

Causal Inference and Research Design

Economics 4349 and 5349

Tuesday and Thursday,

Foster 203 3:30pm-4:45pm

Professor information

Dr. Scott Cunningham

Preferred email address: scunning@gmail.com

<https://www.scunning.com>

Office Location: 320.15

Office Hours: Tuesday and Thursday 10:45am- 12:00pm or by Zoom appointment
(254) 537-2239

Github repo: <https://github.com/scunning1975/University-Causal-Inference>

Platform: https://www.twitch.tv/causalinf_did

Newsletter: <https://causalinf.substack.com>

This syllabus may change, but I am making an effort to make it fixed.

Course Description: The modern field of causal inference is an applied statistics and sub field within econometrics built on a theory of counterfactuals and the potential outcomes framework (Cunningham, 2021; Imbens and Rubin, 2015). My course is primarily based on the design tradition, though I will also sometimes discuss the model tradition too (Pearl, 2009). Our focus this semester is to train you in the art and science of this field by learning more about empirical microeconomics by learning the major designs and econometric estimators used in causal inference, as well as advance your skills in empirical work.

Prerequisite(s): Econometrics or equivalent.

Course Objectives:

- to develop a solid understanding of design based causal inference.
- to develop a solid understanding of empirical workflow
- to develop a solid understanding of statistical language (like R, python or julia) or statistical software (like Stata)
- to develop experience applying all three to empirical microeconomics research

How I will try to help you reach these goals:

1. **Coding together in class.** Every now and then throughout the semester, we will take breaks and work on the Lott and Mustard (1997) project, as well as your research project. You are required on those days to these and cannot work on other work.

2. **Empirical workflow.** You will be early on doing some simple analysis related to data collection, data cleaning, automation and production of tables and figures, as well as writing a simple paper discussing what you found.
3. **Replications.** We will apply these research designs throughout the semester. The difference-in-differences replication is semester long and will go through stages of development, but the others will be based on what we are covering around that time.
4. **Original empirical project.** You will collect your own data by the week before spring break (last week of February) and show me simultaneously an idea, a design/strategy, and preliminary analysis. You cannot proceed unless all three occur.

Required and Supplemental Textbooks

There is only one required textbook, but you do not have to purchase it as it is available online free. There is also an excellent supplemental book I am assigning

- **Required:** Cunningham (2021), Causal Inference: the Mixtape (Yale University Press). This can be accessed via my website for free at <https://mixtape.scunning.com>.
- **Supplemental:** Huntington-Klein (2022), The Effect: An Introduction to Research Design and Causality (CRC Press). This can be accessed for free at <https://theeffectbook.net>.

Classwork and your final grade:

- **Coding assignments (25%):** Throughout the semester, there will be several coding assignments. You are expected to work on these together but you must turn in your assignments separately. These are pass/fail.
- **Extending Lott and Mustard (1997) (25%):** A main focus of the semester is an extension to a controversial paper from the 1990s by Lott and Mustard (1997). You are expected to be thoroughly familiar with the original paper, the followup Donohue, Aneja and Zhang (2011), the laws more generally, the methods the authors used, and the dataset itself. The dataset we will use is the state-level versions (i.e., not the county-level version of the original). See https://works.bepress.com/john_donohue/89/ and scroll to the bottom for the data. We will meet regularly to discuss your progress as we try to reconcile differences in our analysis as well as extend the paper using the Callaway and Sant'Anna (2020) estimator as well as stacking. We will meet regularly throughout the semester to discuss what we are finding, solve problems, "code together", and reconcile results. Our goal by early April is to have completed our analysis and produced a final review of both the county and state level analysis using TWFE, Callaway and Sant'Anna (2020) and stacking. Our goal is as much collaborative as anything else, though, so we will oftentimes meet and check in on these things. You are encouraged to work together even though your final output will be a paper written in the style of an empirical microeconomics paper discussing the original paper, the theory, the dataset, the methodological issues with the original paper, your two extensions (in addition to a replication), results and interpretation and conclusion.
- **Original research project (50%):** You will write an original research paper for this class. It will require collecting data, cleaning it, analyzing using a research design and appropriate econometric estimator. It will require writing a formal paper in the style and rhetoric of an empirical microeconomics paper. You will be judged on success which includes collecting the data, successfully cleaning it following the empirical workflow set up this semester, analysis using research design and econometric modeling, and a good paper following the same structure I just outlined.

