

**ECON 590 (M1)**  
**Applied Econometrics: Advanced Topics in Program Evaluation and Policy Analysis**  
MSPE, Department of Economics  
Fall 2023

**Instructor:**

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DKH 101-E  
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**Class meetings:** Tuesday/Thursday, 9:30 am-10:50am CT in DKH 119.

**Office Hours:**

- Individual office hours: Mon 3:30-4:30pm CT, Tues 1:30-2:30pm CT Schedule time [here](#). Can also schedule alternative appointment if necessary. Office hours are an opportunity to discuss questions you have about the class, problems with the assignments, or broader topics related to the course material and economics/econometrics more broadly. Office hours are available in DKH 101-E or on zoom (zoom room [here](#), passcode 160866).
- Group office hours: Mon 4:30-5:30pm CT on zoom (room [here](#), passcode 160866), Tues 2:30-3:00pm CT in person (in DKH 101-E). No appointment necessary.

**Course Description:** This course will cover modern econometric techniques for estimating causal effects including experiments, regression and matching, instrumental variables, difference-in-differences, synthetic control, and regression-discontinuity designs. We will discuss the properties of each of these techniques and illustrate them using examples from health policy, education policy, workforce development programs, environmental and labor market regulations, and economic development programs. Students will gain experience applying the techniques to study policies in real-data sets using the statistical programming language R. Emphasis will be placed on following good coding and data practices.

**Course Goals:** At the end of this course, students should be able to:

- 1) Be informed consumers of research & news regarding causal effects of public /private policies.
- 2) Describe advantages and limitations of different techniques for estimating causal effects.
- 3) Implement a variety of strategies for estimating causal effects using R programming language.

**Prerequisites:** Econ 502 and 503 are strongly recommended for individuals taking this course. Please schedule a meeting with me if you have not completed these courses. The course assumes that students have knowledge of calculus, linear algebra, and basic statistics and econometrics. In particular, students should be familiar with basic multivariate calculus (first and second derivatives and how to obtain them), matrix operations, basic properties of random variables, calculating expectations, variances, correlations, conditional expectations and variances, and multiple linear regression.

**Credits:** 4 credits

**Course structure:** The course will be a “flipped” course. I will post videos of lecture segments (usually one or two per class meeting) prior to our class meeting. During our class meeting, we will then discuss the lecture and readings, have activities, go through coding examples, and provide feedback to one-another. Students are expected to attend all classes whenever possible and participate in all discussions. Students taking the class virtually will be given the class activity and discussion topics prior to the start of the class I will cold call throughout the semester.

### Learning Resources:

The four required textbooks for this course are:

- *Mastering 'Metrics: The Path from Cause to Effect* by Josh Angrist and Jorn-Steffen Pischke (2014)
- *Foundations of Agnostic Statistics* by Peter Aronow and Benjamin Miller (2019)
- *Counterfactuals and Causal Inference, 2<sup>nd</sup> Edition* by Morgan and Winship (2015)
- *Introduction to Statistical Learning, Corrected 7<sup>th</sup> Edition* by James, Witten, Hastie, and Tibshirani (2017). Available for free [here](#).

Additional materials, as well as assignments and practice materials will be available on Illinois Canvas (<http://canvas.illinois.edu>). Announcements about assignments, readings, and other course items will be posted on Canvas.

This course will use R, which is a free statistical computing language. R can be downloaded at <http://www.r-project.org>. Additional background materials on R will be provided throughout the course. Students are strongly encouraged to take the introduction to R class offered by the economics department the first two weeks of the semester.

