

# PH.D. ECONOMETRICS III (CAUSAL INFERENCE)

## SYLLABUS

ECON 7175-01, 3 credit hours

Spring 2020

TR 2-3:15 P.M. in Tilton Hall 307

Instructor: Professor Patrick Button  
Department of Economics  
School of Liberal Arts  
Tulane University

Pronouns: He/Him/His (What's this?)

Office: Tilton Hall 205 (I will not be here so this is pretty irrelevant right now.)

Office hours: Drop in hours on Saturdays 4 to 5 pm via Zoom: [tulane.zoom.us/j/940926677](https://tulane.zoom.us/j/940926677)

Appointments: [patrickbutton.youcanbook.me](https://patrickbutton.youcanbook.me)

Email: [pbutton@tulane.edu](mailto:pbutton@tulane.edu) (preferred, I regularly check 9-5, M-F, and a few times on weekends)

Twitter: @ProfPButton

### Course Description

This course builds somewhat on the content of PhD Econometrics I, and II, which is taught concurrently. This course covers methodologies that would be in any applied microeconometricians "toolbox". These include regression control, instrumental variables, experiments, panel methods, difference-in-differences, synthetic control case studies, regression discontinuity design, and propensity score matching. The course will cover the basic theory, applications, and best practices. Students will put these techniques into practice with actual data sets, using Stata, and will flesh out their own research proposal that incorporates one or more of these techniques.

### Prerequisites and Corequisites

The prerequisite for this course is ECON 7160 (PhD Econometrics I). The co-requisite (should be taken at the same time as this course) for economics PhD students is ECON 7170 (PhD Econometrics II). Students who are not in the economics PhD program are welcome to continue to take this course without also having enrolled in ECON 7170. Registering in that course at the same time will be helpful but is not required. There are a few topics that I build upon that are covered in ECON 7170, so for those of you not in that course, you may have to do some extra readings on your own or attend some of the lectures for that course.

If you would like to take this course but are outside the economics PhD program then please contact me, if you have not already, so we can discuss. Generally, I let some students into this course that have an econometrics or statistics background and are looking to learn more about policy analysis. This includes, for example, some M.A. in Economics students or exceptional undergraduates, and Ph.D. students in Accounting, Business, Political Science, and Sociology.

In this course I will assume that you have significant exposure to linear regression and related statistical methods, such as maximum likelihood. The methodologies I will cover will build off of this. Those who have difficulty understanding basic concepts such as hypothesis testing, regression coefficients, standard errors, asymptotics, and maximum likelihood, will need to brush up

on these concepts as you will fall behind in your understanding if you do not understand these basics. Please ask for help if you feel like you're getting too lost (some amount of being lost is normal, since econometrics courses are always difficult). The first midterm is a good test of how you are doing in the course, as you'll see that my exam questions focus more on intuition.

## Program Outcomes

This course is fundamental to your entire Ph.D. program. The vast majority of you will need to estimate the effects of policies, laws, or programs in a way that gets close to the estimation of the causal effect. The techniques taught in this course are fundamental to the toolbox of any applied economist. Almost all students write empirical papers as a part of their dissertation, and they all use one or more of the techniques I will be teaching you in this class. I will also be introducing you to how to use Stata for applied work and for research. While R is also great, using Stata is more common and the vast majority of students need to learn it well as soon as possible.

## Learning Outcomes

After completing this course, students will be able to...

### – Regression Control

- Explain the pitfalls of the “Kitchen Sink” regression approach.
- Explain how omitted variables can bias OLS estimates.
- Explain how measurement error can bias OLS estimates.
- Explain how simultaneity makes it difficult to estimate causal effects or isolate demand or supply curve.
- “Sign” the bias from omitted variables, measurement error, and simultaneity in an example.

### – Standard Errors and Weighting

- Explain why “robust” standard errors are more realistic than “raw” standard errors.
- Estimate robust standard errors and clustered standard errors in Stata (extremely easy).
- Argue what asymptotic assumptions are necessary to estimate standard errors, and how bootstrapping gets around this.
- Explain bootstrapping intuitively to senior undergraduates taking econometrics.
- Apply bootstrapping using Stata or R.
- Explain why Monte Carlo experiments are useful to compare methodologies.
- Explain the concept of a cluster and how it affects the estimation of standard errors.
- Discuss when weighting a regression (using survey weights) is appropriate and when it may not be (as per Solon, Haider and Wooldridge (2015)).
- Estimate weighted and unweighted means and regressions in Stata.

### – Instrumental Variables

- Explain how IV is a possible solution to omitted variables, endogeneity, and measurement error.

- Explain the identifying assumptions of IV and what happens when they are violated.
- Explain what happens when instruments are weak.
- Explain why IV may be necessary in the context of the classical experiment.
- Explain the concept of non-compliance and the local average treatment effect (LATE).
- Identify instruments as either “good” or “bad” based on if they violate the IV assumptions, are weak, or provide LATE estimates without external validity.
- Run IV and two-stage least squares (2SLS) in Stata (see Nichols (2007)).
- Conduct tests of weak instruments and over-identification tests and explain why they are important.
- Explain reasons why the IV/2SLS estimates and the OLS estimates may differ (e.g., bias, measurement error, LATE).
- **Experiments**
  - Explain how experiments generate unbiased estimates and avoid the earlier problems that plague regression control.
  - Explain how compliance affects the estimation of treatment effects.
  - Explain what must be done in situations of imperfect compliance.
  - Contrast “intent-to-treat” (ITT) and “treatment-on-the-treated” (TOT) estimates. What do they measure and how are they related?
  - Explain why it is necessary to show that baseline characteristics are the same for the treatment and control groups.
  - Assess the external validity of an experiment (e.g., field experiment vs. lab experiment)
- **Difference-in-Differences**
  - Explain what panel data is and why it is useful.
  - Assess whether fixed effects or random effect is more appropriate, appealing largely to arguments about omitted variables.
  - Determine which controls would not be required (i.e. they drop out) when first differences or fixed effects are used.
  - Contrast the first difference and fixed effects.
  - Explain concepts like “within-group variation”
  - Explain a simple difference-in-differences to my undergraduate students (it’s possible and not hard) using a 2 by 2 grid, an intuitive explanation, and an example.
  - Explain intuitively, and using an example, what variation fixed effects control for and what variation time effects control for.
  - Explain what variation is not controlled for under a DiD or DiDiD and what possible variation or shocks remain as threats to the casual estimate.
  - Explain a DiDiD, including what two-way fixed effects capture.
  - Assess to what extent policies analyzed in a DiD or DiDiD could be endogenous, and discuss how the sign could be signed.
  - Understand why standard errors should be clustered at the level of policy variation, and what happens when you don’t do this, i.e. Bertrand, Duflo and Mullainathan (2004)

and Moulton (1990).

- Understand why the above clustering is a poor approach with few treated units (i.e. Cameron, Gelbach and Miller (2008), Conley and Taber (2011)).
  - Explain what two-way or multi-way clustering is (i.e. Cameron, Gelbach and Miller (2011)).
  - Explain what time trends are and why they are fundamental to DiD studies.
  - Explain the “Parallel Paths” assumption, and the weaker assumptions such as “Parallel Growth” (as in Mora and Reggio (2019)).
  - Speculate, using an example (e.g., Acemoglu and Angrist (2001)) if there are likely to be time trends that are differential for the treatment and control groups.
  - Estimate DiD and DiDiD models in Stata both with and without time trends.
  - Assess if there appear to be time trends in aggregate by creating an event study figure.
  - Assess if treatment effects would appear in levels or in growth rates, and if time trends would attenuate estimates or not (see Meer and West (2016)).
  - Understand how the average DiD estimate is a weighted combination of all 2x2 estimates (i.e. (Goodman-Bacon, 2019a))
  - Conduct a Bacon decomposition using Stata
- **Synthetic Control Case Studies**
- Explain the “synthetic control” approach in an intuitive way to undergraduate students (it’s possible).
  - Explain how the control group (synthetic control) is constructed.
  - Understand how inference is done with this technique.
  - Explain how the control group under synthetic control differs from the control group under panel DiD.
  - Discuss how the methodology has evolved since the seminal Abadie, Diamond and Hainmueller (2010) paper (e.g., how to deal with covariates, how to better construct control groups, how to better deal with multiple outcomes, how to incorporate more than one treated group).
- **Regression Discontinuity Design**
- Explain the difference between a “sharp” and a “fuzzy” RD.
  - Explain how the treatment effects estimated with RD are “local” (i.e. local average treatment effect, or LATE)
  - Contrast RD with an actual experiment, explaining how it is similar and what assumptions are necessary for to be similar.
  - Estimate a discontinuity in Stata using the most up-to-date non-parametric methods
  - Understand best practices for when the assignment variable is discrete (e.g., use parametric methods, cluster as per Lee and Card (2008))
  - Understand why there is so much model uncertainty for parametric estimation of RD (see Button (2016)).



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## Drop-In Office Hours

I have drop in office hours now, in addition to booked office hours using [patrickbutton.youcanbook.me](mailto:patrickbutton.youcanbook.me). These drop in office hours do not require an appointment. You'll start in a waiting room and then i'll pull you into a one on one meeting. Below is the Zoom information for this. For now these are on Saturdays from 4 pm to 5 pm until (and including) April 11. After April 11, if the city re-opens, I will switch from Saturday to another day.

Topic: Metrics III - Optional Drop in Office Hours  
 Time: Mar 21, 2020 04:00 PM Central Time (US and Canada)  
 Every week on Sat, until Apr 11, 2020, 4 occurrence(s)  
 Mar 21, 2020 04:00 PM  
 Mar 28, 2020 04:00 PM  
 Apr 4, 2020 04:00 PM  
 Apr 11, 2020 04:00 PM

Please download and import the following iCalendar (.ics) files to your calendar system.

Weekly: [https://tulane.zoom.us/meeting/tJAtfuuuqDwtL0eDXYRU1E4dBiliVJ4Bxg/ics?icsToken=98tyKuCsrrjIoHNKSt139c7IvA5n4b9\\_2110er4d1pS3QUgUHZiH\\_Out0GOZdCN-B](https://tulane.zoom.us/meeting/tJAtfuuuqDwtL0eDXYRU1E4dBiliVJ4Bxg/ics?icsToken=98tyKuCsrrjIoHNKSt139c7IvA5n4b9_2110er4d1pS3QUgUHZiH_Out0GOZdCN-B)

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Find your local number: <https://tulane.zoom.us/j/7889715349>

## Booking Office Hours

In addition to the drop in office hours, you can also book times with me using [patrickbutton.youcanbook.me](https://patrickbutton.youcanbook.me). There are several times available there, but if you can't find a time that works then please email me. I am working with Tulane IT to link my Zoom account with my [youcanbook.me](https://patrickbutton.youcanbook.me) account (they need to authorize my request). Once I do so, with your booking it'll automatically email us the zoom meeting link. Until then, use this URL for the meetings: <https://tulane.zoom.us/j/7889715349>.

## Text and Reading Materials

The required textbooks for this course are:

Angrist, Joshua D., and Jorn-Steffen Pischke. 2008. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton, NJ: Princeton University Press

Angrist, Joshua D., and Jorn-Steffen Pischke. 2015. *Mastering 'Metrics: The Path from Cause to Effect*. Princeton, NJ: Princeton University Press

In the list of readings below, I refer to these books as MHE and MM, respectively. MM is a follow-up to MHE. They are similar but MM is less technical. I suggest you read both, but you may find one or the other more useful depending on your technical background in econometrics. Start with MM first and then read MHE. My lectures tend to follow MM much more heavily, since I favor intuition. These books are available at the bookstore and are relatively cheap compared to other textbooks.

There are also two required "textbooks" that are both free PDF e-books. One is by Scott Cunningham entitled "Casual Inference: The Mixtape". This is available at [https://scunningham.com/cunningham\\_mixtape.pdf](https://scunningham.com/cunningham_mixtape.pdf). In the list of readings below, I refer to this as "Mixtape". You should read the whole thing eventually, but I indicated below which parts of this correspond to which content in the course.

The second is by Austin Nichols entitled "Casual Inference: Measuring the Effect of X on y". This is available at <http://pped.org/cimexy.pdf>. In the list of readings below, I refer to this as "Causal Inference". You should read the whole thing eventually, but I indicated below which parts of this correspond to which content in the course.

In addition the following books are also helpful for reference and are useful for all graduate students to have:

Greene, William. *Econometric Analysis*. Prentice Hall.

Kennedy, Peter. *A Guide to Econometrics*. Wiley-Blackwell.

Wooldridge, Jeffrey. *Econometric Analysis of Cross-Section and Panel Data*. MIT Press.

There is one required reading from Wooldridge (Ch. 10). It's not required that you buy these three books but owning them may prove helpful. I often find myself referring to all three books. I don't use Kennedy's book as much as reference but it was a helpful book when I was learning econometrics. The book presents material in a different and intuitive way, and it covers issues you'd face in practice.

You may also find the following books useful to learn Stata:

Acock, Alan. 2008. *A Gentle Introduction to Stata, 2nd Edition*. Stata Press

A. Colin Cameron, and Pravin K. Trivedi. *Microeconometrics Using Stata, 2nd Edition*. Stata Press

In addition to the textbooks, there will be several other readings, all of which will be available through the course Canvas page (or I will send them to you another way). These readings are listed below under "Class Schedule and Readings". These readings form a larger part of the required reading for the course. The textbooks above are more for background material or to be used as references. Some of the readings listed below will be required while others will be reference material. Students find this syllabus to be a useful reference later when they need to dig into methodologies more.

It is your responsibility to follow my announcements and do the readings. Not keeping up to date on readings will negatively affect your ability to achieve the student learning outcomes and will negatively affect your grade.

## Evaluation Criteria and Grades

Success at achieving the learning outcomes above is measured through various course assignments and exams.

Final course grades will be based on the following breakdown:

- First Midterm (10%) (Tuesday Feb. 11)
- Second Midterm (10%) (Thursday Mar. 26)
- Cumulative Final Exam (25%) (Saturday May 9)
- Stata Problem Sets (4 total) (20%)
- Research Proposal (25%)
- Class Presentation - Research Proposal (5%)
- Activities (5%)

In determining your final letter grade, I will first calculate a percentage grade based on the above criteria. Then I will convert this final percentage grade to a final letter grade as follows:

- A = 93% to 100%, A- = 90% to 92.99%,
- B+ = 87% to 89.99%, B = 83% to 86.99%, B- = 80% to 82.99%,
- F = 0% to 79.99%

Note that I do not round grades up if you are close to a cut-off or otherwise tweak grades (e.g., apply a curve). I would prefer not to add subjectivity into the process as this is not fair, especially since research suggests that this kind of grade rounding is more likely to be biased against minorities or women. Please do not ask me to do this.

Below are more details on each individual evaluation criteria.

## Midterm Exams

There are two midterm exams, one on **Tuesday Feb. 11** and one on **Thursday Mar. 26**. These are scheduled for the entire class time and will start right when class starts. Each midterm is normally about five short answer questions.

These midterms, and all my other questions, including comprehensive exam questions, focus on short-answer questions where you discuss methodologies. The questions focus on the intuition behind the methodologies and the way that the methodologies can generate causal estimates. There may also be questions on best practices (e.g., what should you do in this situation). I rarely ask questions that require you write out matrix algebra. Rather, I will ask you write your regression equations or perhaps write out how your regression would look if you programmed it in Stata. I do not give questions where you derive estimators or do proofs. Thus, this course is different from your other econometrics or statistics courses. Students often do better or worse on the first midterm than they expect as they get used to discussing intuitive concepts around identification, “treatment variation”, etc., rather than deriving estimators. This is a much different skill that needs to be developed.

If you know you cannot make the midterm please make arrangements with me in advance to reschedule it as soon as possible. Otherwise any missed midterms will result in a zero unless there was a legitimate emergency (that you can document in some way) that led to you being unable to attend the midterm. I am more relaxed about all these policies given the current COVID-19 crisis. I will work with you so you can take your exams.

Calculators are not necessary for any of my exams.