Github repository I will be distributing materials through Github this semester, not Canvas. This is because Github (and git) is the dominant way in which empirical work is done today, but also it is the way in which new estimators are distributed as increasingly statisticians and economists only write in R. Stata distributes its new packages via ssc, but usually R authors distribute new packages via Github. Our Github repo is <https://github.com/scunning1975/University-Causal-Inference>.

Credit and grade distribution Students will be evaluated based coding assignments, extension project, and original research project.

Grade Distribution:

Coding assignments	25%
Extension of Lott and Mustard (1997) paper	25%
Original research project	50%

Final grade scales:

≥ 90 -100	A	70 - 89.99	B
50 - 69.99	C+	≤ 49.99	F

COVID related policies

As each of you know, the United States is now two years into a global pandemic. As of this writing, over 850,000 Americans have died from COVID and 5.55 million worldwide. The epidemic has moved into its second variant called Omicron which is more contagious than the past ones. This disease has been a historic once-in-a-lifetime event affecting public health, mortality, the functioning of our economy, as well as school enrollment and pedagogy. There are two things we must discuss, therefore, related to the pandemic: the format of the class which can change over the semester depending on local factors and mandatory masking. I will discuss each of these now

Class Format Conversion

Due to the COVID-19 pandemic, this course may need to be converted to a [hybrid or] online format at some point in the semester. I have anticipated this possibility as I have prepared for the course, and will provide necessary information for you in that event. If that occurs, or if I as your professor am forced to quarantine, then I will move to asynchronous video lecturing which I will post online at a designated Dropbox folder.

Mandatory Masking

Baylor University is committed to providing a safe educational environment for all students, faculty, and staff. In order to create the healthiest environment possible, students and instructors must properly wear face coverings over their mouths and noses while in Baylor buildings and while in the classroom. In addition, social distancing should be maintained within all classroom environments.

Any student who does not bring a face covering or refuses to wear one will be dismissed from class and be considered absent which for our class means you will not receive class participation for that day. If a student who is not wearing a face covering refuses to leave class, the instructor may dismiss in-person class for that day. Such a student will be subject to disciplinary action through the Student Code of Conduct.

Lauren's Promise Lauren McCluskey, a 21-year-old honors student athlete at the University of Utah, was murdered on Oct. 22, 2018, by a stalker. We must all take actions to ensure this never happens again. Lauren's mother has asked professors to consider adding to the syllabus an assurance of assistance to students in danger called Lauren's Promise. **Lauren's Promise** is my promise to "listen and believe you if someone is threatening you." Any form of sexual harassment or violence will not be excused or tolerated at Baylor University.

In cases of sexual harassment or violence, Baylor will:

- Respond promptly and effectively to sexual assault, relationship violence, and stalking,
- Provide interim measures as necessary
- Provide confidential and non-confidential support resources,
- Conduct a thorough, reliable, and impartial investigation through its Title IX office
- Provide remedies as necessary.

If you are experiencing sexual assault, relationship violence, or stalking, you can take the following actions:

- If you are in immediate danger, call 911.

- Call Baylor Police Department at (254) 710-2222
- Report it to me, and I will connect you to resources. Please call or text me at any hour using my cell phone which is (254) 537-2239. I am pretty good at immediately responding. You can also DM me on Slack, or DM on Twitter at @causalinf.
- Seek confidential sources of support and help:
- Counseling and Consultation Service Available Monday to Friday 8am to 5pm through Baylor Counseling Center, https://www.baylor.edu/counseling_center, (254) 710-2467
- Health services, Monday to Friday, 8am - 5pm, <https://www.baylor.edu/healthservices/>, or call (254) 710-1010 any time to speak to a nurse
- Report the offense to the Title IX Office using the following URL (scroll to the middle of the page and click on “Reporting” <https://www.baylor.edu/titleix/>, email them using the following email address titleix_coordinator@baylor.edu, or call (254) 710-8454

