Class Size on Scholastic Achievement. *The Quarterly Journal of Economics*, 114(2):533–575. [Available via Oxford Journals]

Dynarski, S. M. (2003). Does Aid Matter? Measuring the Effect of Student Aid on College Attendance and Completion. *American Economic Review*, 93(1):279–288. [Available via AEA]

Tyler, J. H., Murnane, R. J., and Willett, J. B. (2000). Estimating the Labor Market Signaling Value of the GED. *The Quarterly Journal of Economics*, 115(2):431–468. [Available via Oxford Journals]

May 13 – Regression Discontinuity & Difference-in-Differences

Readings

Murnane and Willett – Chapter 9.

Card, D. and Krueger, A. B. (1994). Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania. *The American Economic Review*, 84(4):772–793. [Available via JSTOR]

Tasks

Complete Problem Set 5.

Additional Readings

Morgan and Winship – Chapter 9.

Jacob, R. T., Zhu, P., Somers, M.-A., and Bloom, H. (2012). A Practical Guide to Regression Discontinuity. *MDRC Working Papers on Research Methodology*. [Available via MDRC]

Lee, D. S. and Lemieux, T. (2009). Regression Discontinuity Designs in Economics. Working Paper 14723, National Bureau of Economic Research. [Available via SSRN]

Angrist, J. D. and Lavy, V. (1999). Using Maimonides' Rule to Estimate the Effect of Class Size on Scholastic Achievement. *The Quarterly Journal of Economics*, 114(2):533–575. [Available via Oxford Journals]

Neumark, D. and Wascher, W. (2000). Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania: Comment. *The American Economic Review*, 90(5):1362–1396. [Available via JSTOR]

Card, D. and Krueger, A. B. (2000). Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania: Reply. *The American Economic Review*, 90(5):1397–1420. [Available via JSTOR]

Malamud, O. and Pop-Eleches, C. (2011). Home Computer Use and the Development of Human Capital. *The Quarterly Journal of Economics*, 126(2):987 –1027. [Available via Oxford Journals]

May 20 – No class meeting

No class meeting today.

Submit all materials for your field experiment (planning document; dataset and reproducible analysis code; research report).

May 27 – Instrumental Variables

Readings

Murnane and Willett – Chapters 10-11.

Dittmar, J. E. (2011). Information Technology and Economic Change: The Impact of The Printing Press. *The Quarterly Journal of Economics*, 126(3):1133–1172. [Available via Oxford Journals]

Additional Readings

Morgan and Winship – Chapter 7.

Angrist, J. D. and Lavy, V. (1999). Using Maimonides' Rule to Estimate the Effect of Class Size on Scholastic Achievement. *The Quarterly Journal of Economics*, 114(2):533–575. [Available via Oxford Journals]

Hoxby, C. M. (2000). The Effects of Class Size on Student Achievement: New Evidence from Population Variation. *The Quarterly Journal of Economics*, 115(4):1239–1285. [Available via Oxford Journals]

Tasks

Complete peer evaluation of field experiments.

Work on final projects.

Download & read through example IVE analysis.

June 3 – Lightning talks & Assessment

In-class $\leq$ 5 minute presentations of your final projects and discussion. Collective reflection on the design of the course and other related questions of profound significance. Much rejoicing.

Final Projects Due June 9

Final projects due no later than 5pm Central Time, June 9, 2015. Please submit your project via Canvas.

References

Angrist, J. D. and Lavy, V. (1999). Using Maimonides' Rule to Estimate the Effect of Class Size on Scholastic Achievement. *The Quarterly Journal of Economics*, 114(2):533–575.

Angrist, J. D. and Pischke, J.-S. (2008). *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton University Press.

Blattman, C. and Annan, J. (2010). The Consequences of Child Soldiering. *Review of Economics and Statistics*, 92(4):882–898.

Bloom, H. S. (2006). The Core Analytics of Randomized Experiments for Social Research. *MDRC Working Papers on Research Methodology*.

Boutron, I., John, P., and Torgerson, D. J. (2010). Reporting Methodological Items in Randomized Experiments in Political Science. *The ANNALS of the American Academy of Political and Social Science*, 628(1):112–131.

Bowers, J. and Panagopoulos, C. (2011). Fisher's Randomization Mode of Statistical Inference, Then and Now. *Unpublished working paper*.

Bowers, J. and Panagopoulos, C. (2012). Do Newspaper Ads Raise Voter Turnout? *Unpublished working paper*.

Card, D. and Krueger, A. B. (1994). Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania. *The American Economic Review*, 84(4):772–793.

Card, D. and Krueger, A. B. (2000). Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania: Reply. *The American Economic Review*, 90(5):1397–1420.

Casey, K., Glennerster, R., and Miguel, E. (2012). Reshaping Institutions: Evidence on Aid Impacts Using a Preanalysis Plan*. *The Quarterly Journal of Economics*, 127(4):1755–1812.

DellaVigna, S. and Kaplan, E. (2007). The Fox News Effect: Media Bias and Voting. *The Quarterly Journal of Economics*, 122(3):1187–1234.

Dittmar, J. E. (2011). Information Technology and Economic Change: The Impact of The Printing Press. *The Quarterly Journal of Economics*, 126(3):1133–1172.

Dunning, T. (2008). Improving Causal Inference Strengths and Limitations of Natural Experiments. *Political Research Quarterly*, 61(2):282–293.

