**ECON 381-2: Econometrics**                                   MW 2:00-3:20, Recitation F 2:00-3:20
**Northwestern University, Spring 2021**                                                       Zoom

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| **Instructor** | Prof. Vivek Bhattacharya |
|  | vivek.bhattacharya@northwestern.edu |
|  | Office Hours: Mondays 3:45–5:30 pm on Zoom |
|  | (Please shoot me an email if you plan to stop by office hours.) |
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| **TA** | Egor Kozlov |
|  | EgorKozlov2020@u.northwestern.edu |
|  | Office Hours: Thursdays 10:00 am–12:00 pm on Zoom |

**Course Description:** The primary purpose of this course is to teach you some simple tools to take a dataset and learn something about the patterns hidden in it. In the first part of the course, we will go over tools to estimate statistical correlations. These correlations are informative, and it's important to know how to get them right. But, such statistical correlations are often not the object of economic interest. Academic economists, businesspeople, and policy makers alike often care about the *causal* effect a policy instrument and an outcome, which need not coincide with the correlation between the policy and the outcome. We'll discuss why we care about causal effects, what sort of questions can be answered with a precise causal estimate rather than simply a correlation, and why it can be misleading to confuse correlation with causation.

This takes us to the second part of the course—and indeed the meat of it. We will develop formal models that can be used to estimate causal effects. While we will discuss the statistical properties of these models and develop estimators, the goal is not so much to learn how to plug-and-chug but rather to learn how to critically assess (i) what conceptual quantity a model is designed to estimate, and (ii) whether a model is applicable for a particular question. As such, the theory will be interspersed with applications. We'll try to devote a few classes at the end of the course either to critiquing empirical analysis in depth or to student presentations about research topics using the techniques in this class.

Through the problem sets, the recitations, and the final project, you will develop some familiarity with the "practical" parts of econometrics as well. You'll learn how to implement these estimators in statistical software and have a chance to critique them in the context of a recent study of an important policy issue.

**Prerequisites:** While 381-1 is the formal prerequisite, you should be fine if you've taken introductory statistics, probability, linear regression, and linear algebra.

**Textbooks and Software:** I will distribute lecture notes. If you'd like supplemental material, I'd recommend the following textbooks. We won't use these textbooks formally in class (i.e., I won't assign reading from them). So if you are thinking about purchasing them, feel free to buy whichever edition is cheapest. I would strongly recommend acquiring a copy of *Mostly Harmless Econometrics* if it fits with your budget; the others are certainly optional, and I wouldn't recommend buying them if you don't have them already.

- Angrist and Pischke (2009). *Mostly Harmless Econometrics: An Empiricist's Companion.* A lot of the material in my lecture notes will come from this book, although the book is geared towards incoming graduate students rather than advanced undergraduates. If you are

interested in purchasing one book for this course, I'd recommend this one. It's cheap for a textbook, fun to read, and it will also provide you with more material to digest if you decide to keep going with economics, econometrics, or any sort of policy analysis.

- Stock and Watson (2011). *Introduction to Econometrics.* This is a fairly comprehensive overview of the material we cover in class. It is maybe a more "basic" undergraduate textbook, though, and the focus is slightly different. Most of you should have this textbook since it was required in 381-1, but you'll be fine in this class even if you don't have it.

- Angrist and Pischke (2014). *Mastering 'Metrics: The Path from Cause to Effect.* This book is geared towards undergraduates and covers much of the material from *Mostly Harmless Econometrics* that we will cover in class. It's pitched in a somewhat basic (and unfortunately silly) way, but it could be good supplemental material.

- Cunningham (2020). *Causal Inference: The Mixtape.* This book also covers much of the material we'll cover, and you might want to look at it if you want a different treatment from the lecture notes. It's also free online at `http://mixtape.scunning.com`.

Problem sets will require access to Stata. Stata is unfortunately commercial software, but you can find it through NUWorkspace at `http://nuworkspace.northwestern.edu/`. If you do not have an account, I recommend you request one immediately. Egor and I will primarily provide help for Stata.

If you are interested in learning a broader-use, open-source language, you are welcome to complete the problem sets in R or Python. You will get more limited help from Egor and me with technical issues.

**COVID and Online Instruction:** We are living in peculiar times, and as such, many aspects of the past school year have been peculiar. First and foremost, your health and those of your loved ones is most important. If the coronavirus is affecting you or your family, please do not hesitate to get in touch with Egor and me. We will work something out so that you can focus on your health but also learn the material in this class.

