



THE UNIVERSITY OF CHICAGO  
THE HARRIS SCHOOL OF PUBLIC POLICY

PPHA 42100:  
APPLIED ECONOMETRICS II

Spring 2020: Tuesday and Thursday

**Instructor:** Professor Koichiro Ito  
2071 Harris School  
[ito@uchicago.edu](mailto:ito@uchicago.edu)  
Office hours: By appointment

**TA:** Maria Adelaida ([mariaadelaidamc@uchicago.edu](mailto:mariaadelaidamc@uchicago.edu))  
Diego Escobar Salce ([descobarsalce@uchicago.edu](mailto:descobarsalce@uchicago.edu))  
TA office hours: TBA

### Course Description

The goal of this course is for students to learn a set of statistical tools and research designs that are useful in conducting high-quality empirical research on topics in applied microeconomics and related fields. Since most applied economic research examines questions with direct policy implications, this course will focus on methods for estimating causal effects. This course differs from many other econometrics courses in that it is oriented towards applied practitioners rather than future econometricians. It therefore emphasizes research design (relative to statistical technique) and applications (relative to theoretical proofs), though it covers some of each.

### Prerequisites

- PPHA420 (Applied Econometrics I) is the prerequisite for this course. Students should be familiar with **PhD-level probability and statistics, matrix algebra, and the classical linear regression model at the level of PPHA420**. In the Economics department, the equivalent level of preparation would be the 1<sup>st</sup> year Ph.D. econometrics coursework.
- In general, **I do not recommend taking this course if you have not taken PPHA420 or a Ph.D. level econometrics coursework**. This course is a core course for Ph.D. students and MACRM students at Harris School. Therefore, although the course name

is Applied Econometrics, we'll cover **a lot of theoretical econometrics with intensive math**. Your problem sets and exams will be based on these materials.

- Because this is a core course for PhD students, all students including master's students and undergraduates will be **graded in the same way as PhD students**
- In the past, many non-PhD students who did not have the prerequisite took this course anyway and **ended up dropping out or getting low grades**. So, please read this syllabus carefully before you take this course

### Course design for 2020

The challenge in this year is that many of you may encounter logistical difficulties to fully attend real-time lectures because of time difference, network bandwidth issues, childcare issues, illness and etc. To accommodate this challenge, I will combine pre-recorded lectures and real-time Q&A sessions to deliver lecture materials. Here is the current plan:

Date	Time	Item
Saturday	9:30 PM	Professor Ito uploads lecture videos by this time
Monday	9:30 PM	Students must submit quiz answers via Google form
Tuesday	9:30 am -10:00 am	Q&A session (a real-time)
Monday	9:30 PM	Professor Ito uploads lecture videos by this time
Wednesday	9:30 PM	Students must submit quiz answers via Google form
Thursday	9:30 am -10:00 am	Q&A session (a real-time)

To create good pace and incentives for active and continuous learning, I will make a very simple quiz question for each lecture and ask you to submit by 9:30 PM on the day before lecture. Then, I will ask you to bring your questions to real-time Q&A sessions on Tuesdays and Thursdays.

Here is the link to the Google form (<https://forms.gle/e7xS9aS8EMkzoq4bA>). I will send you a link to zoom meetings. Also, I will record all real-time Q&A sessions and make them available in Box so that you can watch them if you miss the class.

The remote learning is the first-time experience for many of us. Therefore, I plan to see how this strategy goes and adjust the plan depending on feedback from students during the quarter.

### Technology

1. Zoom: We use Zoom to do Q&A sessions. Please install the zoom “desktop software” and be familiar with how to set up.
2. UChicago Box: I will share all materials (lecture videos, slides, problem sets and etc.) via Box. Please email TA if you do not have access to our course folder in Box.
3. Statistical software: You may use any software that you wish, but solutions for problem sets will be handed out in Stata. Demonstrations during lectures will also be conducted in Stata.

