

# PSC405: Causal Inference

Mayya Komisarchik

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E-mail: [mayya.komisarchik@rochester.edu](mailto:mayya.komisarchik@rochester.edu)

Office Hours: By Appointment

Office: 322 Harkness Hall

Web: [Linked Here](#)

Class Hours: M/W 9:40-10:55am

Class Room: Online Only

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## Teaching via Zoom

This course will be offered in an online-only format to ensure the safety of students, faculty, and staff. All lectures, office hours, and appointments will be held virtually over Zoom (please see links and details below). All assignments will be submitted via Blackboard.

**Zoom Link for Lecture:** <https://rochester.zoom.us/j/93836959938> (Passcode: 146112021)

**Zoom Link for Office Hours:** <https://rochester.zoom.us/j/98061108788> (Passcode: 548074)

## Course Description

The central focus of this course is a field growing across the social sciences: causal inference. Specifically, this course is about how and when we can make causal claims from empirical evidence. This is hard thing to do, and the bulk of the difficulty rests in making and justifying assumptions about the world that have to hold in order to allow you to say that something causes something else. While we'll learn lots of formulas, none of these - nor any computer program, will get you to causal inference without a rigorous interrogation of your assumptions. This course will provide you with the analytic and quantitative framework to assess and implement these assumptions. Perhaps at the most basic level, this course will sharpen your senses toward the issues of causal reasoning in the social sciences. The structure of the class will mix lectures, discussions, and problem sets. After this class you should understand and be able to apply the standard set of causal inference tools in the social sciences. These include: randomized experiments, matching, weighting, fixed effects, differences-in-differences, instrumental variables, regression discontinuity designs, marginal structural models, and sensitivity analyses.

## Prerequisites

This is a graduate-level course. Students who take this course should have had some exposure to probability and inference, linear models, and basic R programming.

Qualified undergraduates or students from other departments are welcome to take this course.

## Class Structure

This is primarily a lecture-based course, but students are encouraged to participate actively throughout each lecture by asking questions of me and other students, answering questions asked by me or other students, and bringing up any comments or concerns they have about material.

## Assignments

Final grades for the course will be based on:

**Class Participation (10%):** In-class discussion is an important part of this course, and students are expected to contribute regularly to the conversation. Participation can take a variety of forms, including (but not limited to): asking questions of me or other students in the class, answering questions I pose in class, answering questions posed by other students, or offering commentary on course materials. Quality is more important than quantity.

**Problem Sets (50%):** It's virtually impossible to learn new methodological tools without using them yourself. Accordingly, students will be responsible for completing a set of (approximately) bi-weekly problem sets. To receive credit for a problem set, each student must submit a well-formatted .pdf writeup of his/her/their own solutions along with an individual R (or .Rmd) script file containing all relevant code.

**Final Project (40%):** In lieu of a final exam, students in this course will complete a 5-15 page research proposal as individuals. This research proposal will detail plans for an original research project (replications of existing work are not permitted). Students will present their project proposals to the class at the end of the semester. Each research proposal should contain:

1. A brief description of the topic and why it might be an important one to study
2. A description of the research question and hypotheses
3. A description of the data the student has collected or plans to collect in order to address the research question
4. A description of the research design the student plans to use and all of the assumptions the researcher has to make in order to interpret the main quantity of interest as a causal finding
5. A description of the methodology the student will apply in order to obtain results

Literature reviews and other material should either be omitted or included in an appendix.

## Academic Honesty

I wholeheartedly encourage collaboration. You may work together on the problem sets, but every student must submit individual solutions and code. Copying publicly available solutions wholesale violates the spirit of this course and this program.

## Resources

If there are accommodations of any sort that would make the class work better for you, please come talk to me about it.

If you think you may need to seek accommodations due to a disability, the [Office of Disability Resources](#) can help you figure out your options. Speaking with faculty about disability-related accommodations is strictly confidential; I encourage you to come see me with concerns or requests.

Other resources that may prove helpful during your time at the University of Rochester:

- [CARE](#)
- [The Writing & Speaking Center](#)
- [Tutoring](#)
- [University Counseling Center](#)
- [David T. Kearns Center](#)
- [Office of Minority Student Affairs](#)

## Required Readings

We will be reading excerpts from the following books in class; these are both available online in full text.

### Books

1. Angrist, Joshua D. and Jörn-Steffen Pischke. 2008. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton University Press.
2. Hernán, Miguel A. and James M. Robins. 2012. *Causal Inference*. Forthcoming, Cambridge University Press. (Note that this book is still being written and you can find draft PDFs on the linked page above.)