## Logistics of Conducting the Midterm Exam Online

Here is information on how we will conduct Midterm 2 (and the final exam, if needed) online.

**Zoom URL:** I’ll have everyone sign into a Zoom room during the exam. This is so that I can provide updates to students via speaking or typing in the group chat. I can also have a “one on one” meeting with you if you have questions during the exam. Here is the URL for Midterm 2 on Zoom: <https://tulane.zoom.us/j/170356804>

**Timing:** I will post and email the exam at 2 pm on Canvas on Thursday April 26. You must then submit the exam via Canvas by 4 pm that day. I am not increasing the length of the exam (still 4-5 short answer questions) but rather I am giving extra time. So, you have two hours, of which some time (five minutes?) will be spent submitting the exam to me. Exams submitted after 4 pm could incur a penalty.

**Where do I download the exam?** I will post the exam on Canvas under Files -> Exams. I will also email everyone to let them know the exam is posted, and I will also attach the exam file to that email.

**How do I take the exam?** Download the Word file to your computer. You will write the exam either by typing into that Word file (preferred) or by writing on paper and sending a scan of the exam to me (Genius Scan is a great smartphone app for this). You can also use a combination of both or even send graphs made in Microsoft Paint or another program. I don’t anticipate you needing to make graphs or draw things but feel free to use whatever method works for you so long as you use typical file formats and can send everything to me!

**How do I send you the exam?** I would prefer if you sent it to me on Canvas. On Canvas you can upload your files and submit them to me. Please use common file formats: Word (.doc, .docx, .rtf), PDF, and any common image files. If possible please combine everything into one file (e.g., paste images into the word file). Note that I do not have a Mac and cannot accept files made in

Pages or other mac programs unless you save them in a format such as RTF or PDF that can be opened by word or Adobe Acrobat.

As a reminder, the exam is open book so you can use any resources you want. Please do not use the internet to communicate with anyone, but you can use it to download files such as reading and course notes, but try to have those on your computer or printed already.

**Plagiarism warning:** Please do not copy-paste any answers from the Google doc with practice questions or copy-paste or type anything word for word from web pages, papers, class notes etc. I can tell if you are writing things in your own words or just trying to recycle answers from elsewhere. I will be comparing the text of individual student answers to each other and to the Google doc. I will also be running these and other plagiarism checks using Turnitin. I have caught graduate students plagiarising from papers in the past using this approach and I got one former M.A. student barred from applying for our Ph.D. student. In this case this was plagiarism of a research proposal but this concern applies here for the exam too.

**Can I ask you questions during the exam? How?** Yes, please ask me questions if I can help clarify! I have set up a zoom conference call for us (JoinURL:<https://tulane.zoom.us/j/170356804>). We can put everyone on mute (video optional) and then when you have a question, you can either type it into the group chat (if you're ok with others seeing the question), type it to me individually, email it to me, or you I can pull you into a "one on one" zoom chat and we can discuss. If I think the answer needs to be seen by the entire class then I'll type it into the group chat or make an announcement (probably typing would be less disruptive to you).

## Cumulative Final Exam

About half of the content of the final exam will be material that was not covered by the midterm exams (think a "Midterm 3"). The other half will be content from earlier in the course (i.e. "cumulative"), focusing on major concepts and anything that came up multiple times. The "cumulative" final exam questions are similar to comprehensive exam questions for my portion of the Econometrics comprehensive exam. The final exam is scheduled for **Saturday May 9 from 1 P.M. – 5 P.M.** in our normal classroom. If we are still doing courses via Zoom this this will be an open book exam you do at home, just like the midterm. If we do move back to in-person classes (seems unlikely), I might be able to still work with you if you need to take the exam remotely.

## Stata Problem Sets

A fundamental goal of this course is for you to learn how to apply the techniques in class to actual data, using Stata. Mastering Stata is crucial if you plan to do any applied econometrics research in the future (most of you will). Problem sets will focus on topics such as summary statistics and ordinary least squares (OLS), difference-in-differences (DD), synthetic control (or extensions to DiD), and regression discontinuity design (RD). Not all problem sets will have equal weight.

However, R is also very popular and useful, and some of you are in fields other than economics (e.g., political science), where other programs may be the standard. You are welcome to use another program other than Stata, however I cannot provide you with any support. If you plan to use another program, you will have to see if programs or code are available that allow you to do the estimation. Sometimes only Stata code (or only R code) is available for certain procedures.

You can work alone, but I suggest that you work in pairs, or in groups of three to complete the Stata problem sets. It is useful to work together with others as that improves learning. Please hand in only one assignment per group. While you may want to split up the assignment such that everyone does certain questions I highly suggest that everyone attempt each question and know

how complete it. Simply copying another student's work without doing the problem yourself will be extremely detrimental to your ability to learn Stata.

These Stata problem sets can be submitted by emailing them to the TA, Ziqi Xie (zxie@tulane.edu, attaching the files below). When emailing him, please CC your group members. Please attach the following:

1. A typed document that summarizes your answers or presents your tables or figures (.doc, .docx, or PDF).
2. Your Stata code (please annotate it so anyone can follow along)
3. Your Stata log file.

You will need access to a computer with Stata. If you don't get your own copy, then you can use Stata on the computers in Tilton 307, but those computers are rather outdated. Realistically you should get a Stata license that covers your entire graduate program. Probably getting a perpetual license is best.

I won't be providing direct guidance on how to learn and use Stata. If you need assistance or have Stata-related questions, I would discuss with the TA first since he is going to be charge of grading these problem sets. His name is Ziqi Xie and his email is zxie@tulane.edu. You can email him to book an appointment.

There are lots of resources available for learning Stata on your own. Stata Corp. has a list of excellent web-based tutorials for learning how to use Stata: <https://www.stata.com/teaching-with-stata/> and <https://www.stata.com/links/resources-for-learning-stata/>

For example, here are Stata cheat-sheets that are useful for beginners: <https://www.stata.com/bookstore/statacheatsheets.pdf>

There are also useful Stata resources here: <http://www.ats.ucla.edu/stat/Stata/examples/greene/default.htm> and <http://fmwww.bc.edu/gstat/examples/wooldridge/wooldridge.html>

The problem sets will be graded by the TA, Ziqi Xie (zxie@tulane.edu).

## Research Proposal

It is very important for your success in your program for you to get started on research as soon as possible. Usually the summer after your first year of the Ph.D. program is kind of odd, where you may not have things to do. I suggest that after you take a break of at least a week, you get started on some research.

To get you set up to work on research over the summer, I would like you to develop a research project. Ideally this project would become a field paper or dissertation paper later. If you get a head start this way, then you'll do better on the job market later or will finish your dissertation sooner. You can do this research proposal on your own or with a partner. If you have a partner, the length of the required proposal doubles, and your presentation will be twice as long. See more details below. If you want to have a group larger than two, then please discuss this with me.

*[Other useful things to do over the summer in addition to continuing to develop your research: teach a course if you can (I taught a summer course at my alma matar), learn L<sup>A</sup>T<sub>E</sub>X, Stata, R, or GIS, do RA work for a professor, get in better physical and mental health, take intensive English courses (for non-native speakers).]*

One hard requirement for the research proposal is that it must be empirical, where, using data, you attempt to estimate a causal effect of a policy /law /program/event. While you can add theory to the paper (often the best papers present or develop a theory, and then test the theory on data),

I don't do theory and can't really give you feedback on that. This also isn't a theory course. So, this project needs to be empirical, using data, and ideally using a technique we will cover in class (difference-in-differences is the most common but any causal method is fine.)

This research proposal is the most important part of this course, not only because it receives the most weight in the grading criteria, but also because it is the most useful in gauging your ability to do research and is the most related to teaching you how to do research. I also often have faculty ask me which graduate students would be good to work with. They ask me because my course is the best course in the core requirements that aligns with research methodology or research preparation. I give faculty my candid opinions on students and how you are doing or how you did at the research proposal forms the largest basis of my assessment.

### **Gradual Development of the Proposal**

You will start by coming up with a "pitch" for one or more research ideas. You'll first run those by your classmates outside of class. Then, run it by the TA, Ziqi Xie (zxie@tulane.edu). Any pitch that seems to have survived the scrutiny of your classmates and Ziqi can then be sent to me over email. I would like a few paragraphs for each pitch. You must address the following to the best of your ability at this stage:

1. What is your specific research question that you want to answer?
2. What has been done before on this topic and how would your study contribute to existing knowledge? What does your study add that is unique?
3. What is the general approach you'll use (e.g., difference-in-differences, experiment)?
4. What data source(s) would you use? Does the data exist such that you can actually do this?

At this "pitch" stage, I don't expect everyone to have concrete answers to all those questions. But I won't let you move forward on a project until I am convinced that all the above points are addressed.

Once I get your pitch(es), we will discuss them over email and/or in person. Probably only one out of three of your research ideas, on average, will be a good idea. This is normal. So, expect me to reject some of your pitches or ask you to revise them significantly to clarify your contribution, methodology, or feasibility (i.e. is there actually data that exists to study this.) You can of course continue to send me pitches until we find one that works for you. Even later in the process, if it becomes clear that your proposed idea won't work, then you can start over again with a fresh pitch.

There is no set deadline for when you need to send me your pitch(es). The earlier you start the process, the better. You will fail at this if you don't start early. This is not an assignment that you can try to finish in a week, or even a month. Developing research topics requires continuous input and revisions over a longer time period. While it would be nice to have full exposure to all the research methodologies we will cover before developing your pitches, my suggestion is to read the entire Mastering Metrics book in January, so that you have the intuition behind all the methodologies that you could use.

After I approve your pitch, you can start on the proposal. Your proposal will have content and be formatted as detailed in the sub-sections below. I am willing to provide feedback on your proposal as you develop it. I am willing to "grade" your proposal once before you submit the final version. What I will do during this grading is grade it as if it's the final version, applying the

grading rubric. I will then give detailed comments based on the rubric. This will give you a sense of what you need to improve. If you submit a draft to me that you want graded in this way, then please let me know explicitly that you would like it graded. You can also get feedback from the TA, Ziqi Xie (zxie@tulane.edu), and I will require you to do so before I do this interim grading. I also recommend that you have your classmates look over your drafts as well. I should never be the first person to read a draft. If the draft has obvious major errors, then I'll just reject it and will be reluctant to look at your work in the future. However, if you make consistent progress and outline to me what you're looking for feedback on, then I am often excited to provide feedback. The effort and organization you put in gets reflected in my effort and focus when I provide comments.

Outside of formally giving you this interim grade once, I am happy to comment on your proposal or answer your questions. If you would like feedback in this way, then please email me with specific questions so I know what to focus on. Whenever you submit updated drafts to me, please provide me with a summary of changes you've made to respond to my feedback. The most organized you are in working with me, the better feedback you will get from me.

I will also be available over the summer to provide comments on your research proposal if you decide to continue working on it. But I suggest that you talk to other faculty about your proposal, especially if the research is in a field that I am less experienced in. They may be better suited to provide comments on it as you work on it. Even during this course, you are welcome and encouraged to talk to other faculty about your proposed projects. This is especially important for those of you in fields outside of economics (e.g., political science).

### **Content and Grading of the Proposal**

Once I give you the go-ahead to continue developing one of your ideas, you can start writing up a proposal. Your proposal must have the following:

- An introduction that motivates your project: What is the larger issue or thing we don't know, what are you proposing to do to study it, and why does this help answer that question? I.e. why should I care about your study? "Selling" your research is an exceptionally important skill. It is very important that you make clear what you propose to research and how it will contribute something new.
- A data section that describes the data you will use.
- A methodology section that explains the methodology you will use. This would explain your main regression(s) and not the methodology for every sub-analysis or robustness/sensitivity check. You will need to present regression equation(s) and explain them, including explaining and justifying control variables, etc. Aim to use the most up-to-date methodology. This sections should mirror methodology sections in academic papers but yours would be more concise and less polished at this stage.

I will grade the proposal using the rubric that I have uploaded the Canvas. The rubric scores your proposal out of 10, with 2 points each for content, policy implications, contribution, feasibility, and structure/grammar/references. These categories are detailed in the rubric document.

### **Formatting for the Proposal**

The formatting requirements for the proposal are as follows:

1. Minimum 2,000 words and maximum 4,000 words (unless otherwise authorized). This corresponds to roughly 4 to 8 single-spaced pages. This word count excludes the references section and any tables, figures, or brief appendix material that you might include. Early drafts submitted for feedback, before the final submission, do not need to follow this word requirement but should attempt to. (For those of you doing this in pairs, I want 4,000 to 8,000 words and you'll need to be in touch with me and the TA more often to get feedback on intermediate drafts).
2. 1 inch margins on all sides.
3. 11 or 12 point font (Times New Roman, Arial, Calibri, or Computer Modern, which is the LaTeX default font).
4. I don't have a double/single spacing preference.
5. Citations must use Chicago Author-Date (which AEA uses) or APA format, unless otherwise authorized (e.g., political science may use something else). You must use in-text citations like "Smith (2005) finds..." or "The ACA increased access to health insurance (Smith, 2005)" and include a references section at the end. This references section does not count towards your word count.
6. The proposal must be written either as a Microsoft Word document (and saved as a .doc or .docx) or as a Google Doc that you'll share with me (giving me access to EDIT, see Google doc sharing instructions below.) I will only accept PDF documents if you used LaTeX to create the PDF. PDFs are harder to read and comment on but I want to support students who are learning LaTeX, so I am happy to accept assignments created through LaTeX. But please do not save and submit Word or Google Doc files saved as PDFs.

I reserve the right to take off points on final submissions that do not comply with these formatting requirements. If you submit a draft for feedback and it is not formatted correctly, then I may reject looking at it until it is fixed.

For those in political science or other fields, where you may be in your second or third year and thus have more developed research ideas, you can either pitch a new idea or I can provide feedback on an extension or development of existing work. We can discuss so as to best modify this assignment to suit your needs. I am very flexible here and we will come up with an individualized plan. Note that all projects must be empirical, using some causal inference method.

Similarly, if you are an economics Ph.D. student and already have some existing empirical work that perhaps you started during previous study, we can discuss if it makes sense for you to continue working on that instead of coming up with a new proposal. Please discuss with me so we can best come up with a plan that develops your research trajectory.

### **Class Presentation - Research Proposal**

You will present your research idea from your proposal in a 10 minute presentation (again, with comments it'll end up being more like 15 minutes). For those doing this in pairs, you will either prepare two ten minute presentations, one early and one later in the semester, or one larger 20 minute presentation.

Given that classes moved online now, presentations will be done over Zoom. It's quite easy to present a slideshow over zoom. You would essentially just share your screen (there is a button in the bottom, middle, of the screen to do this). Then, on your computer, you would just go through

your slides. Just be sure to close any browser tabs you don't want use to see ;). If you are at all nervous about how this works, then please zoom me or someone in the class and you can practice.

I will provide you with a presentation score out of 5, along with feedback, via email upon request. Unless there was something odd about your presentation, I don't anticipate emailing you with feedback. But I am happy to give it anytime if you just let me know! Also happy to chat about presentation strategy.

This score out of 5 will only reflect the organization of your presentation and will not be based on the content. I am not grading you on how well your ideas for your project are solidified. The presentation is more for you to get feedback. Better organizing your presentation and ensuring it covers the main points is important to getting feedback. Given that I am not grading you on having a complete/finalized idea, there is no incentive to present later when your idea is more developed. In fact, I will be more lenient to those who present early. You should present when you feel like you can craft a good presentation that would elicit feedback from me and the class. That said, please only present when you've at least discussed the idea with me since I won't want you using the presentation to get feedback on your first idea. Send me a pitch first please!

The remaining 5 points of your presentation score will be based on a reflection statement that you will submit using this form: <https://docs.google.com/forms/d/e/1FAIpQLSezZQ7Pwf8WtzUa9jPttIN2QnB7Em-rviewform>. This statement will discuss your thoughts regarding the proposed research and your presentation and what you think you should change. You can submit this anytime after your presentation, but within a few days is ideal. The ideal time to submit this form reflection form is after you've reflected on the presentation and what your next steps might be. I do not have a rubric for how I am grading the reflection statement. I don't anticipate anyone doing poorly on this so long as they think about and answer the questions.