### **Communication with Instructor and TA about Your Questions**

Although I highly encourage all students to come to the Q&A sessions, these sessions are not mandatory because of logistical difficulties that many of you may encounter this year. I encourage you to bring any questions from the recorded lectures to the Q&A sessions. There will be three ways to ask questions:

1. I will ask you to write your questions on each lecture in each quiz submission.
2. You can ask questions in class by using the real-time chat in Zoom
3. You can ask questions in **Piazza** (a discussion board in Canvas) and TAs and I will answer

In the Q&A session, I will first focus on questions regarding materials covered by pre-recorded lectures for the day. I then take any other questions.

For questions regarding problem sets, please ask TAs to get help first (we have excellent and helpful two TAs). In case TAs cannot provide sufficient help, please do not hesitate to ask these questions in the Q&A sessions, but I will first take questions regarding lecture materials.

### **Assignments and Grading**

1) Quiz submissions (10%): TAs will grade your quiz submissions.

2) Problem sets (40%)

- Students can work as a group
- **Each student must submit his/her problem set individually**
- Answers have to be **typed**. Handwriting will not be accepted for problem sets.
- Please submit two separate PDF documents using the following file names (example for problem set 1):
  1. PS1\_firstname\_lastname\_main.pdf: This PDF includes your answers with properly formatted tables and figures.
  2. PS1\_firstname\_lastname\_program\_log.pdf: This PDF includes program files and log files from your statistical programs.
- Problem sets are due before class (i.e. 9:30 am) on the schedule listed below.

3) Final (50%): Open Book, No Collaboration Allowed, Date: June 4, Time TBA

### **Late Submission of Assignments**

To be fair to all students, late problem sets will incur a penalty of 50% of the total points per day except for medical or emergent reasons with a doctor's official note, or communication with instructor.

### **Re-Grading of Assignments**

Instructor (not TAs) will handle re-grading. Note that when I re-grade, I do that for your entire problem set so that there is a chance that your total grade gets lower compared to the grading done by TAs.

### **Academic Honesty**

Please do not cheat on exams. We want to trust all of you, but also TAs and I plan to implement exams that prevent the possibility of cheating and allow us to detect cheating. In case we find cheating, we will take actions according to Harris school's guidelines, so please do not cheat!

## Course Schedule (subject to change)

Date	Lecture #	Topic	Deadline
4/7	1	Course Logistics, Randomized Controlled Trials	
4/9	2	Randomized Controlled Trials	
4/14	3	Randomized Controlled Trials	
4/16	4	Regression Discontinuity Design	Problem Set #1 due
4/21	5	Regression Discontinuity Design	
4/23	6	DID, Fixed Effects, Event Study Design	
4/28	7	DID, Fixed Effects, Event Study Design	Problem Set #2 due
4/30	8	Matching and Synthetic Controls	
5/5	9	Matching and Synthetic Controls	
5/7	10	Clustering and Bootstrapping Standard Errors	Problem Set #3 due
5/12	11	Discrete Choice Methods with Individual Data	
5/14	12	Discrete Choice Methods with Individual Data	
5/19	13	Introduction to GMM	Problem Set #4 due
5/21	14	Discrete Choice with Aggregated Data (BLP)	
5/26	15	Discrete Choice with Aggregated Data (BLP)	
5/28	16	Numerical Optimization Methods	Problem Set #5 due
6/2	17	Review session	
6/4	18	<b>Final exam</b> (time TBA, Open Book)	

Note: This year, grade deadline for graduating students is 6/6 for non-Harris graduating students and noon 6/9 for Harris graduating students.

## Textbooks and Notes

The main materials for this course will be my lecture slides, two textbooks: 1) the econometrics notes at NBER econometrics courses written by Imbens and Wooldridge [WNE] and 2) the econometrics textbook by Cameron and Trivedi [CT], and several academic papers listed below.