## Preliminary Schedule

This schedule is tentative. Please come to class each Monday and Wednesday prepared to discuss the readings listed for that date. Readings marked with a (★) are **required**.

### Part I: Introduction to Causal Inference

#### Monday, 02/01 Introduction to the Course

- Overview
- Course Requirements
- Course Outline

#### Wednesday, 02/03 Reviewing Statistics Concepts and Notation

- Random Variables
- Measures of Location and Dispersion
- Inference and Properties of Estimators

#### Monday, 02/08 - Wednesday, 02/10 Potential Outcomes

- Counterfactuals and the Fundamental Problem of Causal Inference
- Graphical Causal Models
- Estimands and Assignment Mechanisms

#### Reading

- Hernán and Robins, Chapter 1, 6. (★)
- Angrist and Pischke: Chapter 1. (★)
- Sekhon, J.S. 2004. [Quality Meets Quantity: Case Studies, Conditional Probability and Counterfactuals](#). Perspectives on Politics, Vol. 2: 281-293.

#### Monday, 02/15 - Wednesday, 02/17 Randomized Experiments and the “Gold Standard”

- Randomization
- Implementation, Estimation, Diagnostics, Blocking
- Effect Modification

#### Reading

- Angrist and Pischke: Chapter 2. (★)

- Hernán and Robins, Sections 2.1-2.3, 4.1-4.3. (★)
- Imbens and Rubin, Chapter 4.

### Monday, 02/22 - Wednesday, 02/24 Randomization Inference

- Fisher's Approach to Inference
- Sharp Null Hypothesis
- Randomization Distributions
- Permutation Tests

#### Reading

- Bower, Jake and Panagopoulos, Costas. 2011. [Fisher's Randomization Mode of Inference, Then and Now](#). (★)
- Rosenbaum, Paul R. 2002. [Covariance Adjustment in Randomized Experiments and Observational Studies \(with discussion\)](#). *Statistical Science*, Vol. 17(3): 286–327. (★)
- Imbens and Rubin, Chapter 5.
- Ho, Daniel E. and Kosuke Imai. [Randomization Inference with Natural Experiments: An Analysis of Ballot Effects in the 2003 California Recall Election](#). *Journal of the American Statistical Association*. 2006. 101 (475): 888-900

## Part II: Selection on Observables

### Monday, 03/01 - Selection on Observables

- Identification under Selection on Observables
- Back-Door Criterion
- Subclassification

#### Reading

- Hernán and Robins, Chapter 7. (★)
- Rubin, Donald B. 2008. [For Objective Causal Inference, Design Trumps Analysis](#). *Annals of Applied Statistics* 2(3): 808-840.(★)
- Acemoglu, D. 2005. [Constitutions, Politics, and Economics: A Review Essay on Persson and Tabellini's The Economic Effects of Constitutions](#). *Journal of Economic Literature* Vol. XLIII: 1025-1048. (★)
- Rosenbaum, Paul R. 2002. *Observational Studies*. Springer-Verlag. 2nd edition. Chapter 3.
- Rosenbaum, P. R. 2005. [Heterogeneity and Causality: Unit Heterogeneity and Design Sensitivity in Observational Studies](#). *The American Statistician*, Vol. 59: 147-152.

- Cochran, W. G. 1968. [The Effectiveness of Adjustment by Subclassification in Removing Bias in Observational Studies](#), *Biometrics*, vol. 24: 295-313.

**Wednesday, 03/03 University Study Break Day. No Class.**

**Monday, 03/08 -Wednesday, 03/10 Matching**

- Covariate Matching
- Balance Checks
- Properties of Matching Estimators

**Reading**

- Stuart. 2010. [Matching Methods for Causal Inference: A Review and a Look Forward](#). *Statistical Science*. Vol. 25, No. 1: 1–21 (★)
- Sekhon, Jasjeet S. 2009. [Opiates for the Matches: Matching Methods for Causal Inference](#). *Annual Review of Political Science* 12: 487-508.(★)
- Morgan and Harding. 2006. [Matching Estimators of Causal Effects: Prospects and Pitfalls in Theory and Practice](#).
- Ho et. al. 2007. [Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference](#). *Political Analysis*, Vol. 15: 199-236.
- Abadie, A. and G. W. Imbens. 2006. [Large Sample Properties of Matching Estimators for Average Treatment Effects](#), *Econometrica*, vol. 74, 235-267.
- Abadie, A. and G. W. Imbens. 2011. [Bias Corrected Matching Estimators for Average Treatment Effects](#), *Journal of the American Statistical Association*, Vol. 29, No. 1, . (PDF) .