All classes will be conducted via Zoom. You will need

- A reliable internet connection to stream classes and get homework assignments

- Access to a scanning device to upload homework and exams, if you choose to write them by hand. Taking pictures of your work on your phone (especially with an app like Genius Scan) should suffice. If you have a tablet, you can of course upload work you do directly on the tablet. If you do not have a way to convert hand-written work into something submittable online, I highly recommend that you familiarize yourself with a mathematical typesetting program like LaTeX. The equation editor on Microsoft Word should suffice too.

If either one of the above requirements poses a difficulty for you, please contact me by the end of the first week of class.

*Attending Class and Recording Material.* Please attend class. It is the easiest way to ask me questions and make sure you are following along with the material. I do understand that for some of you, time zone differences will make it difficult for you to attend. Or perhaps internet connections may not work all the time. To accommodate such students, I will record class sessions and make them available on Canvas for this term. I would like to keep these course recordings for future

classes to aid in learning, so please see the end of the syllabus for statements about how I may use these recordings beyond the term. Students are **not** allowed to record any classes themselves.

Official statements from Northwestern University about class recordings are at the end of the syllabus.

*Etiquette on Zoom.* Please follow these simple directions.

- Keep yourself muted when you are not talking.

- If your bandwidth and your study situation allows it, please keep your video on. Seeing faces will help me gauge whether the pace of the class is appropriate. I understand that life is chaotic and you may not want to share your situation at all times, though.

- To ask questions, use the Raise Hand feature on Zoom. When I call on you, unmute yourself and ask your question. If I do not notice you, then feel free to unmute yourself at a natural point to interrupt and ask the question.

- I'd hope this goes without saying, but inappropriate or obscene behavior will not be tolerated. To prevent outsiders from harming the classroom environment, please ask me before distributing the meeting ID or the password to anyone outside the class.

*Meeting Passwords.* The class sessions and office hours all require a password. It is `metrics`.

**Grading:** Problem Sets: 15%, Midterm 1: 35%, Midterm 2: 35%, Final Project: 15%.

- *Problem Sets:* There will be 5 problem sets. I'll drop your lowest score, so you can feel free to miss one assignment without penalty if things get busy during the semester.

  Problem sets will be submitted on Crowdmark. I will not give extensions on problem sets, nor will I accept late problem sets, other than in truly exceptional situations (with a Dean's note).

  You can work in groups of up to four (although I'd recommend no more than three) on each problem set. Groups can turn in a single copy of their solutions through Crowdmark. Make sure you have an active role in solving the problems. It is not in your best interest to free-ride off others: you'll have to do the exams yourself! Moreover, if you are working in groups, please respect public health guidelines; meet online, and only work together in person if allowed by your local department of public health.

  A randomly selected subset (and possibly all) of the problems will be graded carefully for accuracy. The remainder of the problem set will be graded on completion. Show all your work. For computational problems, submit the (well-documented) code and the output, but also incorporate your results into your writeup in a clean, readable fashion.

  Be neat. If Egor and I can't read your work, we won't grade it. I'd recommend typing your problem sets, especially if you have messy handwriting.

- *Exams:* The midterms will be on **Wednesday, April 28** and **Wednesday, May 26**. We will not have class those days. If you anticipate having legitimate conflicts with the midterm dates, please let me know by **April 3**.

  You will have 24 hours during which you can take 2 hours to complete the exam. Exams will be posted on Crowdmark at 10 am Central Time, and you will have until 12 pm Central Time the following day to upload the exam. You can access the exam at any point during that

window, finish the exam, and upload it back to Crowdmark within two hours of when you started the exam. Crowdmark automatically records the time you accessed the exam and the time you uploaded it, so we can check if you took more time. The exam is designed to take 90 minutes, so you can use the rest of the time to upload the exam. If you run into issues with Crowdmark, then email us your solutions to the exam. But it is up to you to budget your time properly to leave time for uploading the exam. Late exams will be penalized.

Given the nature of the exam, you can use any material you would like to solve it. But, do not talk to anyone about it. Do not download the exam and share it with others. Moreover, to be fair to people in different time zones, Egor and I will **not** be answering any questions about the exam over email. If anything is unclear, be explicit about how you interpreted the question and answer what you think we are asking.

- *Final Project:* A goal of the class is to prepare you to think critically about analyses done in various settings—academic papers, policy briefs, popular press, etc. The final project will give you an opportunity to conduct such an analysis. Approximately three weeks before the end of the class, I will distribute a piece of empirical analysis about a current policy issue. You will write a 3–5 page (single-spaced) critique of this paper. What question does it answer? Do you find the answer convincing? Why or why not? What other analyses could the authors conduct to convince you of the results? What do you think their empirical strategies are missing? How would you do the analysis differently?

  Most likely, I will also offer an alternate option of submitting a research proposal using materials from this class. Depending on interest in this option, we may devote time for student presentations of their research proposals at the end of the class.