In addition, Angrist and Pischke [AP] provide intuitive, practical, and less mathematical explanations for some topics. Wooldridge [JW] is at the same level of WNE and CT. For each topic, I reference chapters from these sources.

For discrete choice methods with individual data, the best textbook is Kenneth Train [KT]. We use its relevant chapters later in the course.

- [WNE] Imbens, Guido and Jeffrey Wooldridge (2007). *What's New In Econometrics*, NBER Summer Course.
- [CT] Cameron, A. Colin and Pravin Trivedi (2005). *Microeconometrics: Methods and Applications*. Cambridge University Press.
- [JW] Wooldridge, Jeffrey (2002). *Econometric Analysis of Cross Section and Panel Data*. MIT Press.
- [AP] Angrist, Joshua and Jorn-Steffen Pischke (2009). *Mostly Harmless Econometrics*. Princeton University Press.
- [KT] Train, Kenneth (2002). *Discrete Choice Model with Simulation*. Cambridge University Press. A copy is also available at: [eml.berkeley.edu/books/train1201.pdf](http://eml.berkeley.edu/books/train1201.pdf)

## References to each topic

Econometrics is hard, but I personally found that repeated learning is very helpful. For this reason, please do required readings before you come to class. Ask your questions in class. Then, read the relevant chapters and papers again after class. This process helps you to master the knowledge.

- \*\* The main textbook-style materials for each topic (required readings)
- \* Other references that I use for the topic
- # Further readings for the topic, including more theoretical materials

### 1. Causality

\*\* *WNE* [Lecture 1, Section 2.](#)

\*\* *AP* Chapters 1 - 2.

# *CT* Chapter 2.

\*Holland, Paul “[Statistics and Causal Inference.](#)” *Journal of the American Statistical Association*, 1986, 81, 945–960.

\*Rubin, Donald “[Statistics and Causal Inference: Comment: Which Ifs Have Causal Answers?](#)” *Journal of the American Statistical Association*, 1986, 81, 961–962.

# Causal Inference for Statistics, Social, and Biomedical Sciences: An Introduction 1st Edition, by [Guido W. Imbens](#), [Donald B. Rubin](#) (2015)

### 2. RCT

\*\* Sections 1,2,4,5,6 in:

E. Duflo, R. Glennerster, and M. Kremer. Chapter 61 using randomization in development economics research: A toolkit. In T. Paul Schultz and John A. Strauss, editor, *Handbook of Development Economics*, volume Volume 4, pages 3895–3962. Elsevier, 2007.

\* Julian Cristia, Ana Santiago, Santiago Cueto, Pablo Ibarraran, and Eugenio Severio “Technology and Child Development: Evidence from the One Laptop per Child Program” (February, 2012) IDB Working Paper Series 304

Koichiro Ito, Takanori Ida, and Makoto Tanaka, “Moral Suasion and Economic Incentives: Experimental Evidence from Energy Demand,” NBER Working Paper 20910

Koichiro Ito, Takanori Ida, and Makoto Tanaka, “Information Frictions, Switching Costs, and Selection on Elasticity: A Field Experiment on Electricity Tariff Choice,” Working Paper

\* Esther Duflo and Emmanuel Saez, “The Role of Information and Social Interactions in Retirement Plan Decisions: Evidence from a Randomized Experiment,” QJE (2003)

# Causal Inference for Statistics, Social, and Biomedical Sciences: An Introduction 1st Edition, by [Guido W. Imbens](#), [Donald B. Rubin](#) (2015)

### 3. Regression Discontinuity Designs

\*\* Imbens, Guido and Thomas Lemieux. “[Regression Discontinuity Designs: A Guide to Practice](#).” *Journal of Econometrics*, 2008, 142, 615–635.

\*\* [WNE Lecture 3](#).

CT Chapter 25.6.

\* AP Chapter 6.