### **Providing Feedback on the Presentations of Other Students**

During the presentation, students are encouraged to ask questions (preferably by typing them into the chat or by using the "raise hand" feature on zoom, but you can also speak up). We will follow the common approach in economics of asking questions throughout the presentation if the question is relevant or clarifying. Often if you are confused about something, then others are as well, and by asking the question you may help clarify everything for the audience. I would save more general questions to the end.

After the presentation, please submit a feedback form. The URL for this is: <https://docs.google.com/forms/d/e/1FAIpQLSeeGnhHTP7mIB8cmQVnLVUrs-IPBB14Jy3KNHPedQygzDiQJg/viewform>. You are not required to submit this for every student, would we would appreciate that. I would like you to submit this for at least five presentations, and I have made five in-class activities for this. Thank you in advance for providing helpful comments to your peers!

You can see the feedback by looking at this spreadsheet: [https://docs.google.com/spreadsheets/d/1tiLWK\\_ju3j7CYgFBR51\\_zXHRHnCGE7D69xvUKIfDR3s/edit?usp=sharing](https://docs.google.com/spreadsheets/d/1tiLWK_ju3j7CYgFBR51_zXHRHnCGE7D69xvUKIfDR3s/edit?usp=sharing). This is the most efficient way to distribute the feedback. You will need to search through this using your name to find the feedback about your presentation (note that some people might spell your name wrong by accident).

### **Activities**

Research shows that students learn better when professors adopt some "active learning", which means the students do something other than just passively listen to lecture. I will thus have some in-class activities, and a few out of class minor homework activities that you will do. I will grade

these quickly, mostly giving full points if well executed, taking a point or two off if there are major issues, or giving zero points if the activity was not done. Not all activities will be for points, although points should not be your motivation for doing the activities. For example, one activity I often give is practice exam questions, which I randomly assign everyone and have them do on a Google Doc. I will not be tracking or policing who did which questions, as I know that if any students don't do their assigned questions then they will look bad to me and their classmates, which is enough of a disincentive.

## Regrading

Students may ask that an exam or assignment be regraded if they feel that a mistake has been made, by giving the TA (for the Stata problem sets) or me (for everything else) a request via email explaining the reasoning behind why there was a grading error. Students can also raise the issue in a meeting with the TA or me, although we will not immediately do the regrading then and there (we will follow up with you via email after considering your situation further). Please do not come up to me before, during, or after class to ask me to regrade a question unless it is simply an addition error. I cannot and will not re-grade "on the spot" (except for addition errors) as I need more time to carefully consider your situation.

If we do decide to regrade the assignment or exam, then the entire item will be regraded. After regrading, the grade may rise or fall. Students who are fishing for points typically have no change on average, although some have had scores go down. Those with legitimate concerns sometimes get an increase. Please note that regrading will only be available for students who take their exams in pen (as opposed to in pencil) (this point only relevant if we move back to in-person exams).

## Additional Flexibility and Support During the COVID-19 Crisis

The most important thing right now is that you are secure and your mental and physical health is supported. If I can do anything to support you, please let me know. I may have resources available if you suddenly lose income, access to housing, or food. I am in a rather privileged position and would be glad to help with no judgement whatsoever. I want to reduce any barriers to learning, and I imagine it's hard to learn if you face a huge loss in income, etc. My Venmo is @Patrick-Button if you ever want to him me up with requests.

You may also just need someone to talk to, or may need more contact to discuss your research or academic plans, given that contact may be limited right now. I would be delighted to help you out with any of this, although I cannot do anything in person.

Given the current crisis, many of you may find it difficult to attend class regularly or complete assignments, etc, "on time". I can be flexible about almost everything and I can work out a plan with you to make things up, extend deadlines, or take exams later. Please get in touch with me if you need any adjustments. For example, I usually won't have any concerns about delaying deadlines into the summer, especially for the research proposal.

## Course Schedule

- Problem Set 1 (due on Tuesday Feb. 4)
- Midterm 1 (Tuesday Feb. 11 from 2-3:15 P.M. )
- Midterm 2 (Tuesday Mar. 24 from 2-3:15 P.M. )

- Problem Set 2 (due on Thursday Apr. 2)
- Optional Problem Set 3 (due on Saturday May 9 unless you make alternative arrangements)
- Problem Set 4 (due Friday May 8)
- Final Exam (Saturday May 9 from 1 P.M. – 5 P.M. )
- Research Proposal (due Saturday May 9 unless you make alternative arrangements)

Class presentations will be scheduled later, sometime after Mardi Gras, unless any students prefer to present earlier. Problem set deadlines are subject to change.

## Readings and Rough Schedule

This is a list of topics covered in the course and the related readings. Readings other than the main textbooks will be available in PDF format on the course Canvas page (or I will send them to you another way). This schedule and reading list is subject to change. I anticipate making changes as we approach certain topics, as I may make tweaks that allow you to be focus on more important readings. I will notify you of any changes. I will update the syllabus on Canvas is I make any changes.

This list of readings is obviously too long for you to read thoroughly just in this course. The goal of this list is to make you aware of important classic reference prices (denoted with “C”), practitioners guides (“P”), technical pieces (“T”), and notable application papers (“A”). Papers with “J” are ones you won’t have to read: you’ll read one of the papers in the set and you will “teach” that paper to classmates, and they will teach their assigned papers to you. It’s a quick way for you to see multiple examples. We will be doing this when I want to expose you to lots of examples without forcing you to read lots of papers.

Don’t get freaked about by the number of readings on the syllabus. You’ll probably only read half of the papers on the syllabus. And when I say “read”, usually you’ll be focusing on the introduction and conclusion. In few cases will you need to intimately know everything about a paper - usually it’s all about getting the takeaway.

For the half you don’t read, you may want to read them later. This syllabus is also a guide to you later as you start using causal inference techniques. If you end up using a particular technique in your research later, I urge you to come back to this syllabus to take a look at the other methods papers that are listed here but that we couldn’t cover in class. It is important for you to use up-to-date methodology in your research as otherwise you might be seen as lacking when you go on the job market (this has been discussed recently on # EconTwitter, with some economists saying that recent job market candidates who didn’t incorporate the recent DiD literature were doing poorly).

In coming up with this list of papers, I acknowledge the support of my former professors (Marianne Bitler, now at UC Davis, and Christopher “Kitt” Carpenter, now at Vanderbilt) as they came up with useful lists of papers that I still use as references. I also acknowledge the support Keith Finlay (former faculty here) who taught this course previously and had his own list of papers. I also thank many economists and researchers who contribute to # EconTwitter who helped me crowd-source some new papers e.g., Scott Cunningham - causalinf), especially recent difference-in-differences methodology papers.

I will stress in class or by email which papers you will need to read, how much of them to read (e.g., in-depth versus skim), and by when. Generally I expect you to have read or skimmed the papers before class and again sometime after. As a rough guide, the more \*’s I include in front of the paper, the more important it is. Any paper with two \*\*s will almost surely be required reading. Papers with one \* are more likely to be important ones that you should at least skim, focusing

on the intro and conclusion (and maybe the application section if it's a technical paper with an application) so you can intuitively understand the technique and the rationale for it. Reading all the proofs in papers is not important, unless you want to do pure econometrics research (i.e. developing methods), which I doubt.

The papers without \*'s are still useful or important, but they are more likely ones that you'd refer back to if you were to use the methodology in your own work. Or these are example papers if you want to see the technique in action again. It may be good to know a few examples of techniques in action as you can use them in examples during exams or in your own research. These readings could change, but I will keep you advised of any changes.

All readings are on Canvas, under "Files" then "Readings" and then sub-folders from there.

Schedule of Topics:

### Introduction to the Course (1 class)

- Overview of the course
- My course vs. Prof. Long's and Prof. Denteh's courses
- Using Mendeley to organize papers and create a bibliography
- Work-life balance and mental health
  - \*\*MHE Ch. 1, 2
  - \*\*MM Ch. 1
  - \*Mixtape Pages 1 to 80
  - \*\*Causal Inference Pages 1 to 27 (good overview of basic statistics and basic commands in Stata)
  - \*Causal Inference Pages 38 to 44 (check this over if you need a refresher on concepts like bias, consistency, and mean squared error)
  - \*Causal inference bootcamp for high school and undergraduate students: <https://mattmasten.github.io/bootcamp/>

### Introduction to Causal Inference (1 class)

- The fundamental problem of causal inference
- Overview of methods
  - \*\*MM Ch. 2
  - \*\*MHE Ch. 3 (read everything but instead of a full read, skim 3.1.1., 3.1.2., skip 3.3 for now, also skip 3.4.2, 3.4.3, and 3.5 for now)
  - \*Scott Cunningham's Causal Inference Mixtape: [https://scunning.com/cunningham\\_mixtape.pdf](https://scunning.com/cunningham_mixtape.pdf) (do a "heavier" skim of pages 81 – 103, this provides another presentation of the content from MHE)
  - \*C,P - Imbens and Wooldridge (2009) (Overview of causal inference)
  - \*\*Causal Inference Pages 46 to 56 (The fundamental problem of causal inference. Great overview of when bias can occur.)

- \*\*P - Useful infographic of a flow-chart of causal inference, from Gema Zammaro, Dick Murnane, John Willett. Photo posted by David D. Liebowitz on Twitter: <https://twitter.com/DavidDLiebowitz/status/1214234438206246912/photo/1>
- \*\*P - Another useful infographic from David Liebowitz, from Twitter: <https://twitter.com/DavidDLiebowitz/status/1196473161094615044/photo/1>
- \*P - Edward Rubin's slides on causal inference (past about slide 41 it gets into IV, which is covered later): [https://raw.githubusercontent.com/edrubin/EC421W19/master/LectureNotes/11InstrumentalVariables/11\\_instrumental\\_variables.html#1](https://raw.githubusercontent.com/edrubin/EC421W19/master/LectureNotes/11InstrumentalVariables/11_instrumental_variables.html#1)

### Regression Control (1 class)

- Can we use regression to do causality?
- Controlling for observables (i.e. "kitchen sink" OLS)
- Selection on Observables vs. Selection on Unobservables
- Other cautionary tales (omitted variables, measurement error, simultaneity)
  - \*C - Angrist and Krueger (1999) (Has a great discussion of regression control and how useful/not useful it is)
  - \*C - Freedman (1991) (A classic overview of why regression doesn't guarantee causality)
  - \*\*A - Krueger (1993) (A problematic example of selection on unobservables)
  - \*\*A - DiNardo and Pischke (1997) (Critiques the above "kitchen sink" OLS paper)
  - \*\*A - Black et al. (2003) (A great example of selection on observables)

### Binary Dependent Variables (1 class)

- Linear probability model (LPM) vs. probit vs. logit
- Bias and inconsistency in LPM
- Marginal effects
- Estimation in Stata
  - \*\*Most intro econometrics textbooks have a good and more accessible section on binary dependent variables. I suggest you read that chapter. If you don't have a good undergraduate econometrics text, talk to your classmates in economics who can help.
  - \*\*Causal Inference Pages 27 to 30 (some coverage of LPM, logit, and probit)
  - \*\*P - Slides on LPM by Jonah Simmons <https://slideplayer.com/slide/8654838/>
  - \*\*P - A short, accessible, overview by Andrew Dustan that covers a bit of all the topics in this section: <https://are.berkeley.edu/courses/EEP118/fall2010/section/13/Section%2013%20Handout%20Solved.pdf>
  - \*\*P - A nice, accessible, overview by Paul von Hippel: <https://statisticalhorizons.com/linear-vs-logistic>
  - \*\*P - Estimation in Stata and some intuition, via UCLA's Statistical Consulting office: <https://stats.idre.ucla.edu/stata/output/logistic-regression-analysis/>

- (Logit) and <https://stats.idre.ucla.edu/stata/dae/probit-regression/> (Probit) (FYI they have many useful guides to Stata and common statistics issues!)
- \*\*P,T - Williams (2012) (Using the margins command in Stata. Also explains average marginal effects and marginal effects at the mean)
  - P,T - Bartus (2005) (Useful for its explanation of average marginal effects versus marginal effects at the mean. The Stata code being used is a bit out of date since the “new” command “margins” is now used. So the above article would probably be better)
  - When is LPM ok? Applied researchers and econometricians debate it out.
  - Usually econometricians/statistician say to almost never use LPM. Usually applied and empirical researchers say “it depends”
  - What I want to focus on here is weighting those downsides with some of the benefits of the LPM and what is used in practice, and why.
    - \*T - Horrace and Oaxaca (2006) (one of the best, short, articles that discusses the bias and inconsistency issues of the LPM)
    - \*P - Dave Giles argues why one should avoid the LPM: <https://davegiles.blogspot.com/2012/06/another-gripe-about-linear-probability.html> (TL;DR: Don’t use LPM except in a few specific circumstances. Here all the reasons why not, including bias in marginal effects. I don’t care about the minor benefits of LPM you bring up. The issues are severe.)
    - \*P - Jörn-Steffen Pischke responds to some of Dave Giles’ critiques: <http://www.mostlyharmlesseconometrics.com/2012/07/probit-better-than-lpm/> (TL;DR: The bias from LPM is less of an issue wrt estimating marginal effects, which is what we usually care about. LPM works fine for saturated models (lots of fixed effects, say, e.g., panel DiD regressions). Generally, LPM isn’t bad and logit and probit aren’t necessarily the true model.)
    - \*P - Jed Friedman discusses the debate between the two above: <https://blogs.worldbank.org/impactevaluations/whether-to-probit-or-to-probe-it-in-defense-of-the-linear> (TL;DR: Is more sympathetic to LPM, and highlights that if the predicted probabilities fall well within 0 and 1 then it’s probably fine. Again highlights Pischke’s point that even if the effects are non-linear, logit and probit aren’t necessarily the “correct” non linear models.)

### Standard Errors, Clustering, Bootstrapping, and Weighting (2 classes)

- “Raw” standard errors vs. “Robust” standard errors
- Clustering and the Moulton factor
  - \*\*MHE Ch. 8.2 (pages 308 to 315)
  - \*C,T - Moulton (1990) (Classic paper that introduces the clustered standard errors issue)
  - \*\*T,P - Cameron and Miller (2015) (Practitioner’s guide to cluster-robust inference. Skip “few clusters” and “extensions” sections for now)
  - \*\*T,P - Abadie et al. (2017) (Newer paper on when to cluster)
- Two-way / multi-way clustering

- \*T - Cameron, Gelbach and Miller (2011) (Multi-way clustering. Important if you have two different non-nested clusters. E.g., you need to cluster on state since you have panel data, but you also need to cluster spatially)
- \*P - Tom Zimmerman has a useful blog post on two-way clustering in Stata: <http://tomzimmermann.net/2018/08/22/two-way-clustering-in-stata/>
- As for how to do two-way/multi-way clustering in Stata, check out `ivreg2`, `cgmreg`, or `reghdfe` Stata programs. All three programs can do it but they have some slight differences.
- Weighting
  - \*\*P,T - Solon, Haider and Wooldridge (2015) (Very helpful reference that discusses why/when weighting should be done. The go-to paper that is a crucial read.)
  - \*\*P,T - Short notes on using weights in Stata, by Yannick Dupraz: [https://parisschoolofeconomics.eu/docs/dupraz-yannick/using-weights-in-stata\(1\).pdf](https://parisschoolofeconomics.eu/docs/dupraz-yannick/using-weights-in-stata(1).pdf)
  - \*P,T - Deaton (1997) - (pages 67-73)
- Asymptotics vs. bootstrapping
  - \*\*MHE Ch. 8.2 (pages 293 to 308)
  - \*\*Wooldridge (2010) Ch. 12.8.2
  - \*C,T - Horowitz (2001) (Standard introduction to the bootstrap)
  - \*C,T - MacKinnon (2002) (Another useful overview of the bootstrap. This one is probably easier to read. Skip section 5 since that isn't that important for what I want you to focus on.)

