

Causal Analysis

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Class Time: Wednesday, 16:40 – 19:30 (with 10 min. break). Room 307 at Armyanski pereulok, 4, building 2.

Office hours: Wednesday, 12:00 – 15:00, and by appointment. Room 404 at Kri-vokolenny pereulok, 3 (place may change later).

Course Description

Finding causes of various natural and social phenomena is at the core of scientific reasoning. Indeed, many research questions are formulated in the language of causal analysis: “what causes X to behave in a certain way” or “why a certain historic process took one trajectory and not the other”. Political science is no exception, as questions like “what causes the country’s prosperity” or “why some people are more likely to vote than others” are nowadays a common standard.

The goal of this course is to introduce you to methods of causal analysis. The general question that we will consider can be roughly stated as follows: “how do we know that X causes Y, and if X does indeed cause Y, how great is this effect?” Many brilliant statisticians and social scientists dedicated their entire careers to finding answers to various components of this question, and we’ll touch upon their work in this class.

The class consists of two parts. In the first part, we’ll discuss causal analysis in the setting of randomization. Even a decade ago, studies that employed randomization were quite rare in social sciences, but recently the trend has reversed drastically, and more and more experimental studies appear in the literature. Our main focus will be on foundations of the so-called **Rubin Causal Model**. The main goal will be to develop a strong substantive and technical foundation upon which you can further build your research. In the second part, we’ll discuss causal inference in situations when a researcher cannot exercise direct control over treatment assignment by randomization. These methods also gained major popularity during the last two decades, especially in political science and economics. We’ll discuss the

theory behind the most popular approaches and practice their implementation in statistical software.

Prerequisites

The most important prerequisite for this class is your commitment to hard work. Learning methods is often difficult, but the payoff is worth it. You should also be familiar with basic statistical concepts and linear algebra.

Software and Computing

While this class is not a programming class, coding constitutes important part of the curriculum, as the best way to learn the ideas of causal analysis is by actually implementing them. We'll use Python, as this was the language you learned during your first year, but you can also use R if you so choose. I will be able to help you with R programming, but complete homework solutions will be provided only in Python.

Important Dates

Midterm Exam	October, 21 - 27
Final Paper Proposal	November, 1
Final Paper Submission	December, 22
Final Presentation	December, 23 - 31

I will notify you about the exact date and time for the midterm exam and the final presentation when they become available.

Grading

- All assignments will be graded using 10 point scale. At the end of the course, I will convert your scores into percentages of the final grade in accordance with the weight of each assignment.
- Each assignment contributes the following % to the final grade: Homeworks – 50 %, Midterm Exam – 20 %, Final Paper – 20 %, Final Presentation – 10 %.

Description of Assignments

- Homeworks

Homeworks will be distributed every week and will be based upon the material covered in lectures. You should submit the written part of the assignment and the code, if required by the assignment, to me electronically before the beginning of the following week's class. You are free to use any text processor for editing the written part of assignments, but I encourage you to try LaTeX since it is a standard formatting language for scientific publications.

- Final Paper – 3000-3500 words

For this project, you have two options.

Option I - Replication Paper. For this option, you need to select a paper that employs experimental/quasi-experimental methods and replicate it. Your first goal is to replicate all the results reported in the paper and provide a thoughtful critique of authors' arguments. Your second goal is to apply alternative analytical techniques to authors' data in order to check whether authors' conclusions hold. You should justify analytical technique(s) you selected. Your paper, therefore, should include Introduction where you provide general overview of authors' arguments and methods, Methodology Section where you discuss how the authors collected and analyzed the data, Results where you report and discuss the authors' results, Review where you thoroughly assess authors' arguments and methodology, Extension where you implement alternative analyses, and Conclusion.

Option II - Research Design Paper. For this option, you need to come up with your own research question and develop empirical strategy that allows you to answer this question. Your empirical strategy should be either experimental or quasi-experimental. You do not need to collect and/or analyze the actual data for this project, but you need to thoroughly describe the data you plan to collect and methods you intend to use in your analysis. Essentially, you need to write a draft for the full research paper with the exception of empirical results.

- Midterm Exam

Midterm Exam will consist of both analytical and substantive questions. Exam will be open-book, i.e., you are allowed to use laptops and books you bring with you.

