Causal Inference

Olgahan Çat

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Office: TBD

Course Page: https://olgahan.com/causal-inference/
Class Hours: Wednesday, 4-6:30pm
Classroom: TBD

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TA Office: Grad Student Lounge
TA Office Hours: Tuesday, 2-3pm

Main Reference: Cunningham, Scott. *Causal inference: The mixtape.* Yale University Press, 2021.

Course Overview

This PhD seminar introduces core principles and cutting-edge methods of causal inference in social sciences. We cover experimental and observational strategies for identifying causal effects, drawing from statistics, econometrics, and applied political research. Students will critically assess empirical work and develop their own research designs, culminating in a research paper proposal suitable for journal submission.

Objectives

By the end of this semester, students should be able to:

Understand key concepts such as counterfactuals, identification, and the potential outcomes framework.

Evaluate causal claims in political science research.

Design and analyze randomized and observational studies.

Gain hands-on experience with methods including matching, instrumental variables, difference-in-differences, and regression discontinuity.

Get familiar with recent literature using cutting-edge methods.

Develop a publishable empirical paper using causal inference tools.

Grading

Discussions (10%):

At the start of the class in some weeks (see schedule below), you are expected to identify a published paper using the method of that particular week, preferably in a reputable journal in your subfield. At the beginning of class, you will take 5-6 minutes to summarize the paper you chose and present the results.

Final paper proposal (40%):

Throughout the semester, you are expected to develop a **proposal for an original research paper** that uses causal inference methods to answer a political science question. This is a key step toward a final paper, which may serve as the basis for a dissertation chapter or a publishable article. The proposal is due in **December 15**, and should include the following components:

Research Question

Clearly state the political science question you aim to answer.

Explain its theoretical and/or substantive significance.

State how it contributes to the relevant literature.

Theory and Hypotheses

Provide a brief conceptual framework or theory motivating your hypothesis.

Clearly articulate the causal claim you intend to test.

Specify the treatment, outcome, and the mechanism(s), if relevant.

Research Design

Identify your causal identification strategy (e.g., experiment, IV, diff-in-diff, RDD, matching).

Justify why this strategy is appropriate for your question.

Discuss potential threats to validity (internal and external) and how you plan to address them.

Data and Measurement

Describe the dataset(s) you plan to use or collect.

Define your treatment, outcome, and control variables.

Discuss any assumptions necessary for your identification strategy (e.g., parallel trends, exclusion restriction).

Preliminary Analysis (if applicable)

Provide descriptive statistics or visualizations, if available.

Include a brief discussion of data access and feasibility.

Timeline

Outline a timeline for completing the analysis and writing the final paper.

References

Include a bibliography of relevant literature, and key sources related to your theory, design, and methods.

Length: 15-20 pages (double-spaced, not including references)

Due Date: December 15

Check in with the professor: No later than **October 10**

Final exam or alternative assignment (30%):

You may choose between the following two options to complete the course:

Option A: Final In-Class Exam
A traditional, cumulative exam covering key concepts and methods from the course. This will be a closed-book, in-class exam during the scheduled exam period. It will include short-answer conceptual questions and applied problems involving design evaluation, critique of empirical studies, and methodological reasoning.

Option B: Alternative Assignment (Recommended)
This option is intended to serve a concrete academic or professional purpose. It is particularly recommended for students working on research that intersects with causal inference. Possible projects include:

A grant proposal for a research project using causal inference methods (e.g., NSF, SSRC, or internal funding)

An IRB application for an experiment or field study involving human subjects

A revise-and-resubmit response and updated manuscript draft (if you are currently working on one)

A research pre-registration for an observational or experimental study (e.g., OSF, EGAP, AEA registry)

A detailed methods appendix for a dissertation chapter or article in progress

You may propose an alternative project if it aligns with the course's goals. All alternative assignments must be approved by the instructor by **October 10**.

Submission Requirements: Submit a polished version of the assignment along with a 1-page cover memo describing how it connects to your research agenda and how the course informed its development.

Deadline for Option B: December 15

In-Class Presentation: Cutting-Edge Causal Inference Method or Approach (10%)

As part of this course, you will deliver one in-class presentation on a recent methodological advance or innovative approach in causal inference. This presentation simulates a professional conference talk focused on methodological innovation—using a published paper authored by others as the core content.

Goals

The presentation aims to:

Deepen your understanding of advanced causal inference methods or approaches

Develop your skills in communicating complex methodological ideas clearly to peers

Connect theoretical innovation to empirical applications and political science research

Presentation Content

Your 10–12 minute presentation should cover the following elements:

Problem or Motivation — Explain the substantive or methodological problem that the method or approach is intended to address. What limitations or gaps in existing tools does it seek to overcome?

Core Idea or Mechanics — Describe the main features of the method or approach. Explain any key equations, models, or algorithms involved, interpreting them for the audience.