### Introduction to Directed Acyclic Graphs (DAGs) (1 class)

- DAGs are a way to visually show how variables interact and what your research design is.
- DAGs are common in other fields but are only now becoming popular in economics.
- Economics uses more of the "Rubin Causal Framework" right now, which is what you see in the MHE textbook, but also in Mixtape pages 81 to 104.
  - \*\* Mixtape (pages 67 to 80)
  - \*\* Imbens (2019) (pages 1 to 24 for now)
  - \*\* Steiner et al. (2017) (skip sections on IV, RD, and propensity score matching until we get to those sections)

### Instrumental Variables (3 classes)

- IV as a possible solution to omitted variables, endogeneity, and measurement error
- Identifying assumption: exclusion restrictions
- Weak instruments
- IV in the context of the classical experiment
- Non-compliance and the local average treatment effect (LATE)
- Background and Introduction

- \*MHE Ch. 4
- \*\*MM Ch. 3
- \*\*Mixtape: Instrumental Variables (pages 205 to 243)
- \*\*Causal Inference Pages 83 to 104 (A nice, accessible, overview of IV)
- \*\* Christopher Baum's slides on IV. Helpful overview and discusses how to estimate IV in Stata: [https://www.researchgate.net/profile/Christopher\\_Baum2/publication/4923008\\_Using\\_instrumental\\_variables\\_techniques\\_in\\_economics\\_and\\_finance/links/02bfe50f6008716fed000000.pdf](https://www.researchgate.net/profile/Christopher_Baum2/publication/4923008_Using_instrumental_variables_techniques_in_economics_and_finance/links/02bfe50f6008716fed000000.pdf)
- \* P - Bollen (2012) (A nice, accessible, overview of IV)
- \* Edward Rubin's slides on IV (scroll back on slides for a causal inference review): [https://raw.githubusercontent.com/edrubin/EC421W19/master/LectureNotes/11InstrumentalVariables/11\\_instrumental\\_variables.html#42](https://raw.githubusercontent.com/edrubin/EC421W19/master/LectureNotes/11InstrumentalVariables/11_instrumental_variables.html#42)
- \* Steiner et al. (2017) (sections on IV)
- \*C,P - Angrist and Krueger (2001) (Important overview of how IV is used)
- \*C - Rosenzweig and Wolpin (2000) (Similar to the above)
- \*P - Nichols (2007) (Good coverage of DiD, IV, and RD with Stata examples)
- C,T - Angrist, Imbens and Rubin (1996) (Foundational paper that discusses IV and assumptions, etc, required for it)
- \*\*P,T - Baum, Schaffer and Stillman (2007) (Discusses the "iv2reg" Stata program)
- T - Imbens (2014) (An econometrician's perspective on the statistics literature on IV. Helpful as a summary of the stats literature on this topic, which is often harder to understand.)
- Weak IVs: issues and what to do about it
  - \*\*P,T - Andrews, Stock and Sun (2019) (Recent paper with up-to-date advice on what to do regarding weak IVs, especially when there are other common concerns like heteroskedasticity and clustering)
  - \*\*P,T - Pflueger and Wang (2015) (Weak IV tests in Stata)
  - T - Swanson et al. (2018) (Excellent resource and summary article for IV with binary variables)
  - C,T - Bound, Jaeger and Baker (1995) (Classic paper on weak IVs)
  - C,T - Staiger and Stock (1997) (Another classic paper on weak IVs)
  - T - Flores-Lagunes (2007) (Weak IV bias in finite samples)
  - P,T - Finlay and Magnusson (2009) (Weak IV test - "rivtest" - in Stata)
- IVs and the Local Average Treatment Effect (LATE)
  - T - Angrist and Fernandez-val (2013) (Extrapolating the LATE to a larger population using covariates)
  - T - Mogstad, Santos and Torgovitsky (2018) (Another paper on trying to learn about the broader ATE)
- Evaluating examples of IVs – Activity
- Which IVs seem to meet the exclusion restriction?

- Which IVs might be weak?
- Which IVs provide a useful (or less useful) LATE? I.e. to what extent are the results externally valid?
  - \*\*P - Twitter thread on the “Huh?” test for the IV, via Andrew Heiss and Scott Cunningham: <https://twitter.com/andrewheiss/status/1193927703818227712>
  - A,J - Levitt (1997), McCrary (2002), and Levitt (2002) (Paper-Reply-Rejoinder on a famous IV paper)
  - A,J - Hoxby (2000), Rothstein (2007), and Hoxby (2007) (Another famous, and more heated, dispute about an IV paper)
  - A,J - Anderson and Matsa (2011) (Casual effect of fast-food restaurants on obesity)
  - A,J - Angrist and Evans (1998) (Causal effect of children on labor supply, using mixed-gender preferences for children)
  - A,J - Bhalotra and Clarke (2019) (Are twin births a good IV for number of children?)
  - A,J - Algan et al. (2017) (Political science-ish paper that uses a Bartik “shift-share” instrument)
  - A,J - Levitt (2016) (Extremely influential and cool “coin toss” nudge paper)
  - A,J - von Hinke et al. (2016) (Using genetic markers as an IV)
  - C,A,J - Angrist and Lavy (1999) and the replication, Angrist et al. (2017) (Classic paper using class-size rules as an IV)
- Measurement error and IVs
  - \*C,T - Hyslop and Imbens (2001) (Classical paper on measurement error and IVs)
  - T - This Twitter thread by Vitor Possebom (PossebomVitor) has a useful discussion of recent research on applying partial identification to measurement error. Focuses on binary variables that have measurement error: <https://threadreaderapp.com/thread/1203029622893486080.html>
- Bartik “shift-share” instruments
  - Originated in Bartik (1991) and popularized in Blanchard and Katz (1992).
  - My goal for you here is that you have a sense of what this IV is and how it’s constructed, so that you can (1) understand when it is used and (2) think about how it could be used in a possible paper.
  - \*P - Goldsmith-Pinkham, Sorkin and Swift (2019) (Recent popular paper that walks you through this IV)
  - A - Borusyak, Hull and Jaravel (2019) (Similar to the above)
  - A - Algan et al. (2017) (Political science-ish paper that uses a Bartik “shift-share” instrument)
- Other interesting IV methodology papers
- Most of these are working papers. They will be important to watch.
  - T - Das and Polachek (2019) (Recent paper to watch. Suggests a sort of “reverse IV” as an alternative to traditional IVs.)

- T - Young (2019) (Working paper that makes some bold claims about how IVs have been used in practice. Generally has a negative view about IV.)
- T - Lewbel (2012) (IV in mismeasured regressor models, triangular systems, and simultaneous equation systems)
- T - “ivreg2h” Stata code, which implements Lewbel (2012): <https://econpapers.repec.org/software/bocbocode/s457555.htm>

## Experiments (2 classes)

- Intent-to-Treat (ITT) vs. Treatment-on-the-Treated (TOT)
- Compliance rates
- Balance/Randomization tests
  - \*\*Causal Inference Pages 44 to 45 (overview of experiments)
  - \*\*A - Ludwig et al. (2012) (One of the many papers on Moving to Opportunity. A good summary piece because it’s so short.)
- Examples of Experiments: Moving to Opportunity, Tennessee STAR, field experiments, health insurance experiments
  - A,J - Krueger (1999) (Notable experiment looking at classroom size and academic outcomes)
  - A,J - Manning et al. (1987) (Notable health insurance experiment)
  - A,J - Finkelstein et al. (2012) (Notable health insurance experiment)
  - A,J - Flory et al. (2019) (Increasing diversity in hiring through diversity language in job ads)
- Actual “natural” experiments (exploiting unintentional randomization)
- Technically these are IV but have a strong “experimental” flavor and I wanted to highlight them.
  - A,J - Maestas, Mullen and Strand (2013) (Effect of Social Security Disability Insurance on employment)
  - A,J - Palmer, Phillips and Sullivan (2019) (Effect of a homelessness prevention program on the likelihood of committing crime)
  - A,J - Sacerdote (2001) (Solves the “Manski reflection problem”, i.e. endogenous choice of peers)
  - A,J - Bhuller et al. (2016) (Using random assignment to picky or less picky judges to determine the effect of incarceration on recidivism)
- Field experiments
  - Brief intro on lab vs field experiments
  - Brief intro on audit field experiments
  - A,J - Neumark, Burn and Button (2019) (My recent audit field experiment using resumes, studying age discrimination in hiring)
  - A,J - Giulietti, Tonin and Vlassopoulos (2019) (Racial discrimination in access to local services)

- A,J - Butler and Broockman (2011) (Do political representatives racially discriminate against constituents?)
- A,J - Ameri et al. (2018) (Disability discrimination in AirBnB bookings)
- Lab Experiments
  - \*P - Falk and Heckman (2009) (Overview of lab experiments in economics)
  - \*C,A - Gneezy, Niederle and Rustichini (2003) (Gender differences in competition)
  - A - Horton, Rand and Zeckhauser (2011) (Introduction to using MTurk for experiments)

### **Difference-in-Differences (6 classes)**

- This is the largest and most important part of the course. About half of causal inference papers use a DiD over other strategies. This is largely because most policy examinations allow for a DiD but not other approaches.
- The DiD methodology literature is evolving quickly, with some major papers written on it in the last few years. It is not possible for me to cover all these papers in this course. I will do my best to give you a solid understanding of DiD and what I think the best practices now are. But I strongly urge you to read more of these papers and follow the evolution of the methodology literature if you end up doing a DiD paper. You will need to be using something close to best practices in your dissertation research. You may not be able to rely on your dissertation advisers to tell you what the best methodology to use is. Some professors are up-to-date and some are not at all. PhD candidates when they go on the job market are expected to be using the most up-to-date methodologies, and often more senior researchers learn about the new methods because the fresh PhD candidates/graduates are using them.
- Summary and Background Readings
  - \*\*Wooldridge (2010) Ch. 10 (intro to panel methods)
  - \*\*MHE Ch. 5
  - \*\*MM Ch. 5
  - \*\*P - Zeldow and Hatfield (2019) (Good applied overview, with applications to health policy. <https://diff.healthpolicydatascience.org/>)
  - \*\*Mixtape: Panel Data and Difference in Differences Chapters (Pages 245 to 286)
  - \*\*Causal Inference Pages 71 to 82 (A nice, accessible, overview of panel methods and DiD)
  - \*\*C - Meyer (1995) (Good coverage of DiD)
  - \*\*P - Nichols (2007) (Good coverage of DiD but also IV and RD)
  - \*\* Twitter thread by Daniel Millimet (dlmillimet) on why it's very important for you to strive to use the most up-to-date methods in DiD, especially given recent developments: <https://twitter.com/dlmillimet/status/1175152198558240768>
  - Intro to DiD
- Benefits of a triple difference (Difference-in-Difference-in-Differences - DiDiD or DDD)
- Fundamental DiD assumption of parallel trends

- What happens when parallel trends is violated?
  - \*C,A - Acemoglu and Angrist (2001) (A classic DD paper, but with problematic methodology)
  - \*\*A - Button (2018) (Critiques Acemoglu and Angrist (2001) and provides an excellent example of DiD vs. DiDiD, an event study, and the importance of controlling for group-specific time trends.)
- Endogeneity of Policies, Bias, and an Introduction to Parallel Trends
- Another DiD assumption - the Stable Unit Treatment Value Assumption (SUTVA)
  - \*C - Besley and Case (2000) (Issues with endogeneity of policies)
  - \*\*A - Button (2019) (An application that thoroughly explores endogeneity and DiD assumptions, including SUTVA)
- Introduction to Clustering, Standard Errors, and Inference in DiD
  - A re-cap of the clustering issue and multi-way clustering, but in a DiD context
  - \*\*MHE Ch. 8
  - \*C,T - Bertrand, Duflo and Mullainathan (2004) (One of the most cited papers in economics and applied statistics. Brought up the issue that we need to cluster standard errors - or similar - at the “level of policy variation” in DiD studies.)
  - \*\*C,T,P - Cameron and Miller (2015) (Guide to cluster-robust inference. Good to re-read, but again skip “few clusters” and “extensions” for now)
  - \*T - Cameron, Gelbach and Miller (2011) (Multi-way clustering. Important if you have two different non-nested clusters. E.g., you need to cluster on state since you have panel data, but you also need to cluster spatially)
- Inference with Few Treated Clusters
  - \*\*C,T,P - Cameron and Miller (2015) (Now read the “Few clusters” section for a summary of this literature)
  - \*\*C,T,P - Donald and Lang (2007) (Important paper that makes clear how a DiD with only two groups can be problematic)
  - \*\*P - Roodman et al. (2019) (Discusses the Stata program “boottest” which allows for wild cluster bootstrapping in many contexts)
  - \*C,T - Cameron, Gelbach and Miller (2008) (Bootstrapping to improve inference when there are few clusters)
  - \*T - Conley and Taber (2011) (The paper that introduced “Conley-Taber confidence intervals”. Required when there are fewer than ten treated clusters but at least 20 or so clusters total.)
  - \*T - Mackinnon and Webb (2019) (Applies randomization inference to the situation of few treated clusters in a DiD. Presents a more accessible summary of randomization inference. Like Conley and Taber (2011), won’t work if there are fewer than about 20 clusters total.)
  - T - MacKinnon and Webb (2018) (Similar to the above paper but less specific to DiD)
  - T - Mackinnon and Webb (2017) (Similar to the above paper but deals with clusters)

that differ significantly in size (some clusters have lots of observations while others do not))

- Group-Specific Time Trends and the Parallel Trends Assumption
- Blog post summarizing recent literature by David McKenzie: [https://blogs.worldbank.org/impactevaluations/revisiting-difference-differences-parallel-trends-assumption-part-i-cid=SHR\\_BlogSiteShare\\_EN\\_EXT](https://blogs.worldbank.org/impactevaluations/revisiting-difference-differences-parallel-trends-assumption-part-i-cid=SHR_BlogSiteShare_EN_EXT)
  - \*\*T - Mora and Reggio (2019) (A clear presentation of the assumptions behind “parallel paths” in the DiD)
  - \*C,A - Friedberg (1998) (Classic paper on the effect of unilateral divorce laws on divorce rates)
  - \*C,A,P - Wolfers (2006) (Critiques the paper above by showing how sensitive the results are to estimated group-specific time trends)
  - \*\*T - Kahn-Lang and Lang (2019) (Important reflections on issues that arise in a DiD)
  - \*A,T - Meer and West (2016) (Raises the issue of if the treatment effect would appear in levels or in growth, and how time trends could attenuate estimates.)
  - \*\*T - Freyaldenhoven, Hansen and Shapiro (2019) (Suggests a novel way to net out pre-trends)
  - T - Roth (2019) (Doing a pre-test for parallel pre-trends is problematic)
  - T - Rambachan and Roth (2019) (Suggests a more “honest” way to deal with pre-trends)
- Some examples of dosage design / treatment intensity
  - A - Goodman-Bacon (2018) (Effect of medicaid on mortality)
  - C,A - Bleakley (2007) (Classic paper showing huge short and long term effects of a campaign to eradicate hookworm in the American South)
  - A - Argys et al. (2017) (Effects of losing public health insurance on financial distress)
- Event Study (a.k.a. Staggered Adoption Design)
  - \*A - Button (2018) and Button (2019) (Previously covered papers, include event study figures)
  - A - Reber (2005) (A very clear demonstration of the event study, which lets you visualize time trends)
  - C - Jacobson, Lalonde and Sullivan (1993) (Classic reference/example of an event study)
  - A,C - McCrary (2007) (Another somewhat classic and great example)
  - T - Abraham and Sun (2019) (Treatment effect heterogeneity makes previous event studies hard to interpret)
  - T - Borusyak and Jaravel (2017) (Raises concerns about the common methodology used in event studies. An important paper to watch.)
  - T - Abraham and Sun (2019) (Treatment effect heterogeneity makes previous event studies hard to interpret)

- Introduction of Synthetic Control (SC)
  - Introduction and comparison to a more “standard” DiD
  - \*\*C,P,T - Abadie, Diamond and Hainmueller (2010) (The paper that introduced this technique)
  - \*\*Mixtape: Synthetic Control (Pages 287 to 314)
  - T - Gardeazabal and Vega-Bayo (2017) (Paper comparing synthetic control to DiD, generally finds that synth is better if it can provide a good fit)
  - A - Cavallo et al. (2013) (Notable application to studying the effects of natural disasters)
  - A - Billmeier and Nannicini (2013) (Notable application to studying the the effects of economic liberalization episodes)
- Synthetic control with multiple treated groups
  - A,T - Dube and Zipperer (2016) (Application to minimum wages)
  - A,T - Kreif et al. (2016) (Application to health economics - hospital P4P schemes and mortality)
- Covariates and synthetic control
  - T - Kaul et al. (2017) (Never use all pre-period outcome variables together with controls)
  - T - Botosaru and Ferman (2017) (More discussion/analysis of covariates in synthetic control)
- Other methodological improvements in synthetic control since Abadie, Diamond and Hainmueller (2010)
  - A,T - Eliason and Lutz (2018) (Constructing synthetic control weights when you have more than one outcome variable)
  - \*T - Arkhangelsky et al. (2019) (Introduces Synthetic DiD [SDiD], a superior combination of SC and DiD. Hopefully Stata/R code is made available so that this technique can become common practice. Seems like this may become the standard over the more “classic” synthetic control.)
  - T - Athey et al. (2018) (Matrix completion methods applied to DiD. A good paper to watch to see if code gets created to do this, such that this technique becomes more standard.)
  - T - Ben-Michael, Feller and Rothstein (2018) (Introduces augmented synthetic control, which can reduce bias, and introduces the R package “augsynth”. Consider adopting this approach if you use synthetic control.)
  - T - Ferman, Pinto and Possebom (2020) (Discusses specification searching (“cherry picking”) in SC and how to avoid it)
- The Bacon Decomposition
- While it’s still hard to say where the DiD methodology will settle - i.e., which methods written about recently will become standard - it seems like it will be the Bacon decomposition. Even if a clear standard methodology does not form, this is a significant and popular methodological improvement that is one of the easiest to use, thanks to help-

ful Stata code and additional writing by Andrew Goodman-Bacon and others using his approach.