- Final Presentation

You will present your final paper project to me and your classmates and will answer questions. A presentation should not exceed 10 minutes, and the total time for presentation plus questions should not exceed 15 minutes. I will evaluate both the presentation quality and your participation in discussion of your peers' projects.

Grade Appeals

If you wish to appeal a grade you have received, you must submit a one-page computer-edited (e.g., in Word) statement to me at least 24 hours after receiving the grade. The statement must clearly and thoroughly explain the reasons why your work deserved a higher grade. Your assignment will then be re-graded, taking your statement into consideration. **The revised grade may be higher, lower, or the same as the initial grade.**

Course Outline

Part I

Introduction	September, 11
Causal Inference Framework	September, 18
Randomized Experiments & Their Types	September, 25
Fisher's Approach to Inference	October, 2
Neyman's Approach to Inference	October, 9
Regression Methods in Experimental Setting	October, 16
Midterm Exam	October, 21 - 27
Model-Based Inference in Experimental Setting	October, 30
Stratified & Pairwise Randomized Experiments	November, 6

Part II

Matching Estimators and Propensity Scores	November, 13
Difference-in-Difference Estimation	November, 20
Instrumental Variables Estimation	November, 27
Regression Discontinuity Design	December, 4
Causal Analysis in Surveys	December, 11
Final Presentations	December, 23 - 31

Readings

The first part of the course will rely heavily on the following text:

Imbens, Guido W., and Donald B. Rubin. 2015. *Causal Inference for Statistics, Social, and Biomedical Sciences. An Introduction.* Cambridge University Press. [henceforth IR]

This book is quite technical, but offers large payoffs, as mastering the material gets you into the position to read and write cutting-edge experimental research. It also extensively discusses some of the statistical concepts (e.g., confidence intervals) that often receive only cursory treatment in more general methodological courses.

The other book that is excellent source for this course:

Morgan, Stephen L., and Christopher Winship. 2007. *Counterfactuals and Causal Inference: Methods and Principles for Social Research.* Cambridge University Press. [henceforth MW]

The content in MW and IR often overlap, and I will list appropriate chapters from MW when this is the case in the recommended readings. If you feel that you struggle with technical details in IR, you can always go to MW.

This book is a standard review source for probability theory and statistics:

Casella, George, and Roger L. Berger. 2002. *Statistical Inference.* Duxbury. [henceforth CB]

Other books you may find useful for this class are:

Rosenbaum, Paul R. 2010. *Design of Observational Studies.* Springer. [henceforth Rosenbaum]

Rubin, Donald B. 2006. *Matching Sampling for Causal Effects.* Cambridge University Press. [henceforth Rubin]

Greene, William H. 2012. *Econometric Analysis.* Pearson. [henceforth Greene]

I will provide you with access to necessary chapters from books, but full electronic versions are also available.

Detailed reading lists for each topic are provided in the next section.

Schedule

September, 11 – Week 1

Introduction. Course overview. Review of probability theory and statistics. Probability spaces, the law of total probability, random variables, expectation, variance, and covariance. The law of iterated expectations and the law of total variance. Estimators and their properties. Python, numpy and pandas libraries.

Recommended Readings:

- CB, Chapters 1 - 5.
- Any tutorials for numpy and pandas.

September, 18 – Week 2

Statement of the problem that causal analysis seeks to solve. Assumptions of causal analysis. Potential outcomes. Assignment mechanisms. Stability assumption (SUTVA). Introduction to randomization.

Required Readings:

- IR, Chapters 1, 3.
- Holland, Paul W. 1986. “Statistics and Causal Inference”. *Journal of the American Statistical Association* 81 (396): 945-960.
- King, Gary, Robert O. Keohane, and Sidney Verba. 1994. *Designing Social Inquiry: Scientific Inference in Qualitative Research*. Princeton University Press. Chapter 3.

Recommended Readings:

- IR, Chapter 2.
- MW, Chapters 1, 2.

September, 25 – Week 3

Randomized experiments in detail. Classification of randomized experiments. Examples of randomized experiments from political science and economics. Ethics of randomized experiments.