### Requirements:

- **Assignments:** There will be 6 mandatory assignments that together will count for 20% of the grade. I will drop your two lowest assignment scores when computing this grade. The assignments will be due on:
  - Assignment 1: September 5<sup>th</sup>
  - Assignment 2: September 14<sup>th</sup>
  - Assignment 3: September 28<sup>th</sup>
  - Assignment 4: October 12<sup>th</sup>
  - Assignment 5: October 26<sup>th</sup>
  - Assignment 6: November 14<sup>th</sup>
  - Assignment 7: November 30<sup>th</sup> (optional)
- **Midterms:** There will be 1 midterm that will count for 15% of the grade
  - Midterm, October 22<sup>nd</sup>
- **Research Project:** Students will complete a research project worth a total of 35% of the grade. This project will be done in **groups of two**.
  - Topic brainstorming presentations: October 24<sup>th</sup> and 26<sup>th</sup> (2.5% of grade)
  - First draft of proposal. November 7<sup>th</sup> (2.5% of grade)
  - Final Proposal: November 16<sup>th</sup> (10% of the grade)
  - Final version: December 5<sup>th</sup> (20% of the grade)
- **Final Exam:** There will be a 3-hour exam during finals week which will cover the entire course material and be worth 30% of the grade. The final exam is currently scheduled for Friday, December 8<sup>th</sup> from 1:30-4:30pm CT and will be held online.

**Assignments:** Will be mixture of problem sets and other assignments.

**Research Project:** Students will propose their own program evaluation or other piece of policy analysis. There will be a series of deadlines to help students put together these projects, involving both peer and instructor feedback. More details to come.

**Grading:** Overall Grades will be on a +/- scale and may follow a light curve.

### Assessment Policies:

### *Assignment Policies:*

Student grades on their lowest three assignments will be dropped. All assignments are to be turned in at the beginning of the class in which they are due. Late assignments receive *no* credit without an instructor approved excuse. Acceptable excuses include physical and mental illness, and personal or family emergencies. A written request for an extension must be submitted at least 48 hours in advance.

Assignments can be turned in early at your instructor's office or via email. You are encouraged to work as a group with your classmates on problems sets, although you have to hand in your own solutions.

Note that we cannot grade assignments that we cannot read. Consequently, please be careful to make all assignments legible.

### *Exam Policy:*

In the event that a student misses one of the exams, the instructor reserves the right to give the student a zero on that exam. There are no make-up exams without an instructor approved excuse. Instructor approved excuses include 1) medical reasons, in which case you should bring a letter from a medical professional describing your reason for missing the exam, 2) death or serious illness of an immediate family member or close friend (documentation required), or 3) conflict with a religious holiday. Requests for exam make-ups should be made as far in advance as possible.

We will follow the University guidelines on student conflicts with final exams. For this year's student code, see [http://admin.illinois.edu/policy/code/article3\\_part2\\_3-201.html](http://admin.illinois.edu/policy/code/article3_part2_3-201.html) .

### *Regrades:*

All regrade requests must be submitted in writing no more than one week after the assignment or exam is returned. The request must be written and include a detailed summary of why the student believes the grade they received was incorrect. I generally regrade the entire exam or assignment, so the grade may go up or down. Consequently, students should only request a regrade if they are very confident that the original grade they received was incorrect.

### **Statement on Academic Integrity**

We will follow Articles 1-401 through 1-406 of the *Student Code* (beginning at [http://studentcode.illinois.edu/article1\\_part4\\_1-401.html](http://studentcode.illinois.edu/article1_part4_1-401.html)). This rule defines infractions of academic integrity, which include, but are not limited to, cheating, fabrication, and plagiarism. You are responsible for following these guidelines (ignorance is no excuse). If you have any questions about whether something would be an infraction, consult with the instructor before proceeding.

### **Requests for Special Accommodations:**

To obtain disability-related adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call (217)-333-4603, email [disability@illinois.edu](mailto:disability@illinois.edu) or go to the DRES website.

Please also schedule a private meeting with the course instructor to discuss your needs and requirements. The instructor will attempt to meet all reasonable course accommodations once the student self-identifies. Please note that accommodations are not retroactive to the beginning of the semester, but begin the day you contact the instructor with a current letter of accommodation from DRES.