Title IX Office – Title IX Coordinator, Kristan Tucker

Related to Lauren’s Promise is the Title IX Office, which I mentioned briefly above. As the Title IX Office is distinct from Lauren’s promise, let me explain it now. Baylor University does not discriminate on the basis of sex or gender in any of its education or employment programs and activities, and it does not tolerate discrimination or harassment on the basis of sex or gender. If you or someone you know would like help related to an experience involving sexual or gender-based harassment, sexual assault, sexual exploitation, stalking, intimate partner violence, or retaliation for reporting one of these type of prohibited conduct, please contact the Title IX Office at (254) 710-8454 or report online at www.baylor.edu/titleix.

The Title IX office understands the sensitive nature of these situations and can provide information about available on- and off-campus resources, such as counseling and psychological services, medical treatment, academic support, university housing, and other forms of assistance that may be available. Staff members at the office can also explain your rights and procedural options if you contact the Title IX Office. You will not be required to share your experience. If you or someone you know feels unsafe or may be in imminent danger, please call the Baylor Police Department (254-710-2222) or Waco Police Department (9-1-1) immediately. For more information on the Title IX Office, the Sexual and Gender-Based Harassment and Interpersonal Violence policy, reporting, and resources available, please visit the website provided above.

Makeup exam policy My makeup exam policy is that if you miss an exam for any reason, then the final exam will count for both the missed exam and the final itself.

Students with Disabilities Any student who needs learning accommodations should inform me immediately at the beginning of the semester. The student is responsible for obtaining appropriate documentation and information regarding needed accommodations from the Baylor University Office of Access and Learning Accommodation (OALA) and providing it to the professor early in the semester. The OALA phone number is (254) 710-3605 and the office is in Paul L. Foster Success Center - Sid Richardson - Room 190.

Academic Honesty

All students must be familiar with and abide by Baylor’s Code of Academic Conduct, which is available online at <http://www.baylor.edu/honorcode/index.php?id=44060>. I take matters of academic honesty very seriously. A student who commits academic dishonesty disrespects the hard work of his classmates. Any student found cheating, plagiarizing, or colluding during the course will be referred to the Associate Dean. If you fall behind in your coursework and even feel tempted to be dishonest, please see me first so that we find a way for you to turn in your work late (but with some penalty). That said, students are encouraged to study together and to collaborate on homework, although each student must write up her own homework.

Tentative Schedule and Topics

The following is a rough schedule of the topics we will cover in class. Usually, the Oyer chapters will be due every Thursday until we run out of chapters. This is a tentative schedule, but I will attempt to stay on schedule. The first day of class is January 19th and runs through May 5th 2021. We will start the first day immediately with lectures. I will be using a deck of slides in pdf form which I will be posting to Canvas. You are free to download them obviously and use them to help you understand the lectures.

Tentative Course Outline:

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments. Remember each Friday your Substack must cover no fewer than 2 of the readings.

Week	Content
Week 1	<ul style="list-style-type: none"> Review syllabus, history of design based causal inference, hidden curriculum, empirical workflow Due Friday night by midnight: Personal essay
Week 2	<ul style="list-style-type: none"> Finish Hidden curriculum, empirical workflow Mixtape Chapter 4: Potential outcomes Due Friday night by midnight: Empirical workflow assignment
Week 3	<ul style="list-style-type: none"> Mixtape Chapter 4: Potential outcomes Effect Chapter 10-11 Due Friday night by midnight: Perfect doctor exercise
Week 4	<ul style="list-style-type: none"> Mixtape Chapter 8: Panel (Two-way fixed effects or TWFE) Effect Chapter 16 Coding Together on Thursday – TWFE, cleaning, focus on sample sizes for Lott and Mustard (1997)
Week 5	<ul style="list-style-type: none"> Discuss TWFE results of Lott and Mustard (1997), cleaning choices (sample sizes) Mixtape Chapter 9: Difference-in-differences – regression, event studies and Abadie and Gardeazabal (2003), Sant’Anna and Zhao (2020) Effect Chapter 18
Week 6	<ul style="list-style-type: none"> Mixtape Chapter 9: Difference-in-differences and differential timing Callaway and Sant’Anna (2020), Goodman-Bacon (2021), Sun and Abraham (2020) Effect Chapter 18
Week 7	<ul style="list-style-type: none"> Mixtape Chapter 9: Difference-in-differences and differential timing – Cengiz et al. (2019) Effect Chapter 18 Coding together on Thursday – implementing stacking (anticipate a lot of problem solving), estimating Callaway and Sant’Anna (2020)
Week 8	<ul style="list-style-type: none"> SPRING BREAK – March 7 to 11
Week 9	<ul style="list-style-type: none"> Zoom class schedule due to travel Coding together on Tuesday – using Callaway and Sant’Anna (2020) Mixtape Chapter 6: Regression discontinuity Effect Chapter 20