Required Readings:

- IR, Chapter 4.
- Bertrand, Marianne, and Sendhil Mullainathan. 2004. "Are Emily and Greg More Employable than Lakisha and Jamal? A Field Experiment on Labor Market Discrimination". *The American Economic Review* 94 (4): 991 - 1013.
- Chattopadhyay, Raghavendra, and Esther Duflo. 2004. "Women as Policy Makers: Evidence from a Randomized Policy Experiment in India". *Econometrica* 72 (5): 1409 - 1443.
- Enikolopov, Ruben, Vasily Korovkin, Maria Petrova, Konstantin Sonin, and Alexei Zakharov. 2013. "Field Experiment Estimate of Electoral Fraud in Russian Parliamentary Elections". *Proceedings of the National Academy of Sciences* 110 (2): 448-452.
- Frye, Timothy. 2019. "Economic Sanctions and Public Opinion: Survey Experiments From Russia". *Comparative Political Studies* 52 (7): 967-994.

Recommended Readings:

- Beath, Andrew, Fotini Christia, Georgy Egorov, and Ruben Enikolopov. 2016. "Electoral Rules and Political Selection: Theory and Evidence from a Field Experiment in Afghanistan". *The Review of Economic Studies* 83 (3): 932-968.
- Broockman, David E., and Donald P. Green. 2014. "Do Online Advertisements Increase Political Candidates Name Recognition or Favorability? Evidence from Randomized Field Experiments". *Political Behavior* 36 (2): 263-289.
- Duflo, Esther, Abhijit Banerjee, Rachel Glennerster, and Michael Kremer. 2006. "Using Randomization in Development Economics: A Toolkit". *Handbook of Development Economics*.
- Gerber, Alan S., Donald P. Green, and Christopher W. Larimer. 2008. "Social Pressure and Voter Turnout: Evidence from a Large-Scale Field Experiment". *American Political Science Review* 102 (1): 33-48.
- Nickerson, David W. 2008. "Is Voting Contagious? Evidence from Two Field Experiments". *American Political Science Review* 102 (1): 49 - 57.
- Collier, Paul, and Pedro C. Vicente. 2013. "Votes and Violence: Evidence from a Field Experiment in Nigeria". *Economic Journal* 124 (574): F327 - F355.

- Wantchekon, Leonard. 2003. “Clientelism and Voting Behavior: Evidence from a Field Experiment in Benin”. *World Politics* 55 (3): 399-422.
- Frye, Timothy, Ora John Reuter, and David Szakonyi. “Vote Brokers, Clientelist Appeals, and Voter Turnout: Evidence from Russia and Venezuela”. Forthcoming in *World Politics*.

October, 2 – Week 4

Fisher’s exact p-values approach. Fisher’s sharp null hypothesis. Randomization distribution. Test statistic. Robustness of alternative test statistics.

Required Readings:

- IR, Chapter 5.

Recommended Readings:

- Rosenbaum, Chapter 2.

October, 9 – Week 5

Neyman’s average treatment effect. Finite population perspective. Properties of Neyman’s estimator. Random sampling from a super-population perspective.

Required Readings:

- IR, Chapter 6.
- Duflo, Esther, Rema Hanna, and Stephen P. Ryan. 2012. “Incentives Work: Getting Teachers to Come to School”. *American Economic Review* 102 (4): 1241-1278.

October, 16 – Week 6

Why use regression in experimental studies? The role of covariates in the evaluation of experiment. Linear regression with covariates and interactions in experimental setting.

Required Readings:

- IR, Chapter 7.
- Olken, Benjamin. 2007. “Monitoring Corruption: Evidence of a Field Experiment in Indonesia”. *Journal of Political Economy* 115 (2): 200-249.

October, 21-27 – Week 7

No readings – Midterm Exam (exact date will be announced later).

October, 30 – Week 8

Stochastic potential outcomes. Inference in the presence of stochastic potential outcomes.

Required Readings:

- IR, Chapter 8.
- Dehejia, Rajeev H., and Sadek Wahba. 1999. “Causal Effects in Nonexperimental Studies: Reevaluating the Evaluation of Training Programs”. *Journal of the American Statistical Association* Vol 94 (448): 1053-1062.

November, 6 – Week 9

Design of stratified randomized experiments. Pairwise randomized experiments. Evaluation through Fisher’s, Neyman’s, Regression, and Model-based frameworks.