### **Emergency Response Recommendations:**

The university maintains guidelines for emergency responses. A list of recommendations when to

evacuate and when to find shelter are available at:

[http://illinois.edu/cms/2251/general\\_emergency\\_response\\_recommendations\\_8\\_16\\_13\\_final.docx](http://illinois.edu/cms/2251/general_emergency_response_recommendations_8_16_13_final.docx)

Floor plans for specific buildings are available at: <http://police.illinois.edu/emergency-preparedness/building-emergency-action-plans/>

### Course Schedule (tentative)

1	Aug 22	Course overview, logistics, and introduction to causality
	Aug 24	Introduction to causality: Potential Outcomes
2	Aug 29	Introduction to causality: Directed Acyclic graphs (DAGs)
	Aug 31	Randomization Day #1
3	Sept 5	Randomization Day #2
	Sept 7	Statistical programming in R Day #1
4	Sept 12	Statistical programming in R Day #2
	Sept 14	Hypothesis testing in experiments day #1
5	Sept 19	Hypothesis testing in experiments day #2
	Sept 21	Power Day #1
6	Sept 26	Power Day #2
	Sept 28	Block randomization
7	Oct 3	Noncompliance and Instrument Variables Day #1
	Oct 5	Noncompliance and Instrument Variables Day #2
8	Oct 10	When experiments go wrong: i) bad control, ii) SUTVA violations
	Oct 12	Introduction to observational studies: basics of matching
9	Oct 17	Conditional Independence Assumption/Back-Door Criterion
	<b>Oct 19</b>	<b>Midterm</b>
10	Oct 24	Regression
	Oct 26	Regression discontinuity
11	Oct 31	Differences-in-differences
	Nov 2	Difference-in-differences continued
12	Nov 7	Synthetic control and inference complications in synth/did
	Nov 9	Instrumental variables in observational settings
13	Nov 14	When is a causal estimate not enough?
	Nov 16	Introduction to prediction day 1: bias/variance tradeoff
14	<i>Nov 21</i>	<i>Thanksgiving Break</i>

	Nov 23	Thanksgiving Break
15	Nov 28	Introduction to prediction day 2: regularization
	Nov 30	Introduction to prediction day 3: tree based methods
16	Dec 5	Limits of quantitative analysis

**Course Readings (tentative – will be updated frequently)**

**Week 1:** Basics of causal questions

- *Mastering 'Metrics (MM): Introduction (xi-xv) and Chapter 1 (pages 1-17)*
- *Mostly Harmless Econometrics: Chapter 1, Chapter 2 pages 12-15 (posted on canvas)*

**Weeks 2:** Potential Outcomes and DAG Frameworks for Causal Inference

- *Morgan and Winship: Chapter 2 (pages 37-74)*
- *Morgan and Winship: Chapter 3 (pages 77-84)*

**Week 3:** Randomization

- *Mastering 'Metrics: Pages 17-46*
- *Fundamentals of Agnostic Statistics: Pages 89-116*

**Week 4:** Programming

- *Grant McDermott's data science lectures 3, 4, and 5. They're at <https://github.com/uo-ec607/lectures>*

**Week 5:** Hypothesis Testing in Randomized Experiments

- *Fundamentals of Agnostic Statistics: Pages 124-135*

**Week 6:** Statistical Power

- *Running Randomized Experiments, Chapter 6 (uploaded)*
- *Green and Gerber, Chapter 3 (uploaded)*

**Week 7:** Non-compliance and instrumental variables

- *Mastering Metrics, pages 98-139*

**Week 8:** Bad control / conditioning on colliders

- *Mastering Metrics, Chapter 6, pages 209-217*
- *Elwert and Winship (2014) Article: Endogenous Selection Bias: The Problem of Conditioning on a Collider Variable (uploaded)*

**Week 9:** Selection on observables and the back-door criterion

- *Mastering Metrics: pages 47-97*
- *Morgan and Winship: Chapters 4 and 5, pages 105-187*

**Week 10:** Regression Discontinuity

- *Mastering Metrics: Pages 147-177*

**Week 11:** Differences-in-differences

- *Mastering Metrics: Pages 178-209*

**Week 12:** Observational IV

- *Mastering Metrics: Pages 115-146*

**Weeks 13-14:** Prediction basics: cross-validation

- *Introduction to Statistical Learning: Chapter 2, Pages 15-42 (uploaded)*
- *Introduction to Statistical Learning: Chapter 5, Pages 175-197 (uploaded)*

**Week 15:** Prediction methods: regularization and tree-based methods

- *Introduction to Statistical Learning: Chapter 6, Pages 203-259 (uploaded)*
- *Introduction to Statistical Learning: Chapter 8, Pages 303-332 (uploaded)*

**Week 16:** Limits to quantitative analysis

- *To be announced*