**Monday, 03/15 -Wednesday, 03/17 Propensity Score Methods**

- Propensity Score Estimation
- Matching on the Propensity Score
- Weighting on the Propensity Score
- Reweighting Methods

**Reading**

- Imbens, G. 2004. [Nonparametric Estimation of Average Treatment Effects under Exogeneity: A Review](#). *Review of Economics and Statistics* 86 (1): 4–29. (★)
- Morgan and Winship: Chapter 3.
- Rubin, D. 2006. Chapters 10, 11 and 14 (all with Paul R. Rosenbaum).

**Monday, 03/22 -Wednesday, 03/24 Regression**

- Non-parametric Regression
- Identification with Regression

### Reading

- Angrist and Pischke: Chapter 3. (★)
- Morgan and Winship: Chapter 5. (★)
- Chapter in Winship and Morgan on Matching vs Regression.
- Härdle, W and Linton, O. 1994. [Applied Nonparametric Methods](#), in R. F. Engle and D. L. McFadden eds. Handbook of Econometrics, vol. 4. New York: Elsevier Science.
- White, H. 1980. [Using Least Squares to Approximate Unknown Regression Functions](#). International Economic Review, vol. 21: 149-170.

### Monday, 03/29 - Wednesday, 03/31 Wrapping Up Selection on Observables

- Can Non-Experimental Method Recover Causal Effects?

### Reading

- Dehejia, R. H. and Wahba, S. 1999. [Causal Effects in Non-Experimental Studies: Re-Evaluating the Evaluation of Training Programs](#), Journal of the American Statistical Association, vol. 94: 1053-1062.(★)
- Shadish, W. M. Clark, H., and Steiner, P. 2008. [Can Nonrandomized Experiments Yield Accurate Answers? A Randomized Experiment Comparing Random and Nonrandom Assignments](#). Journal of the American Statistical Association, Vol. 103, No. 484: 1334-1344. (★)
- Heckman, J. J., H. Ichimura and P. E. Todd (1997), [Matching as an Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Programme](#), Review of Economic Studies, vol. 64, 605-654.
- Arceneaux, Kevin, Alan S. Gerber, and Donald P. Green. 2006. [Comparing Experimental and Matching Methods using a Large-Scale Voter Mobilization Experiment](#). Political Analysis 14: 1-36.
- John Concato, Nirav Shah, and Ralph Horwitz. 2000. [Randomized, Controlled Trials, Observational Studies, and the Hierarchy of Research Designs](#). New England Journal of Medicine 342(25): 1887-92.
- Benson, Kjell and Arthur J. Hartz. 2000. [A Comparison of Observational Studies and Randomized, Controlled Trials](#). New England Journal of Medicine 342(25): 1878-86.

### Part III: Causal Effects under Selection on Time-Invariant Characteristics

#### Monday, 04/05 -Wednesday, 04/07 Panel Data

- Fixed Effects
- Random Effects

**Reading**

Theory:

- Angrist and Pischke: Chapter 5.1 (★)
- Angrist and Pischke: Chapter 8 (★)
- Sobel, Michael E. [Does Marriage Boost Men's Wages? Identification of Treatment Effects in Fixed Effects Regression Models for Panel Data](#). 2012. Journal of The American Statistical Association. 107(498): 521-529. (★)

Applications:

- Imai, Kosuke, and In Song Kim. 2012. [On the Use of Linear Fixed Effects Regression Models for Causal Inference](#). Working paper. (★)
- Ladd, Jonathan McDonald, and Gabriel S. Lenz. 2009. [Exploiting a Rare Communication Shift to Document the Persuasive Power of the News Media](#). American Journal of Political Science 53(2): 394-410. (★)
- Cox, Gary W., and William Terry. 2008. [Legislative Productivity in the 93d-105th Congresses](#). Legislative Studies Quarterly 33(4): 603-16.
- Berrebi, C. and Klor, E. 2008. [Are Voters Sensitive to Terrorism? Direct Evidence from the Israeli Electorate](#). American Political Science Review (2008), 102:279-301.