Required Readings:

- IR, Chapters 9, 10.
- King, Gary et. al. 2007. “A “Political Robust” Experimental Design for Public Policy Evaluation, with Application to the Mexican Universal Health Insurance Program”. *Journal of Policy Analysis and Management* 26 (3): 479-506.
- Mosteller, F. 1995. “The Tennessee Study of Class Size in the Early School Grades”. *The Future of Children: Critical Issues for Children and Youths* V: 113-127.

November, 13 – Week 10

Causal inference in observational studies. Matching estimators and their properties. Propensity scores.

Required Readings:

- Stuart, Elizabeth A. 2010. “Matching Methods for Causal Inference: A Review and a Look Forward”. *Statistical Science* 25 (1): 1 - 21.
- MW, Chapters 4, 5.

- Lyall, Jason. 2010. “Are Co-Ethnics More Effective Counter-Insurgents? Evidence from the Second Chechen War”. *American Political Science Review* 104 (1): 1-20.
- Blattman, Christopher, and Jeannie Annan. 2010. “The Consequences of Child Soldiering”. *The Review of Economics and Statistics* 92 (4): 882 - 898.

Recommended Readings:

- Rubin, Donald. 2001. “Using Propensity Scores to Help Design Observational Studies: Application to the Tobacco Litigation”. *Health Services and Outcomes Research Methodology* 2 (3-4): 169-188.
- Rubin, Chapters 3-5, 10, 11, 14.
- Sekhon, Jasjeet S. 2009. “Opiates for the Matches: Matching Methods for Causal Inference”. *Annual Review of Political Science* 12: 487-508.
- King, Gary, and Richard Nielsen. 2019. “Why Propensity Scores Should Not Be Used for Matching”. *Political Analysis*. Online First.
- Abadie, Alberto, and Guido W. Imbens. 2006. “Large Sample Properties of Matching Estimators for Average Treatment Effects”. *Econometrica* 74 (1): 235-267.
- Stuart, Elizabeth A., and Donald Rubin. 2007. “Best Practices in Quasi-Experimental Designs: Matching Methods for Causal Inference.” In *Best Practices in Quantitative Methods*, edited by Jason Osborne: 155-176. New York: Sage.
- Kam, Cindy D., and Carl L. Palmer. 2008. “Reconsidering the Effects of Education on Political Participation”. *Journal of Politics* 70 (3): 612-631.
- Imbens, Guido W. 2004. “Nonparametric Estimation of Average Treatment Effects under Exogeneity: A Review”. *Review of Economics and Statistics* 86 (1): 4-29.
- Gilligan, Michael J., and Ernest J. Sergenti. 2008. “Do UN Interventions Cause Peace? Using Matching to Improve Causal Inference”. *Quarterly Journal of Political Science* 3 (2): 89-122.

November, 20 – Week 11

Difference-in-differences estimator. Requirements for the data. Applications of difference-in-difference design.

Required Readings:

- Angrist, Joshua D., and Jorn-Steffen Pischke. 2008. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton University Press. Section 5.2.
- Card, David, and Alan B. Krueger. 1994. “Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania”. *American Economic Review* 84 (4): 772-793.
- Weintraub, Michael. 2016. “Do All Good Things Go Together? Development Assistance and Insurgent Violence in Civil War”. *Journal of Politics* 78 (4): 989-1002.

Recommended Readings:

- Abadie, Alberto. 2005. “Semiparametric Difference-in-Difference Estimators”. *Review of Economic Studies* 72 (1): 1-19.
- Athey, Susan, and Guido W. Imbens. 2006. “Identification and Inference in Nonlinear Difference-in-Difference Models”. *Econometrica* 74 (2): 431-491.
- Blundell, Richard, Amanda Gosling, Hidehiko Ichimura, and Costas Meghir. 2007. “Changes in the Distribution of Male and Female Wages Accounting for Employment Composition Using Bounds”. *Econometrica* 75 (2): 323-363.
- Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan. 2004. “How Much Should We Trust Differences-in-Differences Estimates?” *Quarterly Journal of Economics* 119(1): 249-75.

November, 27 – Week 12

Instrumental variables estimation. Criteria for a good instrument. Two-stage least squares.