- \*T - Goodman-Bacon (2019a) (The DiD estimator is a weighted combination of all 2x2 - two group/two period - DiD estimators)
- \*\*P - Slides on the Bacon decomposition. Very helpful, accessible walk-through of the intuition behind the paper: [https://www.stata.com/meeting/chicago19/slides/chicago19\\_Goodman-Bacon.pdf](https://www.stata.com/meeting/chicago19/slides/chicago19_Goodman-Bacon.pdf)
- \*\*P - Thread by Andrew Goodman-Bacon where he explains the Bacon decomposition: <https://twitter.com/agoodmanbacon/status/1039126592604303360>. See also this other thread by Andrew Goodman-Bacon: <https://twitter.com/agoodmanbacon/status/1154158589323415552>
- \*\*P - Goodman-Bacon (2019b) (“So you’ve been told to do my difference-in-differences thing: a guide” by Andrew Goodman-Bacon. URL: [https://cdn.vanderbilt.edu/vu-my/wp-content/uploads/sites/2318/2019/10/09023516/so\\_youve\\_been\\_told\\_dd\\_10\\_9\\_2019.pdf](https://cdn.vanderbilt.edu/vu-my/wp-content/uploads/sites/2318/2019/10/09023516/so_youve_been_told_dd_10_9_2019.pdf))
- \*\*T,P - The Stata command “BACONDECOMP” conducts the “Bacon decomposition” and can be downloaded: <https://ideas.repec.org/c/boc/bocode/s458676.html>. A related Stata journal article is likely forthcoming so watch this space. The help file for the program is pretty good though.
- \*\*P - Blog post where Andrew Baker provides a more accessible summary of a DiD that has more than two time periods and more than two groups: <https://andrewcbaker.netlify.com/2019/09/25/difference-in-differences-methodology/>
- A - Twitter thread where Andrew Baker replicates a paper using the Bacon decomposition and other methods: [https://twitter.com/Andrew\\_\\_\\_Baker/status/1212136421974110209](https://twitter.com/Andrew___Baker/status/1212136421974110209)
- A - Hill, Slusky and Ginther (2019) (A newer DiD that incorporates some recent methodologies, such as Goodman-Bacon (2019a))
- Fuzzy DiD
  - A DiD where treatment is not binary - e.g., partial or gradual exposure to the treatment.
  - \*C,A - Duflo (2001) (An example of a fuzzy DiD)
  - T - de Chaisemartin and D’Haultfoeuille (2018) (Critiques the Wald-DID method and suggests two better alternatives)
  - T,P - de Chaisemartin, D’Haultfoeuille and Guyonvarch (2019) (Information on the “fuzzydid” Stata program that you can download: <https://ideas.repec.org/c/boc/bocode/s458549.html>.)
- Additional recent technical papers that you’ll want to possibly adopt if you do a DiD paper. These papers are mostly working papers and it will be important to see how the published versions differ, and to what extent these papers get incorporated into common practice. You may be left in the dust if you can’t keep up with this breaking work. We don’t have time to get into these papers so you’ll want to take a look at them later as you continue working on your own DiD papers.
  - T - Athey and Imbens (2018) (Applies design-based analysis to a DiD setting)

- T - Callaway and Sant'Anna (2019) (Proposes a new and improved DiD estimation strategy)
- T - Keele et al. (2019) (Develops a sensitivity analysis test to determine how much bias would be necessary to change a study's conclusions)
- T - Kropko and Kubinec (2017) (Why the two-way fixed effects model is difficult to interpret)
- T - Manski and Pepper (2018) (A notable application that applies bounded variation to DiD)
- T - Miller and Ulrich (2019) (Introduces the issue of selection into identification in DiD)
- T - Roth (2019) (Doing a pre-test for parallel pre-trends is problematic. Develops a pre-testing correction.)
- T - Sant'Anna and Zhao (2018) (Suggests combining inverse probability weighted estimators with ones that deal with treatment effect heterogeneity)
- T - Xu (2017) (Incorporates the interactive fixed effects model into the synthetic control. Had a good discussion in the introduction of the pre-trends issue and how it has been dealt with.)
- T - Zimmert (2018) (On DiD estimation with common trends that are controlled for with covariates. Discusses a more efficient way to estimate this.)
- T - Gibbons et al. (2018) (Dealing with heterogeneous treatment effects)
- T - Abraham and Sun (2019) (Treatment effect heterogeneity makes previous event studies hard to interpret)
- Some other helpful or interesting DiD examples (not covered in class)
  - C,A - Gruber (1994) (One of the first DiDiDs)
  - A - Bitler and Carpenter (2016) (An excellent DiDiD)
  - A - Greenstone, Hornbeck and Moretti (2010) (Effect of million dollar plants on agglomeration spillovers. Uses a unique method to come up with a relatively good control group.)
  - A - Madrian (1994) (A DiD without a time dimension. Treatment based on the intersection of two different groups.)
- Matching and DiD/Synthetic Control - Important papers to watch to see how these techniques develop
  - A,T - Deryugina, MacKay and Reif (2018) (An innovative application that tries to better merge synthetic control and DiD using matching)
  - T - Imai, Kim and Wang (2019) and Imai and Kim (2019) (Applies matching models to DiD)
  - T - Daw and Hatfield (2018b) and Daw and Hatfield (2018a) (Bias from regression to the mean in matching DiD estimation)
- Negative weights in DiD (time permitting, check this out later if we don't have time to cover it)
- Related somewhat to the "Bacon Decomposition"

- T - de Chaisemartin et al. (2019) (One of a few recent papers showing that weights in a DiD can sometimes be negative, leading to incorrect inference. The authors propose a novel estimation strategy that gets around this.)
- T,P - The “did\_ multipleGT” Stata program: <https://ideas.repec.org/c/boc/bocode/s458643.html>
- T,P - Twitter thread summarizing the “did\_ multipleGT” Stata program: <https://twitter.com/CdeChaisemartin/status/1213188435197906944>

### Regression Discontinuity Design (RD) (3 classes)

- Introduction and background
- Sharp RD
- RD plots
  - \*\*MHE Ch. 6
  - \*\*MM Ch. 4
  - \*\*Mixtape: Regression Discontinuity Design (Pages 153 to 204)
  - \*Causal Inference Pages 105 to 116 (A decent overview with some Stata examples, but other readings are better for the basics)
  - \*\* Steiner et al. (2017) (See DAGs for RD by reading the RD sections)
  - \*\*For all your RD software needs (both Stata and R) see all these RD programs here: <https://sites.google.com/site/rdpackages/home>
  - \*\*P - Cattaneo, Idrobo and Titiunik (2019) (Ch. 1, 2, and 3) (Most important and helpful reading. This book provides an overview of RD and is a good “how to” guide that is more up-to-date. This is relatively more accessible, too.)
  - \*\*P - Skovron and Titiunik (2015) (Another “practical guide” paper, with more emphasis on Political Science examples. Shares some content with Cattaneo, Idrobo and Titiunik (2019))
  - \*P - Lee and Lemieux (2010) (Similar to the above, but a bit out of date given the methodological improvements in the last ten years)
  - P - Imbens and Lemieux (2008) (Similar to the above paper, but not quite as useful)
  - P - Nichols (2007) (Good coverage of DiD, IV, and RD with Stata examples. A bit outdated, Cattaneo, Idrobo and Titiunik (2019) is more up-to-date, as are the other papers by those authors.)
  - T,C - Hahn et al. (2001) (Classic technical RD paper)
  - C - Cook (2008) (Discusses the history of RD in educational psychology, statistics, and economics)
  - C,A - Lee (2008) (Classic paper, used commonly as an example. Measures the incumbency effect in U.S. House elections.)
  - C,A - Lee, Moretti and Butler (2004) (Classic paper, used commonly as an example. I ended up replicating this in grad school and it led to two publications, one replication, and one theory paper - Button (2016))
- Current best practices in estimating RD

- The authors Calonico, Cattaneo, and Titiunik (and some other co-authors) have spent a lot of time developing the current standard for RD when the assignment variable is continuous
- Below are a collection of papers that detail the most-to-do methodologies.
- There are a mix of the theoretical papers (where they developed the techniques) and lots of applied papers that are easier to learn from, and that teach you how to estimate this in Stata or R
- \*\*P - Cattaneo, Idrobo and Titiunik (2019) (Ch. 4)
- \*\*P,T - Calonico, Cattaneo and Farrell (2016) (Useful summary, with a more detailed discussion of their “rdrobust” program, which is also discussed in Ch. 4 of the book above)
- T - Calonico, Cattaneo and Titiunik (2014b) (More technical piece that introduces their approach)
- T,P - Calonico, Cattaneo and Titiunik (2014a) (Older Stata journal article)
- Validating the RD design
- Testing the non-manipulation assumption using a density test of the assignment variable
- Testing the continuity of covariates
- Testing alternative (“fake”) cutoffs as a falsification test
  - \*\*P - Skovron and Titiunik (2015) (Pages 25 and 30)
  - \*\*P - Cattaneo, Idrobo and Titiunik (2019) (Ch. 5 and 6)
  - \*T - McCrary (2008) (non-parametric test)
  - \*T - Frandsen (2017) (parametric test)
- Example of a fuzzy RD
  - \*\*A - Müller and Shaikh (2018) (How does your spouse’s retirement affect your health?)
- Other RD issues
  - Discrete assignment variables, heaping bias, rounding bias, measurement error, parametric model selection, model uncertainty
  - I will briefly summarize, but, due to time constraints, I will probably only get to discussing discrete assignment variables.
  - T - Button (2016) (Why we really don’t know what we’re doing with parametric estimation in RD)
  - T,C - Lee and Card (2008) (Issues with discrete data with an RD)
  - T - Gelman and Imbens (2019) (Don’t use high order polynomials with RD)
  - T - Barreca, Lindo and Waddell (2016) (An issue that can come up with discrete assignment variables)
  - T - Dong (2015) (Another issue that can come up with discrete assignment variables)

- T - Pei and Shen (2017) (Discusses the issue of measurement error in the assignment variable)
- T - Bartalotti and Brummet (2017) (Improves the methodology of RD when you have clustered data)
- RD with multiple cutoffs and multiple scores and Geographic Regression Discontinuity Design (GRD)
  - Sometimes you have more than one assignment variable. This occurs for Geographic Regression Discontinuity Design (GRD), where you exploit the fact that policies change discontinuously at borders.
  - \*\*T,P - Keele and Titiunik (2015) (Intro. to using geography with an RD, with applications in Political Science)
  - P - The “rdmulti” package for Stata and R: <https://sites.google.com/site/rdpackages/rdmulti>
  - T - Cattaneo et al. (2016) (A more up-to-date paper discussing the multiple score/cutoff issue. Tests different approaches and suggests that sometimes the prior methods were not ideal.)
  - T - Reardon and Robinson (2012) (A very thorough piece. Compares and contrasts five different approaches that can be used.)
  - T - Wong, Steiner and Cook (2013) (Similar to above: compares different approaches)
  - T - Cattaneo et al. (2019) (New approach to extrapolate a treatment effect in a multi-cutoff RD)
- RD-DiD (Research designs that combine an RD with a DiD)
- Will cover briefly so you get the sense of what this methodology looks like
  - \*A - Asfaw (2019) (but one good example - on Medicare Part D)
- Regression Kink Design (RKD)
- Brief overview so you can see which situations allow you to use an RKD
  - \*\*Mixtape (pages 202 to 204)
  - \*T,P - Card et al. (2017) (Great overview paper)
- Comparative Regression Discontinuity Design (CRD)
  - Combines an RD with an untreated (control) group. Useful in the instances where you have one group that gets treated based on an RD, but some other group that you have data on but that doesn't get treated.
  - C,T - Wing and Cook (2013) (Introduced the technique)
  - T - Tang et al. (2017) (Builds on the above and improves the methodology)
- Other recent technical papers (check these out if you do an RD in the future)
- Will be important to watch these to see how the methodology improves or how standards change around what to do
  - T,P - Eggers et al. (2018) (Read this if your assignment variable is based on population)
  - T - Calonico et al. (2019) (RD with covariates)

- T - Cattaneo, Titiunik and Vazquez-Bare (2019) (Power calculations using the Stata program “rdsampsi”. Useful if you are going to come up with treatment based on an RD and you want to know how many observations you need.)
- T - Cerulli et al. (2017) (Introduces the concepts of a treatment effect derivative and a complier probability derivative. These measure the stability of the treatment effect. The estimation is easy and can be done in Stata.)
- T - Bartalotti, Calhoun and He (2017) (Suggests a new approach that creates bootstrapped confidence intervals)
- T - Bartalotti and Brummet (2017) (Improves the methodology of RD when you have clustered data)
- More notable RD examples (if you are interested, not covered)
  - These may use some out-of-date methodology but are really interesting or important examples of RD
  - A - Anderson and Magruder (2012) (Do Yelp ratings affect restaurant demand?)
  - A - Carpenter and Dobkin (2009) (Effect of alcohol consumption on mortality - using age and legal drinking age)
  - C,A - Card, Dobkin and Maestas (2008) (Effect of Medicare on health care utilization - using age)
  - C,A - Card, Dobkin and Maestas (2009) (Related to above, but effect of Medicare on mortality)
  - C,A - Ludwig and Miller (2007) (Effect of Head Start on education and mortality - using cut-off funding assignment of counties)
  - A - Matsudaira (2008) (Effects of summer school on educational outcomes)

### Propensity Score Matching (1 class)

- Introduction to the technique
  - \*\*Causal Inference Pages 57 to 70 (A nice, accessible, overview of matching)
  - \*\*A - Anderson (2017) (A well-done, modern application of propensity score matching)
  - \*\* Slides on p-score matching by Vivien Chen and Krissy Zeiser: <http://t.edu.jg.com.cn:81/forum/201206/24/b16b694ff70c/Implementing%20Propensity%20Score%20Matching%20Causal%20Analysis%20with%20Stata%EF%BC%88%E9%87%8D%E8%A6%81%EF%BC%89.pdf>
  - \*\* Steiner et al. (2017) (See DAGs for propensity score by reading the sections that relate to this)
  - \*Mixtape: Matching and subclassification Chapter (pages 105 to 151)
  - P - Stata program “PSMATCH2” by Edwin Leuven and Barbara Sianesi: <https://econpapers.repec.org/software/bocbocode/S432001.htm>
  - C,T - Rosenbaum and Rubin (1983) (Classic introduction to propensity score matching)
  - C,T - Heckman, Ichimura and Todd (1998) (Another classic technical paper. Extends Rosenbaum and Rubin (1983).)