Week	Content
Week 10	<ul style="list-style-type: none"> • Mixtape Chapter 6: Regression discontinuity • Effect Chapter 20 • Coding together on Thursday: Work on DiD and/or Hansen (2015) replication • Due Friday night by midnight: Extension of Lott and Mustard (1997) (final draft)
Week 11	<ul style="list-style-type: none"> • Mixtape Chapter 7: Finish RDD; Instrumental variables • Effect Chapter 19
Week 12	<ul style="list-style-type: none"> • Diadeloso: April 5th • Mixtape Chapter 7: Instrumental variables • Effect Chapter 19 • Due: Hansen (2015) replication
Week 13	<ul style="list-style-type: none"> • Mixtape Chapter 10: Synthetic control
Week 14	<ul style="list-style-type: none"> • Mixtape Chapter 5: Matching • Effect Chapter 14 • Due on Friday by midnight: Synthetic control assignment
Week 15	<ul style="list-style-type: none"> • Mixtape Chapter 5: Matching • Effect Chapter 14 • Due on Friday by midnight: Matching assignment unless otherwise stated (i.e., we were unable to get through matching)
Week 16	<ul style="list-style-type: none"> • DAGs if we have time • Original research project due following Monday May 9th

Articles and Books on the Syllabus

- Abadie, Alberto and Javier Gardeazabal. 2003. “The Economic Costs of Conflict: A Case Study of the Basque Country.” American Economic Review 93(1):113–132.
- Callaway, Brant and Pedro H. C. Sant’Anna. 2020. “Difference-in-differences with Multiple Time Periods.” Journal of Econometrics .
- Cengiz, Doruk, Arindrajit Dube, Attila Lindner and Ben Zipperer. 2019. “The Effect of Minimum Wages on Low-Wage Jobs.” Quarterly Journal of Economics pp. 1405–1454.
- Cunningham, Scott. 2021. Causal Inference: The Mixtape. 1st ed. Yale University Press.
- Donohue, John J., Abhay Aneja and Alexandria Zhang. 2011. “The Impact of Right to Carry Laws and the NRC Report: Lessons for the Empirical Evaluation of Law and Policy.” American Law and Economics Review 13(2):565–632.
- Goodman-Bacon, Andrew. 2021. “Difference-in-differences with variation in treatment timing.” Journal of Econometrics .
- Hansen, Ben. 2015. “Punishment and Deterrence: Evidence from Drunk Driving.” American Economic Review 105(4):1581–1617.
- Huntington-Klein, Nick. 2022. The Effect: An Introduction to Research Design and Causality. 1st ed. CRC Press.
- Imbens, Guido W. and Donald B. Rubin. 2015. Causal Inference for Statistics, Social and Biomedical Sciences: An Introduction. 1st ed. Cambridge University Press.
- Lott, John R. and David B. Mustard. 1997. “Crime, Deterrence and the Right-to-Carry Concealed Handguns.” Journal of Legal Studies 26:1–68.
- Pearl, Judea. 2009. Causality. 2nd ed. Cambridge University Press.

- Sant'Anna, Pedro and Jun Zhao. 2020. "Doubly Robust Difference-in-Differences Estimators." Journal of Econometrics 219:101–122.
- Sun, Liyang and Sarah Abraham. 2020. "Estimating Dynamic Treatment Effects in Event Studies with Heterogenous Treatment Effects." Journal of Econometrics Forthcoming.