Required Readings:

- MW, Chapter 9.

- Angrist, Joshua D., Guido W. Imbens, and Donald B. Rubin. 1996. *Identification of Causal Effects Using Instrumental Variables*. *Journal of the American Statistical Association* 91(434): 444-455.
- Acemoglu, Daron, Simon Johnson, and James A. Robinson. 2001. “The Colonial Origins of Comparative Development: An Empirical Investigation”. *American Economic Review* 91(5): 1369-1401.
- Miguel, Edward, Shanker Satyanath, and Ernest Sergenti. 2004. “Economic Shocks and Civil Conflict: An Instrumental Variables Approach”. *Journal of Political Economy* 112 (4): 725 - 753.

Recommended Readings:

- Angrist, Joshua D., and Alan B. Krueger. 2001. “Instrumental Variables and the Search for Identification: From Supply and Demand to Natural Experiments”. *Journal of Economic Perspectives* 15 (4): 69-85.
- Wright, Austin L., Luke N. Condra, Jacob N. Shapiro, and Andrew C. Shaver. 2017. “Civilian Abuse and Wartime Informing”. Working paper.
- Iyer, Lakshmi. 2010. “Direct versus Indirect Colonial Rule in India: Long-Term Consequences”. *Review of Economics and Statistics* 92 (4): 693-713.

December, 4 – Week 13

Regression discontinuity estimator. Finding appropriate data. Sharp and fuzzy designs. Bandwidth selection. Nonparametric vs. semiparametric approaches.

Required Readings:

- Imbens, Guido W., and Thomas Lemieux. 2008. “Regression Discontinuity Designs: A Guide to Practice”. *Journal of Econometrics* 142 (2): 615-35.
- MW, Section 11.2
- Angrist, Joshua D., and Jorn-Steffen Pischke. 2008. *Mostly Harmless Econometrics: An Empiricist’s Companion*. Princeton University Press. Chapter 6.
- Dell, Melissa. 2010. “The Persistent Effects of Peru’s Mining Mita”. *Econometrica* 78 (6): 1863 - 1903.

- Ferwerda, Jeremy, and Nicholas L. Miller. 2014. “Political Devolution and Resistance to Foreign Rule: A Natural Experiment”. *American Political Science Review* 108 (3): 642-660.

Recommended Readings:

- Eggers, Andrew, Olle Folke, Anthony Fowler, Jens Hainmueller, Andrew Hall, and James Snyder. 2015. “On the Validity of the Regression Discontinuity Design for Estimating Electoral Effects: New Evidence from Over 40,000 Close Races”. *American Journal of Political Science* 59 (1): 259-274.
- Dell, Melissa. 2015. “Trafficking Networks and the Mexican Drug War”. *American Economic Review* 105 (6): 1738-1779.
- Van Der Klaauw, Wilbert. 2002. “Estimating the Effect of Financial Aid Offers on College Enrollment: A Regression Discontinuity Approach”. *International Economic Review* 43(4): 1249-1287.
- Thistlewaite, Donald, and Donald Campbell. 1960. “Regression-Discontinuity Analysis: An Alternative to the Ex-Post Facto Experiment”. *Journal of Educational Psychology* 51: 309-317.

December, 11 – Week 14

Survey methods for sensitive topics. Response randomization techniques. List experiments. Endorsement experiments.

Required Readings:

- Blair, Graeme, Kosuke Imai, and Yang-Yang Zhou. 2015. “Design and Analysis of the Randomized Response Technique”. *Journal of the American Statistical Association* 110 (511): 1304-1319.
- Blair, Graeme, and Kosuke Imai. 2012. “Statistical Analysis of List Experiments”. *Political Analysis* 20(1): 47-77.
- Lyall, Jason, Graeme Blair, and Kosuke Imai. 2013. “Explaining Support for Combatants during Wartime: A Survey Experiment in Afghanistan”. *American Political Science Review* 107 (4): 679-705.
- Frye, Timothy, Scott Gehlbach, Kyle L. Marquardt, and Ora John Reuter. 2016. “Is Putin’s Popularity Real?” *Post-Soviet Affairs* 33 (1): 1-15.

December, 23 - 31 – Week 15

Final Presentations – I will announce exact date and time later.

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