Assumptions and Identification — Discuss the assumptions required for the method to validly identify causal effects or achieve its intended purpose. Relate these assumptions to the method's structure where possible.

Strengths and Limitations — Assess the advantages and potential drawbacks of the method, including statistical properties (e.g., bias, consistency, efficiency), practical considerations, or scope of applicability.

Applied Example — Present an example illustrating the method's use, either from published research or your own application (e.g., replication, simulation).

Format and Expectations

Prepare professional, clear slides to help visualize concepts, equations, assumptions, and results. Visual aids are crucial for effective communication.

Be ready to engage in audience questions following your talk.

Your presentation should emulate a professional academic conference session focused on methods, including proper attribution and formal tone.

Topic Selection and Preparation

Please meet with the instructor (during office hours or via email) **by November 1** to choose a method or approach to present and plan your presentation. You are encouraged to discuss draft slides or rehearse your presentation with the instructor before your scheduled class.

Final Paper Presentation (10%)

Near the end of the semester, each student will give a 15-minute presentation on their final research paper, which applies causal inference methods to answer an original political science question. This presentation provides an opportunity to share your research progress, receive feedback, and practice professional scholarly communication.

Goals

The presentation is intended to:

Demonstrate your ability to apply causal inference methods to a substantive research question

Communicate your research design, empirical findings, and interpretation clearly and effectively

Engage constructively with peer and instructor feedback to improve your work

Presentation Content

Your presentation should cover the following key elements:

Research Question and Motivation — Clearly state your research question and explain its significance within political science.

Theoretical Framework and Hypotheses — Summarize the theory motivating your causal claims and hypotheses.

Research Design and Identification Strategy — Describe your causal inference approach, including treatment, outcome, control variables, and identification assumptions.

Data and Measurement — Briefly discuss your data sources, variable measurement, and any data challenges.

Empirical Results — Present key findings, including tables, figures, or visualizations that illustrate your main results.

Interpretation and Implications — Discuss what your results imply for theory, policy, or future research.

Limitations and Next Steps — Acknowledge limitations of your study and outline plans for further analysis or revision.

Format and Expectations

Prepare professional slides that clearly communicate your research question, methods, results, and conclusions.

The presentation should last approximately 15 minutes, followed by questions and discussion.

Aim for clarity, conciseness, and scholarly rigor in both content and delivery.

Scheduling and Preparation

Presentations will be scheduled during the final weeks of the course. You are encouraged to meet with the instructor in advance to discuss your presentation and receive feedback on drafts of your slides.

Course Schedule

Week 1: Overview of causal inference and course expectations.

Syllabus
Preface and Chapter 1: "Causality and Data" from *Causal Inference: The Mixtape*

Week 2: Foundations - Potential Outcomes and DAGs

Introduction to the potential outcomes framework and directed acyclic graphs (DAGs) for causal inference.

Chapter 2: "Potential Outcomes"
Chapter 3: "Directed Acyclic Graphs (DAGs)" from *Causal Inference: The Mixtape*

Week 3: Unconfoundedness and Matching

Discuss the unconfoundedness assumption and matching methods to adjust for confounding.

Chapter 4: "Matching"
Discuss a paper that uses Matching.

Week 4: Panel Data

Using panel data and fixed effects to estimate causal effects.

Chapter 5: "Panel Data and Fixed Effects"

Week 5: Instrumental Variables (IV)

Understanding and applying instrumental variables methods.

Chapter 6: "Instrumental Variables"
Discuss a paper that uses an IV.

Week 6: Difference-in-Differences (DiD)

Estimating causal effects using DiD designs.

Chapter 7: "Difference-in-Differences"
Discuss a paper that uses DiD.

Week 7: Regression Discontinuity Design (RDD)

Causal inference with RDD, assumptions, and applications.

Chapter 8: "Regression Discontinuity"
Discuss a paper that uses RDD.

Week 8: Synthetic Control Method

Synthetic control methods for comparative case studies.

Chapter 9: "Synthetic Control"
Discuss a paper that uses Synthetic Control.

Week 9: Experiments

Design, implementation, and analysis of randomized experiments.

Chapter 10: "Experiments"
Discuss a paper that uses an experiment.

Week 10: Empirical Issues - Randomization Inference, Multiple Testing, Clustering, Missing Data, Balance Checks

Practical considerations and common pitfalls in empirical research.

Chapter 11: "Empirical Issues and Diagnostics"

Week 11: Frontiers in DiD, IV, and Other Methods

Recent advances and frontier research in causal inference methods.

Chapter 12: "Recent Advances and Frontiers"

Week 11: Student Presentations, Part 1

Presentations of method papers.

Week 12: Student Presentations, Part 2

Presentations of student research papers.

Week 13: No Class (Thanksgiving Recess)

Week 14: Exam or Alternative Assignment

Cumulative exam or approved alternative assignment.

Week 15: Reading Period

Working on final papers.