Dynarski, S. M. (2003). Does Aid Matter? Measuring the Effect of Student Aid on College Attendance and Completion. *American Economic Review*, 93(1):279–288.

Fisher, S. R. A. (1935). *The Design of Experiments*. Oliver and Boyd, Edinburgh and London.

Freedman, D. (2005). *Statistical Models: Theory And Practice*. Cambridge University Press.

Freedman, D. A. (2008). Randomization Does Not Justify Logistic Regression. *Statistical Science*, 23(2):237–249.

Gelman, A. and Loken, E. (2013). The garden of forking paths: Why multiple comparisons can be a problem, even when there is no "fishing expedition" or "p-hacking"and the research hypothesis was posited ahead of time.

Gerber, A. S. and Green, D. P. (2012). *Field Experiments: Design, Analysis, and Interpretation*. WW Norton, New York.

Hidalgo, F. D. and Sekhon, J. (2011). Causality. In Badie, B., Berg-Schlosser, D., and Morlino, L., editors, *International Encyclopedia of Political Science*, pages 204–211. Sage Publications, Inc, Thousand Oaks, CA.

Holland, P. W. (1986). Statistics and Causal Inference. *Journal of the American Statistical Association*, 81(396):945–960.

Howell, W. G., Wolf, P. J., Campbell, D. E., and Peterson, P. E. (2002). School vouchers and academic performance: results from three randomized field trials. *Journal of Policy Analysis and Management*, 21(2):191–217.

Hoxby, C. M. (2000). The Effects of Class Size on Student Achievement: New Evidence from Population Variation. *The Quarterly Journal of Economics*, 115(4):1239–1285.

Imbens, G. and Rubin, D. B. (2014). *Causal inference for statistics, social, and biomedical sciences: an introduction*. Cambridge University Press, New York.

Inter-university Consortium for Political and Social Research (ICPSR) (2009). Guide to Social Science Data Preparation and Archiving.

Jacob, R. T., Zhu, P., Somers, M.-A., and Bloom, H. (2012). A Practical Guide to Regression Discontinuity. *MDRC Working Papers on Research Methodology.*

Krueger, A. B. and Zhu, P. (2004). Another Look at the New York City School Voucher Experiment. *American Behavioral Scientist*, 47(5):658–698.

Lee, D. S. and Lemieux, T. (2009). Regression Discontinuity Designs in Economics. Working Paper 14723, National Bureau of Economic Research.

Little, R. J. and Rubin, D. B. (2000). Causal Effects in Clinical and Epidemiological Studies Via Potential Outcomes: Concepts and Analytical Approaches. *Annual Review of Public Health*, 21:121–145.

Malamud, O. and Pop-Eleches, C. (2011). Home Computer Use and the Development of Human Capital. *The Quarterly Journal of Economics*, 126(2):987 –1027.

Miller, C., Riccio, J., and Smith, J. (2009). A Preliminary Look at Early Educational Results of the Opportunity NYC—Family Rewards Program: A Research Note for Funders. *New York: MDRC*.

Morgan, S. L. and Winship, C. (2007). *Counterfactuals and Causal Inference: Methods and Principles for Social Research*. Cambridge University Press, New York.

Murnane, R. J. and Willett, J. B. (2011). *Methods Matter: Improving Causal Inference in Educational and Social Science Research*. Oxford University Press, Oxford ; New York.

Myers, D. E. and Mayer, D. P. (2003). Comments On "Another Look at the New York City Voucher Experiment". Mathematica Policy Research, Inc.

Neumark, D. and Wascher, W. (2000). Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania: Comment. *The American Economic Review*, 90(5):1362–1396.

Rosenbaum, P. R. (2002). Covariance Adjustment in Randomized Experiments and Observational Studies. *Statistical Science*, 17(3):286–327.

Rosenbaum, P. R. (2010). *Design of Observational Studies*. Springer series in statistics. Springer, New York.

Rubin, D. B. (1990). Comment: Neyman (1923) and Causal Inference in Experiments and Observational Studies. *Statistical Science*, 5(4):472–480.

Shadish, W. R., Cook, T. D., and Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Wadsworth, Belmont, CA.

Splawa-Neyman, J. (1990). On the Application of Probability Theory to Agricultural Experiments. Essay on Principles. Section 9. *Statistical Science*, 5(4):465–472.

Stodden, V. and Miguez, S. (2013). Best Practices for Computational Science: Software Infrastructure and Environments for Reproducible and Extensible Research. SSRN Scholarly Paper ID 2322276, Social Science Research Network, Rochester, NY.

Tyler, J. H., Murnane, R. J., and Willett, J. B. (2000). Estimating the Labor Market Signaling Value of the GED. *The Quarterly Journal of Economics*, 115(2):431–468.

Verbeek, M. (2012). *A Guide to Modern Econometrics*. John Wiley & Sons, 4th edition edition.

Wantchekon, L. (2003). Clientelism and Voting Behavior: Evidence from a Field Experiment in Benin. *World Politics*, 55(3):399–422.

Wooldridge, J. (2012). *Introductory Econometrics: A Modern Approach*. Cengage Learning, 5th edition edition.

Zhang, X. M. and Zhu, F. (2010). Group size and incentives to contribute: A natural experiment at Chinese Wikipedia. *American Economic Review*, 101:1601–1615.