**Monday, 04/12 -Wednesday, 04/14 Differences-in-Differences**

- Identification
- Estimation
- Falsification Tests

**Reading**

Theory:

- Angrist and Pischke: Chapter 5.2-5.4 (★)
- 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.
- Abadie, Alberto. 2005. [Semiparametric Difference-in-Differences Estimators](#). The Review of Economic Studies 72(1): 1–19.

Applications:

- Lyall, Jason. 2009. [Does Indiscriminate Violence Incite Insurgent Attacks? Evidence from Chechnya](#). Journal of Conflict Resolution 53(3): 331-62.(★)
- Card, D. and A. B. Krueger (1994), [Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania](#)," American Economic Review, vol. 84, 772-793. (★)
- Card, D. (1990), [The Impact of the Mariel Boatlift on the Miami Labor Market](#), Industrial and Labor Relations Review, vol. 44, 245-257.



## Part IV: Causal Effects under Selection on Time-Variant Characteristics

### Monday, 04/19 -Wednesday, 04/21 Instrumental Variables

- Identification
- Estimation
- Falsification Tests

#### Reading

##### Theory:

- Angrist and Pischke: Chapter 5.2-5.4 (★)
- 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.
- Abadie, Alberto. 2005. [Semiparametric Difference-in-Differences Estimators](#). The Review of Economic Studies 72(1): 1–19.

##### Critiques:

- Deaton, Angus. 2010. [Instruments, Randomization, and Learning About Development](#). Journal of Economic Literature 48(2): 424–55. (★)
- Hernan, Miguel A., and James M. Robins. 2006. Instruments for Causal Inference: An Epidemiologist's Dream? Epidemiology 17(4): 360-72.
- Guido Imbens. 2010. [Better LATE Than Nothing: Some Comments on Deaton \(2009\) and Heckman and Urzua \(2009\)](#). Journal of Economic Literature, Vol. 48, No. 2: 399-423. (★)

##### Applications:

- Lyall, Jason. 2009. [Does Indiscriminate Violence Incite Insurgent Attacks? Evidence from Chechnya](#). Journal of Conflict Resolution 53(3): 331-62.(★)
- Card, D. and A. B. Krueger (1994), [Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania](#)," American Economic Review, vol. 84, 772-793. (★)
- Card, D. (1990), [The Impact of the Mariel Boatlift on the Miami Labor Market](#), Industrial and Labor Relations Review, vol. 44, 245-257.

### Monday, 04/26 -Wednesday, 04/28 Regression Discontinuity Designs (RDD)

- Sharp RDD
- Fuzzy RDD
- Falsification Tests

#### Reading

## Theory:

- Imbens, Guido W., and Thomas Lemieux. 2008. [Regression Discontinuity Designs: A Guide to Practice](#). *Journal of Econometrics* 142: 615-35. (Part of special issue on RDD, all of which is of interest.) (★)
- Angrist and Pischke: Chapter 6 (★)

## Critiques:

- Caughey, Devin and Shekon, Jas. 2010. [Regression-Discontinuity Designs and Popular Elections: Implications of Pro-Incumbent Bias in Close U.S. House Races](#).

## Applications:

- Ferraz, C., and F. Finan. 2008. [Motivating Politicians: The Impacts of Monetary Incentives on Quality and Performance](#). Mimeo. 2009 NBER Working paper w14906.
- Lee, David S. 2008. [Randomized Experiments from Non-random Selection in U.S. House Elections](#). *Journal of Econometrics*. Volume 142, Issue 2, Pages 675-697. (★)
- Eggers, A. and Hainmueller, J. 2009. [MPs for Sale? Estimating Returns to Office in Post-War British Politics](#). *American Political Science Review*. Vol. 103, No. 4 November 2009.
- Butler, Daniel M., and Matthew J. Butler. 2006. [Splitting the Difference? Causal Inference and Theories of Split-Party Delegations](#). *Political Analysis* 14(4): 439-55.
- Hainmueller, Jens, and Holger Lutz Kern. 2008. [Incumbency as a Source of Spillover Effects in Mixed Electoral Systems: Evidence from a Regression- Discontinuity Design](#). *Electoral Studies* 27: 213-27.

**Monday, 05/03 Synthetic Controls**

- Synthetic Control Models

**Reading**

- Abadie, Diamond, and Hainmueller. 2010. [Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California’s Tobacco Control Program](#). *Journal of the American Statistical Association*. (★)
- Abadie, Alberto and Javier Gardeazabal. 2003. [The Economic Costs of Conflict: a Case-Control Study for the Basque Country](#). *American Economic Review* 92 (1).

**Wednesday, 05/05 Final Project Presentations**