  You will have to work by yourself on this project. You can research anything online (as long as it is cited). The project should be emailed to me by **Friday, June 4, at 11:59 pm**. I will not accept late work unless you have a good reason. More details will be distributed about the final project closer to the end of the quarter.

**Academic Integrity Statement:** Students in this course are required to comply with the policies found in the booklet, "Academic Integrity at Northwestern University: A Basic Guide". All papers submitted for credit in this course must be submitted electronically unless otherwise instructed by the professor. Your written work may be tested for plagiarized content. For details regarding academic integrity at Northwestern or to download the guide, visit: `https://www.northwestern.edu/provost/policies/academic-integrity/index.html`.

**AccessibleNU Notice:** Northwestern University is committed to providing the most accessible learning environment as possible for students with disabilities. Should you anticipate or experience disability-related barriers in the academic setting, please contact AccessibleNU to move forward with the universitys established accommodation process (e: `accessiblenu@northwestern.edu`; p: 847-467-5530). If you already have established accommodations with AccessibleNU, please let me know as soon as possible, preferably within the first two weeks of the term, so we can work together to implement your disability accommodations. Disability information, including academic accommodations, is confidential under the Family Educational Rights and Privacy Act.

**COVID-19 Testing Compliance Statement:** To ensure the health of our community, Northwestern University currently requires students who come to campus or interact with the campus

community in person regularly to be tested for COVID-19 routinely. Students must keep the Community Interaction Survey in CAESAR up-to-date, which is the method by which students communicate such plans to the University. Community Interaction Survey status, enrollment in classes with face to face meetings, and/or living in an on-campus residence dictate the frequency with which students must be tested.

Students who fail to comply with COVID-19 testing or misrepresent their status in the Community Interaction Survey may face summary disciplinary action, including being restricted from campus or suspended.

**Northwestern Policy on Class Recordings:** This class or portions of this class will be recorded by the instructor for educational purpose and available to the class during the quarter. Your instructor will communicate how you can access the recordings. Portions of the course that contain images, questions or commentary/discussion by students will be edited out of any recordings that are saved beyond the current term.

Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy and state law. Students requesting the use of assistive technology as an accommodation should contact AccessibleNU. Unauthorized use of classroom recordings—including distributing or posting them—is also prohibited. Under the University's Copyright Policy, faculty own the copyright to instructional materials—including those resources created specifically for the purposes of instruction, such as syllabi, lectures and lecture notes, and presentations. Students cannot copy, reproduce, display, or distribute these materials. Students who engage in unauthorized recording, unauthorized use of a recording, or unauthorized distribution of instructional materials will be referred to the appropriate University office for follow-up.

**Support for Wellness and Mental Health:** Northwestern University is committed to supporting the wellness of our students. Student Affairs has multiple resources to support student wellness and mental health. If you are feeling distressed or overwhelmed, please reach out for help. Students can access confidential resources through the Counseling and Psychological Services (CAPS), Religious and Spiritual Life (RSL) and the Center for Awareness, Response and Education (CARE). Additional information on all of the resources mentioned above can be found here:

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https://www.northwestern.edu/counseling/
https://www.northwestern.edu/religious-life/
https://www.northwestern.edu/care/
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## Tentative Schedule

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| March 30 (Tuesday) | Introduction and Discussion of Empirical Work |
| March 31 | Causality and Potential Outcomes |
| April 5 | Ordinary Least Squares |
| April 7 | Ordinary Least Squares |
| April 12 | Limited Dependent Variables |
| April 14 | Limited Dependent Variables and MLE |
| April 19 | Nonparametric Regression |
| April 21 | Nonparametric Regression |
| April 26 | Review for Exam 1 + Panel Data and Fixed Effects |
| April 28 | **Midterm 1 / No Class** |
| May 3 | Instrumental Variables |
| May 5 | Instrumental Variables |
| May 7 (Friday) | Instrumental Variables and Heterogeneity |
| May 10 | Differences-in-Differences |
| May 12 | DID and Regression Discontinuity |
| May 17 | Regression Discontinuity + Review for Exam 2 |
| May 19 | Discussion of Empirical Topics / Student Presentations |
| May 24 | Discussion of Empirical Topic II / Student Presentations |
| May 26 | **Midterm 2 / No Class** |
| June 4 (Friday) | **Final Project Due at 11:59 pm** |

Problem sets will tentatively be due on April 9, April 21, April 26, May 12, and May 24. I will try to stick to the proposed schedule of topics as closely as possible, but the schedule may vary a bit from what's on the syllabus. Recitations will cover additional practice problems as well as (potentially) discussions of empirical papers.