- P - Abadie et al. (2004) (Conducting matching in Stata)
- P - Caliendo and Kopeinig (2008) (Guidance on doing matching)
- Classic propensity score matching papers which replicate and critique LaLonde (1986) (not covered but take a look at these if using p-score in the future)
  - C,A - LaLonde (1986) (Classic paper that compares matching to experimental estimates)
  - T - Smith and Todd (2005) (Also see the comment from Dehejia and Smith and Todd's rejoinder in the same issue of the journal.)
  - A - Dehejia and Wahba (1999)
  - A - Dehejia and Wahba (2002)

### Conclusion of the Course (1 class)

- Overview of the course
- The Ten Commandments of Applied Econometrics
- Next steps over the summer
- Discuss the final and comprehensive exam
  - \*\*P - Kennedy (2002) (The 10 Commandments of Applied Econometrics)
  - \*MM Ch 6. (provides a nice overview of most of the causal inference approaches in the course)

### Preferred Gender Pronouns

My preferred pronouns are he/him/his. If you've never heard of preferred pronouns before, please read this for an introduction: <https://www.ccsu.edu/lgbt/files/PreferredGenderPronounsForFaculty.pdf>.

Thank you to those of you who added your preferred pronouns to your account on Gibson and/or to your email signature! I would appreciate if everyone could add those, regardless of your gender or gender identity. This is helpful for several reasons:

- Members of the Tulane community know which pronouns to use for you, making it more likely that people will use pronouns for you that you prefer.
- It normalizes the use of pronouns. If few people mention preferred pronouns on Gibson or in other contexts (e.g., email signatures) then it stands out more when transgender or gender non-conforming individuals mention them. Cisgender allies can be very helpful by mentioning their preferred pronouns too and helping to normalize this.

For more information on how to add your preferred pronouns to Gibson, or other ways Tulane is working to be more inclusive about preferred pronouns and preferred names, see <https://registrar.tulane.edu/preferred-first-name-and-pronoun/faqs>. If you want to see how you can add pronouns to your email signature, then take a look at my email signature.

### Attendance

Students are expected to attend all classes unless they are ill or prevented from attending by exceptional circumstances or because of other important university-level commitments (e.g., sports

games). Students who find it necessary to miss class are responsible for obtaining notes on material covered in lectures.

Success in this class requires that you attend class regularly. I will regularly cover material that is not in the text or in the assigned readings or I will cover it differently. A lot of the course material is of my own doing and doesn't have a direct parallel in an assigned reading. In addition, important announcements regarding the course may be made during class.

## **ADA and Accessibility Statement**

Any students with disabilities or other needs, who need special accommodations in this course, are invited to share these concerns or requests with the instructor and should contact Goldman Center for Student Accessibility: <http://accessibility.tulane.edu> or 504.862.8433.

It is important to me that all students are able to take the course without barriers that could negatively impact learning. I would like to work with students with disabilities who require accommodations to ensure that they feel supported and integrated into the classroom. To ensure that you are able to access the accommodations you need, please discuss your situation with the Goldman Center for Student Accessibility. I will work with their office to ensure that your accommodation needs are met.

## **Mental Health**

There are many other barriers to learning that I want to remove. For example, students may experience mental health issues during their time at Tulane. Sometimes these are dealt with formally, such that students work through the Goldman Center to get needed accommodations. But oftentimes these situations appear and haven't been dealt with in a formal way. As someone who sometimes struggles with mental health issues, I understand how mental health issues can be a significant barrier to the ability to learn. I want to work with students who have situations that may or may not be documented to see what we can do to reduce any barriers to learning and to ensure that students can take care of their health in addition to performing in the course. If you have facing barriers to your learning, please let me know what I can do to help. Coming to me earlier usually allows me to be of better help, but I can attempt to assist at all stages.

## **Children in Class**

I applaud all of you who go to graduate school with children! It is difficult to balance academic, work, and family commitments, and I want you to succeed. Here are my policies regarding children in class:

1. All breastfeeding babies are welcome in class as often as necessary.
2. Non-nursing babies and older children are welcome whenever alternate arrangements cannot be made. I understand that babysitters fall through, partners have conflicting schedules, children get sick, and other issues arise that leave parents with few other options.
3. In cases where children come to class, I invite parents/caregivers to sit close to the door so as to more easily excuse yourself to attend to your child's needs. Non-parents in the class: please reserve seats near the door for your parenting classmates. All students are expected to join with me in creating a welcoming environment that is respectful of your classmates who bring children to class.

4. I understand that sleep deprivation and exhaustion are among the most difficult aspects of parenting young children. The struggle of balancing school, work, childcare, and graduate school is tiring, and I will do my best to accommodate any such issues while maintaining the same high expectations for all students enrolled in the class. Please do not hesitate to contact me with any questions of concerns.

*(This sub-section adapted from the syllabi of Andrew Heiss and Christopher Jones.)*

## Title IX

Tulane University recognizes the inherent dignity of all individuals and promotes respect for all people. As such, Tulane is committed to providing an environment free of all forms of discrimination including sexual and gender-based discrimination, harassment, and violence like sexual assault, intimate partner violence, and stalking.

**“Lauren’s Promise”:** I will listen and believe you if someone is threatening or harassing you.

Lauren McCluskey, a 21-year-old honors student athlete, was murdered on Oct. 22, 2018, by a man she briefly dated on the University of Utah campus. *We must all take action to ensure that this never happens again.*

If you are in immediate danger, call 911.

If you (or someone you know) has experienced or is experiencing the behaviors detailed above, know that you are not alone. Resources and support are available: you can learn more at [allin.tulane.edu](http://allin.tulane.edu). Any and all of your communications on these matters will be treated as either “Confidential” or “Private” as explained in below. Please know that if you choose to confide in me I am mandated by the university to report to the Title IX Coordinator, as Tulane and I want to be sure you are connected with all the support the university can offer. You do not need to respond to outreach from the university if you do not want. You can also make a report yourself, including an anonymous report, through the form at [tulane.edu/concerns](http://tulane.edu/concerns).

### Confidential

*Except in extreme circumstances, involving imminent danger to one’s self or others, nothing will be shared without your explicit permission.*

Counseling & Psychological Services (CAPS): (504) 314-2277 or The Line (24/7): (504) 264-6074

Student Health Center: (504) 865-5255

Sexual Aggression Peer Hotline and Education (SAPHE): (504) 654-9543

### Private

*Conversations are kept as confidential as possible, but information is shared with key staff members so the University can offer resources and accommodations and take action if necessary for safety reasons.*

Case Management & Victim Support Services: (504) 314-2160 or [srss@tulane.edu](mailto:srss@tulane.edu)

Tulane University Police (TUPD): Uptown - (504) 865-5911. Downtown - (504) 988-5531

Title IX Coordinator: (504) 314-2160 or [msmith76@tulane.edu](mailto:msmith76@tulane.edu)

## Emergency Preparedness and Response

EMERGENCY NOTIFICATION SYSTEM: TU ALERT	RAVE GUARDIAN
<p>In the event of a campus emergency, Tulane University will notify students, faculty, and staff by email, text, and phone call. You were automatically enrolled in this system when you enrolled at the university.</p> <p>Check your contact information annually in Gibson Online to confirm its accuracy.</p>	<ul style="list-style-type: none"> <li>• Download the RAVE Guardian app from the App Store</li> <li>• Communicate with dispatchers silently by selecting “Submit Tip” feature in the app</li> <li>• Use the Safety Timer feature to alert your “guardian” (TUPD, family, friend) when travelling alone at night</li> </ul> <p>For more information, visit <a href="https://publicsafety.tulane.edu/rave-guardian">publicsafety.tulane.edu/rave-guardian</a></p>
ACTIVE SHOOTER / VIOLENT ATTACKER	SEVERE WEATHER
<ul style="list-style-type: none"> <li>• <b>RUN</b> – run away from or avoid the affected area, if possible</li> <li>• <b>HIDE</b> – go into the nearest room that can be locked, turn out the lights, silence cell phones, and remain hidden until all-clear message is given through TU ALERT</li> <li>• <b>FIGHT</b> – do not attempt this option, except as a last resort</li> </ul> <p>For more information on Active Shooter emergency procedures or to schedule a training, visit <a href="https://emergencyprep.tulane.edu">emergencyprep.tulane.edu</a></p>	<ul style="list-style-type: none"> <li>• Follow all TU Alerts and outdoor warning sirens</li> <li>• Seek shelter indoors until the severe weather threat has passed and an all-clear message is given</li> <li>• Do not attempt to travel outside if weather is severe</li> <li>• Monitor the Tulane Emergency website (<a href="https://tulane.edu/emergency/">tulane.edu/emergency/</a>) for university-wide closures during a severe weather event</li> </ul>

## Update History

I am consistently updating this syllabus to fix errors, clarify readings, and to add additional resources (since this syllabus is also a reference guide). Here is a summary of recent changes:

- February 1, 2020: Added Austin Nichols’ free e-book on Causal Inference
- January 29, 2020: Updated the weighting sub-section
- January 27, 2020: Added section on binary dependent variables (LPM vs. logit vs. probit)
- January 25, 2020: Significantly updated the RD section. Added a useful textbook (PDF available) by Cattaneo and co-authors, added multiple score/running variable papers, added regression kink design papers, added some other guides to RD.
- January 19, 2020: Added this update history section. Added more Stata resources, fixed some typos, updated student learning outcomes for DiD to reflect more of the newly-added content. Added Scott Cunningham’s mixtape as a required “textbook” and added suggested readings from this to each section of the suggested readings. Added a few other resources.

## Articles and Books on the Syllabus

Abadie, Alberto, Alexis Diamond, and Jens Hainmueller. 2010. “Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California’s Tobacco Control Program.” *Journal of the American Statistical Association*, 105(490): 493–505.

- Abadie, Alberto, David Drukker, JI Herr, and Gw Imbens.** 2004. "Implementing matching estimators for average treatment effects in Stata." *The Stata Journal*, 4(3): 290–311.
- Abadie, Alberto, Susan Athey, Guido Imbens, and Jeffrey Wooldridge.** 2017. "When Should You Adjust Standard Errors for Clustering?" *NBER Working Paper 24003*.
- Abraham, Sarah, and Liyang Sun.** 2019. "Estimating Dynamic Treatment Effects in Event Studies With Heterogeneous Treatment Effects." *SSRN Electronic Journal*.
- Acemoglu, Daron, and Joshua D. Angrist.** 2001. "Consequences of Employment Protection? The Case of the Americans with Disabilities Act." *Journal of Political Economy*, 109(5): 915–957.
- Acock, Alan C.** 2008. *A Gentle Introduction to Stata*. College Station, TX: Stata Press.
- Algan, Yann, Sergei Guriev, Elias Papaioannou, and Evgenia Passari.** 2017. "The European Trust Crisis and the Rise of Populism." *Brookings Papers on Economic Activity*, , (Fall): 309–400.
- Ameri, Mason, Sean Edmund Rogers, Lisa Schur, and Douglas Kruse.** 2018. "No Room at the Inn? Disability Access in the New Sharing Economy." *Academy of Management Discoveries*.
- Anderson, Michael L.** 2017. "The Benefits of College Athletic Success: An Application of the Propensity Score Design." *Review of Economics and Statistics*, 99(1): 119–134.
- Anderson, Michael L., and David A Matsa.** 2011. "Are Restaurants Really Supersizing America?" *American Economic Journal: Applied Economics*, 3(1): 152–188.
- Anderson, Michael L., and Jeremy Magruder.** 2012. "Learning From the Crowd: Regression Discontinuity Estimates of the Effects of an Online Review Database." *Economic Journal*, 122(September): 957–989.
- Andrews, Isaiah, James H. Stock, and Liyang Sun.** 2019. "Weak Instruments in Instrumental Variables Regression: Theory and Practice." *Annual Review of Economics*, 11(1): 727–753.
- Angrist, Joshua D., and Alan B. Krueger.** 1999. "Empirical Strategies in Labor Economics." In *Handbook of Labor Economics, Vol. 3A.* , ed. Orley C. Ashenfelter and David Card. Amsterdam: Elsevier Science.
- 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.
- Angrist, Joshua D., and Ivan Fernandez-val.** 2013. "ExtrapoLATE-Ing: External Validity and Overidentification in the LATE framework." In *Advances in Economics and Econometrics.* , ed. Daron Acemoglu, Manuel Arellano and Eddie Dekel. Cambridge, MA:Cambridge University Press.
- Angrist, Joshua D., and Jörn-Steffen Pischke.** 2008. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton, NJ:Princeton University Press.
- Angrist, Joshua D., and Jörn-Steffen Pischke.** 2015. *Mastering Metrics*. Princeton, NJ: Princeton University Press.

- Angrist, Joshua D., and Victor Lavy.** 1999. "Using Maimonides' Rule to Estimate the Effect of Class Size on Scholastic Achievement." *The Quarterly Journal of Economics*, 114(May): 533–575.
- Angrist, Joshua D., and William N. Evans.** 1998. "Children and Their Parents' Labor Supply: Evidence from Exogenous Variation in Family Size." *American Economic Review*, 88(3): 450–477.
- 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.
- Angrist, Joshua D., Victor Lavy, Jetson Leder-Luis, and Adi Shany.** 2017. "Maimonides Rule Redux." *NBER Working Paper 23486*.
- Argys, Laura M, Andrew I Friedson, M Melinda Pitts, and D Sebastian Tello-Trillo.** 2017. *Losing Public Health Insurance: TennCare Disenrollment and Personal Financial Distress*.
- Arkhangelsky, Dmitry, Susan Athey, David A Hirshberg, Guido W Imbens, and Stefan Wager.** 2019. "Synthetic Difference in Differences." *NBER Working Paper 25532*.
- Asfaw, Abraham Abebe.** 2019. "The effect of prescription drug insurance on health behavior: Evidence from Medicare Part D." *Health Economics*, 28(3): 403–418.
- Athey, Susan, and Guido Imbens.** 2018. "Design-based Analysis in Difference-In-Differences Settings with Staggered Adoption."
- Athey, Susan, Mohsen Bayati, Nikolay Doudchenko, Guido Imbens, and Khashayar Khosravi.** 2018. "Matrix Completion Methods for Causal Panel Data Models."
- Barreca, Alan I., Jason M. Lindo, and Glen R. Waddell.** 2016. "Heaping-Induced Bias in Regression-Discontinuity Designs." *Economic Inquiry*, 54(1): 268–293.
- Bartalotti, Otávio, and Quentin Brummet.** 2017. "Regression discontinuity designs with clustered data." *Advances in Econometrics*, 38: 383–420.
- Bartalotti, Otávio, Gray Calhoun, and Yang He.** 2017. "Bootstrap confidence intervals for sharp regression discontinuity designs." In *Advances in Econometrics*. Vol. 38, , ed. Matias D. Cattaneo and Juan Carlos Escanciano, 421–453. Emerald Publishing.
- Bartik, Timothy J.** 1991. *Who Benefits from State and Local Economic Development Policies?* Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.
- Bartus, Tamás.** 2005. "Estimation of marginal effects using `margeff`." *The Stata Journal*, 5(3): 309–329.
- Baum, Christopher F., Mark E. Schaffer, and Steven Stillman.** 2007. "Enhanced routines for instrumental variables/generalized method of moments estimation and testing." *The Stata Journal*, 7(4): 465–506.
- Ben-Michael, Eli, Avi Feller, and Jesse Rothstein.** 2018. "The Augmented Synthetic Control Method." , (November).

- Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan.** 2004. "How Much Should We Trust Differences-In-Differences Estimates?" *The Quarterly Journal of Economics*, 119(1): 249–275.
- Besley, T, and a Case.** 2000. "Unnatural Experiments? Estimating the Incidence of Endogenous Policies." *The Economic Journal*, 110(467): F672–F694.
- Bhalotra, Sonia, and Damian Clarke.** 2019. "Twin Birth and Maternal Condition." *The Review of Economics and Statistics*, 101(5): 853–864.
- Bhuller, Manudeep, Gordon Dahl, Katrine Løken, and Magne Mogstad.** 2016. "Incarceration, Recidivism and Employment." *NBER Working Paper 22648*.
- Billmeier, Andreas, and Tommaso Nannicini.** 2013. "Assessing Economic Liberalization Episodes: A Synthetic Control Approach." *Review of Economics and Statistics*, 95(3): 983–1001.
- Bitler, Marianne P., and Christopher S. Carpenter.** 2016. "Health insurance mandates, mammography, and breast cancer diagnoses." *American Economic Journal: Economic Policy*, 8(3): 39–68.
- Black, Dan A., Jeffrey A. Smith, Mark C. Berger, and Brett J. Noel.** 2003. "Is the Threat of Reemployment Services More Effective Than the Services Themselves? Evidence from Random Assignment in the UI System." *American Economic Review*, 93(4): 1313–1327.
- Blanchard, Olivier Jean, and Lawrence F. Katz.** 1992. "Regional Evolutions." *Brookings Papers on Economic Activity*, 1992(1): 1–75.
- Bleakley, Hoyt.** 2007. "Disease and Development: Evidence from Hookworm Eradication in the American South." *The Quarterly Journal of Economics*, 122(1): 73–117.
- Bollen, Kenneth A.** 2012. "Instrumental Variables in Sociology and the Social Sciences." *Annual Review of Sociology*, 38: 37–72.
- Borusyak, Kirill, and Xavier Jaravel.** 2017. "Revisiting Event Study Designs."
- Borusyak, Kirill, Peter Hull, and Xavier Jaravel.** 2019. "Quasi-Experimental Shift-Share Research Designs."
- Botosaru, Irene, and Bruno Ferman.** 2017. "On the Role of Covariates in the Synthetic Control Method."
- Bound, John, David a. Jaeger, and Regina M. Baker.** 1995. "Problems with Instrumental Variables Estimation when the Correlation between the Instruments and the Endogenous Explanatory Variable is Weak." *Journal of the American Statistical Association*, 90(430): 443–450.
- Butler, Daniel M., and David E. Broockman.** 2011. "Do Politicians Racially Discriminate Against Constituents? A Field Experiment on State Legislators." *American Journal of Political Science*, 55(3): 463–477.
- Button, Patrick.** 2016. "Model Uncertainty and Model Averaging in Regression Discontinuity Designs." *Journal of Econometric Methods*, 5(1): 103–116.
- Button, Patrick.** 2018. "Expanding Disability Discrimination Protections for Individuals with Disabilities: Evidence from California." *ILR Review*, 71(2): 365–93.

- Button, Patrick.** 2019. "Do tax incentives affect business location and economic development? Evidence from state film incentives." *Regional Science and Urban Economics*, 77: 315–339.
- Caliendo, Marco, and Sabine Kopeinig.** 2008. "Some practical guidance for the implementation of propensity score matching." *Journal of Economic Surveys*, 22(1): 31–71.
- Callaway, Brantly, and Pedro H C Sant'Anna.** 2019. "Difference-in-Differences with Multiple Time Periods."
- Calonico, Sebastian, Matias D. Cattaneo, and Max H Farrell.** 2016. "rdrobust: Software for Regression Discontinuity Designs." *The Stata Journal*, 17(2): 372–404.
- Calonico, Sebastian, Matias D. Cattaneo, and Rocío Rocio Titiunik.** 2014a. "Robust Data-Driven Inference in the Regression-Discontinuity Design." *The Stata Journal*, vv(2): 1–32.
- Calonico, Sebastian, Matias D. Cattaneo, and Rocio Titiunik.** 2014b. "Robust Nonparametric Confidence Intervals for Regression-Discontinuity Designs." *Econometrica*, 82(6): 2295–2326.
- Calonico, Sebastian, Matias D. Cattaneo, Max H. Farrell, and Rocio Titiunik.** 2019. "Regression Discontinuity Designs using Covariates." *Review of Economics and Statistics*, 101(3): 442–451.
- Cameron, A. Colin, and Douglas L. Miller.** 2015. "A practitioner's guide to cluster-robust inference." *Journal of Human Resources*, 50(2): 317–372.
- Cameron, A. Colin, and P K Trivedi.** 2010. *Microeconometrics Using Stata*. College Station, TX: Stata Press Books.
- Cameron, A. Colin, Jonah B. Gelbach, and Douglas L. Miller.** 2008. "Bootstrap-Based Improvements for Inference with Clustered Errors." *Review of Economics and Statistics*, 90(3): 414–427.
- Cameron, A. Colin, Jonah B. Gelbach, and Douglas L. Miller.** 2011. "Robust Inference With Multiway Clustering." *Journal of Business & Economic Statistics*, 29(2): 238–249.
- Card, David, Carlos Dobkin, and Nicole Maestas.** 2008. "The impact of nearly universal insurance coverage on health care utilization: Evidence from medicare." *American Economic Review*, 98(5): 2242–2258.
- Card, David, Carlos Dobkin, and Nicole Maestas.** 2009. "Does Medicare Save Lives?" *Quarterly Journal of Economics*, 124(2): 597–636.
- Card, David, David S. Lee, Zhuan Pei, and Andrea Weber.** 2017. "Regression kink design: Theory and practice." In *Advances in Econometrics*. Vol. 38, , ed. Matias D. Cattaneo and Juan Carlos Escanciano, 341–382. Emerald Publishing.
- Carpenter, Christopher S, and Carlos Dobkin.** 2009. "The effect of alcohol consumption on mortality: Regression discontinuity evidence from the minimum drinking age." *American Economic Journal: Applied Economics*, 1(1): 164–182.
- Cattaneo, Matias D., Luke Keele, Rocío Titiunik, and Gonzalo Vazquez-Bare.** 2016. "Interpreting regression discontinuity designs with multiple cutoffs." *Journal of Politics*, 78(4): 1229–1248.
- Cattaneo, Matias D., Luke Keele, Rocio Titiunik, and Gonzalo Vazquez-Bare.** 2019. "Extrapolating Treatment Effects in Multi-Cutoff Regression Discontinuity Designs."

- Cattaneo, Matias D., Nicolás Idrobo, and Rocío Titiunik.** 2019. *A Practical Introduction to Regression Discontinuity Designs*.
- Cattaneo, Matias D., Rocío Titiunik, and Gonzalo Vazquez-Bare.** 2019. "Power calculations for regression-discontinuity designs." *The Stata Journal*, 19(1): 210–245.
- Cavallo, E, S Galiani, I Noy, and J Pantano.** 2013. "Catastrophic Natural Disasters and Economic Growth." *Review of Economics and Statistics*, 95(5): 1549–1561.
- Cerulli, Giovanni, Yingying Dong, Arthur Lewbel, and Alexander Poulsen.** 2017. "Testing stability of regression discontinuity models." In *Advances in Econometrics*. Vol. 38, , ed. Matias D. Cattaneo and Juan Carlos Escanciano, 317–339. Emerald Publishing.
- Conley, Timothy G., and Christopher R. Taber.** 2011. "Inference with Difference in Differences with a Small Number of Policy Changes." *Review of Economics and Statistics*, 93(1): 113–125.
- Cook, Thomas D.** 2008. "'Waiting for Life to Arrive': A History of the Regression-Discontinuity Design in Psychology, Statistics and Economics." *Journal of Econometrics*, 142(2): 636–654.
- Cunningham, Scott.** 2018. *Causal Inference: The Mixtape*. . 1.7 ed., Tufte-Latex.Googlecode.com.
- Das, Tirthatanmoy, and Solomon W Polachek.** 2019. "A New Strategy to Identify Causal Relationships: Estimating a Binding Average Treatment Effect." *IZA DP No. 12766*.
- Daw, Jamie R., and Laura A. Hatfield.** 2018a. "Matching and Regression to the Mean in Difference-in-Differences Analysis." *Health Services Research*, 53(6): 4138–4156.
- Daw, Jamie R., and Laura A. Hatfield.** 2018b. "Matching in Difference-in-Differences: between a Rock and a Hard Place." *Health Services Research*, 53(6): 4111–4117.
- Deaton, Angus S.** 1997. *The Analysis of Household Surveys: Micro Econometric Analysis for Development Policy*. Baltimore: The John Hopkins University Press.
- de Chaisemartin, Clement, and Xavier D'Haultfoeuille.** 2018. "Fuzzy differences-in-differences." *Review of Economic Studies*, 85(2): 999–1028.
- de Chaisemartin, Clement, Xavier D'Haultfoeuille, and Yannick Guyonvarch.** 2019. "Fuzzy Differences-in-Differences with Stata." *The Stata Journal*, 19(2): 435–458.
- de Chaisemartin, Clement, Xavier D'Haultfoeuille, Clement de Chaisemartin, and Xavier D'Haultfoeuille.** 2019. "Two-way fixed effects estimators with heterogeneous treatment effects." *NBER Working Paper 25904*, 1–57.
- Dehejia, Rajeev H., and Sadek Wahba.** 1999. "Causal effects in nonexperimental studies: Reevaluating the evaluation of training programs." *Journal of the American Statistical Association*, 94(448): 1053–1062.
- Dehejia, Rajeev H, and Sadek Wahba.** 2002. "Propensity Score-Matching Methods for Non-Experimental Casual Studies." *Review of Economics and Statistics*, 84(1): 151–161.
- Deryugina, Tatyana, Alexander MacKay, and Julian Reif.** 2018. "The Long-Run Dynamics of Electricity Demand: Evidence From Municipal Aggregation." *SSRN Electronic Journal*.

- DiNardo, John, and Jorn-Steffen Pischke.** 1997. "The returns to computer use revisited: have pencils changed the wage structure too?" *The Quarterly Journal of Economics*, 112(1): 291–303.
- Donald, Stephen G, and Kevin Lang.** 2007. "Inference with Difference-in-Differences and Other Panel Data." *Review of Economics and Statistics*, 89(2): 221–233.
- Dong, Yingying.** 2015. "Regression Discontinuity Applications with Rounding Errors in the Running Variable." *Journal of Applied Econometrics*, 30: 422–446.
- Dube, Arindrajit, and Ben Zipperer.** 2016. "Pooling Multiple Case Studies using Synthetic Controls : An Application to Minimum Wage Policies."
- Duflo, Esther.** 2001. "Schooling and Labor Market Consequences of School Construction in Indonesia: Evidence from an Unusual Policy Experiment." *American Economic Review*, 91(4): 795–813.
- Eggers, Andrew C., Ronny Freier, Veronica Grembi, and Tommaso Nannicini.** 2018. "Regression Discontinuity Designs Based on Population Thresholds: Pitfalls and Solutions." *American Journal of Political Science*, 62(1): 210–229.
- Eliason, Paul, and Byron Lutz.** 2018. "Can fiscal rules constrain the size of government? An analysis of the "crown jewel" of tax and expenditure limitations." *Journal of Public Economics*, 166: 115–144.
- Falk, Armin, and James J. Heckman.** 2009. "Lab experiments are a major source of knowledge in the social sciences." *Science*, 326(5952): 535–538.
- Ferman, Bruno, Cristine Pinto, and Vitor Possebom.** 2020. "Cherry Picking with Synthetic Controls."
- Finkelstein, Amy N, Sarah Tauban, Bill Wright, Mira Bernstein, Jonathan Gruber, Joseph P. Newhouse, Heidi Allen, Katherine Baicker, and Oregon Health Study Group.** 2012. "The Oregon Health Insurance Experiment: Evidence From The First Year." *Quarterly Journal of Economics*, 127(3): 1057–1106.
- Finlay, Keith, and Leandro M. Magnusson.** 2009. "Implementing weak-instrument robust tests for a general class of instrumental-variables models." *The Stata Journal*, 9(3): 398–421.
- Flores-Lagunes, Alfonso.** 2007. "Finite Sample Evidence of IV Estimators Under Weak Instrument." *Journal of Applied Econometrics*, 22: 677–694.
- Flory, Jeffrey A., Andreas Leibbrandt, Christina Rott, and Olga Stoddard.** 2019. "Increasing Workplace Diversity: Evidence from a Recruiting Experiment at a Fortune 500 Company." *Journal of Human Resources*.
- Frandsen, Brigham R.** 2017. "Party Bias in Union Representation Elections: Testing for Manipulation in the Regression Discontinuity Design when the Running Variable is Discrete." In *Regression Discontinuity Design: Theory and Applications*. 281–315.
- Freedman, David A.** 1991. "Statistical Models and Shoe Leather." *Sociological Methodology*, 21: 291–313.
- Freyaldenhoven, Simon, Christian Hansen, and Jesse M Shapiro.** 2019. "Pre-event trends in the panel event-study design." *American Economic Review*, 109(9): 3307–3338.

- Friedberg, Leora.** 1998. "Did Unilateral Diverge Raise Divorce Rates? Evidence from Panel Data." *American Economic Review*, 88(3): 608–627.
- Gardeazabal, Javier, and Ainhoa Vega-Bayo.** 2017. "An Empirical Comparison Between the Synthetic Control Method and Hsiao et al.'s Panel Data Approach to Program Evaluation." *Journal of Applied Econometrics*, 32: 983–1002.
- Gelman, Andrew, and Guido Imbens.** 2019. "Why High-Order Polynomials Should Not Be Used in Regression Discontinuity Designs." *Journal of Business and Economic Statistics*, 37(3): 447–456.
- Gibbons, Charles E., Juan Carlos Suarez Serrato, Michael B. Urbancic, Juan Carlos Suárez Serrato, and Michael B. Urbancic.** 2018. "Broken or Fixed Effects?" *Journal of Econometric Methods*, 8(1): 1–12.
- Giulietti, Corrado, Mirco Tonin, and Michael Vlassopoulos.** 2019. "Racial Discrimination in Local Public Services: A Field Experiment in the US." *Journal of the European Economic Association*, 17(1): 165–204.
- Gneezy, Uri, Muriel Niederle, and Aldo Rustichini.** 2003. "Performance in Competitive Environments: Gender Differences." *Quarterly Journal of Economics*, 118(3): 1049–1074.
- Goldsmith-Pinkham, Paul, Isaac Sorkin, and Henry Swift.** 2019. "Bartik Instruments: What, When, Why, and How." *NBER Working Paper 24408*.
- Goodman-Bacon, Andrew.** 2018. "Public insurance and mortality: Evidence from medicaid implementation." *Journal of Political Economy*, 126(1): 216–262.
- Goodman-Bacon, Andrew.** 2019a. "Difference-in-Differences with Variation in Treatment Timing."
- Goodman-Bacon, Andrew.** 2019b. "So You've Been Told to Do My Difference-in-Differences Thing: A Guide."
- Greene, William H.** 2008. *Econometric Analysis*. . 6th ed., Upper Saddle River, NJ:Pearson Prentice Hall.
- Greenstone, Michael, Richard Hornbeck, and Enrico Moretti.** 2010. "Identifying Agglomeration Spillovers: Evidence from Winners and Losers of Large Plant Openings." *Journal of Political Economy*, 118(3): 536–598.
- Gruber, J.** 1994. "The incidence of mandated maternity benefits." *American Economic Review*, 84(3): 622–641.
- Hahn, Jinyong, Petra E. Todd, Wilbert Van Der Klaauw, and Wilbert Van Der Klaauw.** 2001. "Identification and Estimation of Treatment Effects with a Regression-Discontinuity Design." *Econometrica*, 69(1): 201–209.
- Heckman, James J., Hidehiko Ichimura, and Petra Todd.** 1998. "Matching as an econometric evaluation estimator." *Review of Economic Studies*, 65: 261–294.
- Hill, Elaine L, David J.G. Slusky, and Donna K Ginther.** 2019. "Reproductive health care in Catholic-owned hospitals." *Journal of Health Economics*, 65: 48–62.

- Horowitz, Joel L.** 2001. "The Bootstrap." In *Handbook of Econometrics*. Vol. 5, , ed. James J. Heckman and Edward E. Leamer, 3159–3228. Elsevier B.V.
- Horrace, William C., and Ronald L. Oaxaca.** 2006. "Results on the bias and inconsistency of ordinary least squares for the linear probability model." *Economics Letters*, 90(3): 321–327.
- Horton, John J., David G. Rand, and Richard J. Zeckhauser.** 2011. "The online laboratory: Conducting experiments in a real labor market." *Experimental Economics*, 14(3): 399–425.
- Hoxby, Caroline M.** 2000. "Does Competition among Public Schools Benefit Students and Taxpayers?" *American Economic Review*, 90(5): 1209–1238.
- Hoxby, Caroline M.** 2007. "Does Competition among Public Schools Benefit Students and Taxpayers? Reply." *American Economic Review*, 90(5): 1209–1238.
- Hyslop, Dean R, and Guido W Imbens.** 2001. "Bias From Classical and Other Forms of Measurement Error." *Journal of Business & Economic Statistics*, 19(4): 475–481.
- Imai, Kosuke, and In Song Kim.** 2019. "When Should We Use Unit Fixed Effects Regression Models for Causal Inference with Longitudinal Data?" *American Journal of Political Science*, 63(2): 467–490.
- Imai, Kosuke, In Song Kim, and Erik Wang.** 2019. "Matching methods for causal inference with Time-Series Cross-Sectional Data." *Working Paper*.
- Imbens, Guido W.** 2014. "Instrumental variables: An econometrician's perspective." *Statistical Science*, 29(3): 323–358.
- Imbens, Guido W.** 2019. "Potential Outcome and Directed Acyclic Graph Approaches to Causality: Relevance for Empirical Practice in Economics." *NBER Working Paper 26104*.
- Imbens, Guido W., and Jeffrey M Wooldridge.** 2009. "Recent Developments in the Econometrics of Program Evaluation." *Journal of Economic Literature*, 47(1): 5–86.
- Imbens, Guido W., and Thomas Lemieux.** 2008. "Regression discontinuity designs: A guide to practice." *Journal of Econometrics*, 142: 615–635.
- Jacobson, Louis S, Robert J Lalonde, and Daniel G Sullivan.** 1993. "Earnings Losses of Displaced Workers." *American Economic Review*, 83(4): 685–709.
- Kahn-Lang, Ariella, and Kevin Lang.** 2019. "The Promise and Pitfalls of Differences-in-Differences: Reflections on 16 and Pregnant and Other Applications." *Journal of Business and Economic Statistics*.
- Kaul, Ashok, Stefan Klößner, Gregor Pfeifer, and Manuel Schieler.** 2017. "Synthetic Control Methods: Never Use All Pre-Intervention Outcomes Together With Covariates."
- Keele, Luke J., and Rocío Titiunik.** 2015. "Geographic boundaries as regression discontinuities." *Political Analysis*, 23(1): 127–155.
- Keele, Luke J, Dylan S Small, Jesse Y Hsu, and Colin B Fogarty.** 2019. "Patterns of Effects and Sensitivity Analysis for Differences-in-Differences."

- Kennedy, Peter E.** 2002. "Sinning in the Basement: What are the Rules? The Ten Commandments of Applied Econometrics." *Journal of Economic Surveys*, 16(4): 569–589.
- Kennedy, Peter E.** 2003. *A Guide to Econometrics*. Vol. 2, MIT Press.
- Kreif, Noemi, Richard Grieve, Dominik Hangartner, Alex James Turner, Silviya Nikolova, and Matt Sutton.** 2016. "Examination of the Synthetic Control Method for Evaluating Health Policies with Multiple Treated Units." *Health Economics*, 25: 1514–1528.
- Kropko, Jonathan, and Robert Kubinec.** 2017. "Why the Two-Way Fixed Effects Model Is Difficult to Interpret, and What to Do About It."
- Krueger, Alan B.** 1993. "How computers have changed the wage structure: evidence from micro-data, 1984–1989." *Quarterly Journal of Economics*, 108(1): 33–60.
- Krueger, Alan B.** 1999. "Experimental Estimates of Education Production Functions." *Quarterly Journal of Economics*, 114(2): 497–532.
- LaLonde, Robert.** 1986. "Evaluating the Econometric Evaluations of Training Programs with Experimental Data." *American Economic Review*, 76(4): 604–620.
- Lee, David S.** 2008. "Randomized Experiments from Non-Random Selection in U.S. House Elections." *Journal of Econometrics*, 142: 675–697.
- Lee, David S., and David Card.** 2008. "Regression discontinuity inference with specification error." *Journal of Econometrics*, 142: 655–674.
- Lee, David S., and Thomas Lemieux.** 2010. "Regression Discontinuity Designs in Economics." *Journal of Economic Literature*, 48(June 2010): 281–355.
- Lee, David S., Enrico Moretti, and Matthew J Butler.** 2004. "Do Voters Affect Or Elect Policies? Evidence from the U. S. House." *Quarterly Journal of Economics*, 119(0214351): 807–859.
- Levitt, Steven D.** 1997. "Using Electoral Cycles in Police Hiring to Estimate the Effect of Police on Crime." *American Economic Review*, 87(3): 270–290.
- Levitt, Steven D.** 2002. "Using Electoral Cycles in Police Hiring to Estimate the Effect of Police on Crime: Reply." *American Economic Review*, 92(4): 1244–1250.
- Levitt, Steven D.** 2016. "Heads or Tails: The Impact of a Coin Toss on Major Life Decisions and Subsequent Happiness." *NBER Working Paper 22487*.
- Lewbel, Arthur.** 2012. "Using heteroscedasticity to identify and estimate mismeasured and endogenous regressor models." *Journal of Business and Economic Statistics*, 30(1): 67–80.
- Ludwig, Jens, and Douglas L. Miller.** 2007. "Does Head Start improve children's life chances? Evidence from a regression discontinuity design." *The Quarterly Journal of Economics*, 122(February): 159–208.
- Ludwig, Jens, Greg J. Duncan, L. a. Gennetian, Lawrence F. Katz, R. C. Kessler, Jeffrey R. Kling, and L. Sanbonmatsu.** 2012. "Neighborhood Effects on the Long-Term Well-Being of Low-Income Adults." *Science*, 337(6101): 1505–1510.

- MacKinnon, James G.** 2002. "Bootstrap inference in econometrics." *Canadian Journal of Economics*, 35: 615–645.
- Mackinnon, James G., and Matthew D. Webb.** 2017. "Wild Bootstrap Inference for Wildly Different Cluster Sizes." *Journal of Applied Econometrics*, 32: 233–254.
- MacKinnon, James G., and Matthew D. Webb.** 2018. "The wild bootstrap for few (treated) clusters." *Econometrics Journal*, 21(2): 114–135.
- Mackinnon, James G., and Matthew D. Webb.** 2019. "Randomization Inference for Difference-in-Differences with Few Treated Clusters."
- Madrian, Brigitte C.** 1994. "Employment-Based Health Insurance and Job Mobility: Is There Evidence of Job-Lock?" *The Quarterly Journal of Economics*, 109(1): 27–54.
- Maestas, Nicole, Kathleen J. Mullen, and Alexander Strand.** 2013. "Does disability insurance receipt discourage work? Using examiner assignment to estimate causal effects of SSDI Receipt." *American Economic Review*, 103(5): 1797–1829.
- Manning, W. G., J. P. Newhouse, N. Duan, E. B. Keeler, a. Leibowitz, and M. S. Marquis.** 1987. "Health insurance and the demand for medical care: evidence from a randomized experiment." *American Economic Review*, 77(3): 251–277.
- Manski, Charles F, and John V Pepper.** 2018. "How do right-to-carry laws affect crime rates? coping with ambiguity using bounded-variation assumptions." *Review of Economics and Statistics*, 100(2): 232–244.
- Matsudaira, Jordan D.** 2008. "Mandatory summer school and student achievement." *Journal of Econometrics*, 142(2): 829–850.
- McCrary, Justin.** 2002. "Using Electoral Cycles in Police Hiring to Estimate the Effect of Police on Crime: Comment." *American Economic Review*, 92(4): 1236–1243.
- McCrary, Justin.** 2007. "The effect of court-ordered hiring quotas on the composition and quality of police." *American Economic Review*, 97(1): 318–353.
- McCrary, Justin.** 2008. "Manipulation of the running variable in the regression discontinuity design: A density test." *Journal of Econometrics*, 142: 698–714.
- Meer, Jonathan, and Jeremy West.** 2016. "Effects of the minimum wage on employment dynamics." *Journal of Human Resources*, 51(2): 500–522.
- Meyer, Bruce D.** 1995. "Quasi-Experiments in Economics." *Journal of Business & Economic Statistics*, 13(2): 151–161.
- Miller, Jeff, and Rolf Ulrich.** 2019. "The quest for an optimal alpha." *Plos One*, 14(1): e0208631.
- Mogstad, Magne, Andres Santos, and Alexander Torgovitsky.** 2018. "Using Instrumental Variables for Inference About Policy Relevant Treatment Parameters." *Econometrica*, 86(5): 1589–1619.
- Mora, Ricardo, and Iliana Reggio.** 2019. "Alternative diff-in-diffs estimators with several pre-treatment periods." *Econometric Reviews*, 38(5): 465–486.

- Moulton, Brent R.** 1990. "An Illustration of a Pitfall in Estimating the Effects of Aggregate Variables on Micro Units." *The Review of Economics and Statistics*, 72(2): 334–338.
- Müller, Tobias, and Mujaheed Shaikh.** 2018. "Your retirement and my health behavior: Evidence on retirement externalities from a fuzzy regression discontinuity design." *Journal of Health Economics*, 57: 45–59.
- Neumark, David, Ian Burn, and Patrick Button.** 2019. "Is It Harder for Older Workers to Find Jobs? New and Improved Evidence from a Field Experiment." *Journal of Political Economy*, 127(2): 922–970.
- Nichols, Austin.** 2007. "Causal inference with observational data." *The Stata Journal*, 7(4): 507–541.
- Nichols, Austin.** 2009. *Causal Inference: Measuring the Effect of X on y*. Self-Published.
- Palmer, Caroline, David C. Phillips, and James X. Sullivan.** 2019. "Does emergency financial assistance reduce crime?" *Journal of Public Economics*, 169: 34–51.
- Pei, Zhuan, and Yi Shen.** 2017. "The devil is in the tails: Regression discontinuity design with measurement error in the assignment variable." In *Advances in Econometrics*. Vol. 38, , ed. Matias D. Cattaneo and Juan Carlos Escanciano, 455–502. Emerald Publishing.
- Pflueger, Carolin E., and Su Wang.** 2015. "A robust test for weak instruments in Stata." *The Stata Journal*, 15(1): 216–225.
- Rambachan, Ashesh, and Jonathan Roth.** 2019. "An Honest Approach to Parallel Trends."
- Reardon, Sean F., and Joseph P. Robinson.** 2012. "Regression Discontinuity Designs With Multiple Rating-Score Variables." *Journal of Research on Educational Effectiveness*, 5(1): 83–104.
- Reber, Sarah J.** 2005. "Court-ordered desegregation - Successes and failures integrating American schools since Brown versus Board of Education." *Journal of Human Resources*, 40(3): 559–590.
- Roodman, David, James G. MacKinnon, Morten Ørregaard Nielsen, and Matthew D. Webb.** 2019. "Fast and wild: Bootstrap inference in Stata using boottest." *The Stata Journal*, 19(1): 4–60.
- Rosenbaum, P R, and D B Rubin.** 1983. "The Central Role of the Propensity Score in Observational Studies for Causal Effects." *Biometrika*, 70(1): 41–55.
- Rosenzweig, Mark R, and Kenneth I Wolpin.** 2000. "Natural 'Natural Experiments' in Economics." *Journal of Economic Literature*, 38(4): 827–874.
- Roth, Jonathan.** 2019. "Pre-test with Caution: Event-study Estimates After Testing for Parallel Trends."
- Rothstein, Jesse.** 2007. "Does Competition Among Public Schools Benefit Students and Taxpayers? Comment." *American Economic Review*, 97(5): 2026–2037.
- Sacerdote, B.** 2001. "Peer effects with random assignment: Results for Dartmouth roommates." *The Quarterly Journal of Economics*, 116(May): 681–704.
- Sant'Anna, Pedro H. C., and Jun B. Zhao.** 2018. "Doubly Robust Difference-in-Differences Estimators." *SSRN Electronic Journal*.

- Skovron, Christopher, and Rocio Titiunik.** 2015. "A Practical Guide to Regression Discontinuity Designs in Political Science." *Working Paper*, 1–40.
- Smith, Jeffrey A., and Petra E. Todd.** 2005. "Does matching overcome LaLonde's critique of non-experimental estimators?" *Journal of Econometrics*, 125: 305–353.
- Solon, Gary, Steven J. Haider, and Jeffrey M. Wooldridge.** 2015. "What are we Weighting for?" *Journal of Human Resources*, 50(2): 301–316.
- Staiger, D, and J H Stock.** 1997. "Instrumental Variables Regression With Weak Instruments." *Econometrica*, 65(3): 557–586.
- Steiner, Peter M., Yongnam Kim, Courtney E. Hall, and Dan Su.** 2017. "Graphical Models for Quasi-experimental Designs." *Sociological Methods and Research*, 46(2): 155–188.
- Swanson, Sonja A., Miguel A. Hernán, Matthew Miller, James M. Robins, and Thomas S. Richardson.** 2018. "Partial Identification of the Average Treatment Effect Using Instrumental Variables: Review of Methods for Binary Instruments, Treatments, and Outcomes." *Journal of the American Statistical Association*, 113(522): 933–947.
- Tang, Yang, Thomas D. Cook, Yasemin Kisbu-Sakarya, Heinrich Hock, and Hanley Chiang.** 2017. "The comparative regression discontinuity (CRD) design: An overview and demonstration of its performance relative to basic RD and the randomized experiment." In *Advances in Econometrics*. Vol. 38, , ed. Matias D. Cattaneo and Juan Carlos Escanciano, 237–279. Emerald Publishing.
- von Hinke, Stephanie, George Davey Smith, Debbie A. Lawlor, Carol Propper, and Frank Windmeijer.** 2016. "Genetic markers as instrumental variables." *Journal of Health Economics*, 45: 131–148.
- Williams, Richard.** 2012. "Using the margins command to estimate and interpret adjusted predictions and marginal effects." *The Stata Journal*, 12(2): 308–331.
- Wing, Coady, and Thomas D. Cook.** 2013. "Strengthening The Regression Discontinuity Design Using Additional Design Elements: A Within-Study Comparison." *Journal of Policy Analysis and Management*, 32(4): 853–877.
- Wolfers, Justin.** 2006. "Did unilateral divorce laws raise divorce rates? A reconciliation and new results." *American Economic Review*, 96(5): 1802–1820.
- Wong, Vivian C., Peter M. Steiner, and Thomas D. Cook.** 2013. "Analyzing Regression-Discontinuity Designs With Multiple Assignment Variables: A Comparative Study of Four Estimation Methods." *Journal of Educational and Behavioral Statistics*, 38(2): 107–141.
- Wooldridge, Jeffrey M.** 2010. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA:MIT Press.
- Xu, Yiqing.** 2017. "Generalized Synthetic Control Method: Causal Inference with Interactive Fixed Effects Models." *Political Analysis*, 25: 57–76.
- Young, Alwyn.** 2019. "Consistency without Inference: Instrumental Variables in Practical Application."

**Zeldow, Bret, and Laura Hatfield.** 2019. "Difference-in-Differences."

**Zimmert, Michael.** 2018. "Efficient Difference-in-Differences Estimation with High-Dimensional Common Trend Confounding."