\*\* “A credible approach for measuring inframarginal participation in energy efficiency programs” by Judson Boomhower and Lucas W. Davis, *Journal of Public Economics* 113 (2014) 67-79

# Gelman, Andrew and Guido Imbens. “[Why High-order Polynomials Should not be Used in Regression Discontinuity Designs](#).” 2014, *NBER Working Paper* No. 20405.

# Lee, David and Thomas Lemieux. “[Regression Discontinuity Designs in Economics](#).” *Journal of Economic Literature*, 2010, 48, 281–355.

# McCrary, Justin. “[Manipulation of the Running Variable In the Regression Discontinuity Design: A Density Test](#).” *Journal of Econometrics*, 2008, 142, 698–714.

\* Angrist, Joshua and Victor Lavy. “[Using Maimonides’ Rule To Estimate The Effect Of Class Size On Scholastic Achievement](#).” *Quarterly Journal of Economics*, 1999, 114, 533–575.

### 4. Advanced Topics in Instrumental Variables



## A. The IV Estimator

\*\* *CT* Chapter 4.8.

\*\* *AP* Chapter 4.1 - 4.3.

*JW* Chapter 5.

\*Angrist, Joshua. "[Lifetime Earnings and the Vietnam Era Draft Lottery: Evidence from Social Security Administrative Records.](#)" *American Economic Review*, 1990, 80, 313–336.

\*Angrist, Joshua and Alan Krueger, "[Instrumental Variables and the Search for Identification: From Supply and Demand to Natural Experiments.](#)" *Journal of Economic Perspectives*, 2001, 15, 69–86.

## B. Heterogeneous Treatment Effects

\*\* *CT* Chapter 25.7. \*\* *AP* Chapter 4.4 - 4.5.

\*\* *WNE* [Lecture 5](#).

*JW* Chapter 18.4.

\*Angrist, Joshua, Guido Imbens, and Donald Rubin. "[Identification of Causal Effects Using Instrumental Variables.](#)" *Journal of the American Statistical Association*, 1996, 91, 444–455.

## C. 2SLS and Weak Instruments

\*\* *CT* Chapter 4.9.

\*\* *AP* Chapter 4.6.

\* *WNE* [Lecture 13](#).

\*Angrist, Joshua and Alan Krueger. "[Does Compulsory School Attendance Affect Schooling and Earnings?](#)" *Quarterly Journal of Economics*, 1991, 106, 979–1014.

Bound, John, David Jaeger, and Regina Baker. "[Problems With Instrumental Variables Estimation When the Correlation Between the Instruments and the Endogenous Explanatory Variable Is Weak.](#)" *Journal of the American Statistical Association*, 1995, 90, 443–450.

Small, Dylan and Paul Rosenbaum. "[War and Wages: The Strength of Instrumental Variables and Their Sensitivity to Unobserved Biases.](#)" *Journal of the American Statistical Association*, 2008, 103, 924–933.

#### D. Marginal Treatment Effects (MTE)

\*\* Heckman, James J. 2010. "Building Bridges between Structural and Program Evaluation Approaches to Evaluating Policy." *Journal of Economic Literature*, 48(2): 356–398.

\* Brinch, Christian N., Magne Mogstad, and Matthew Wiswall. 2017. "Beyond LATE with a discrete instrument. Heterogeneity in the quantity-quality interaction of children." *Journal of Political Economy*, 125(4): 985–1039.

Carneiro, Pedro, James J. Heckman, and Edward J. Vytlačil. 2011. "Estimating Marginal Returns to Education." *American Economic Review*, 101(6): 2754–2781.

Carneiro, Pedro, James J. Heckman, and Edward Vytlačil. 2010. "Evaluating Marginal Policy Changes and the Average Effect of Treatment for Individuals at the Margin." *Econometrica*, 78(1): 377–394.

Eisenhauer, Philipp, James J. Heckman, and Edward Vytlačil. 2015. "The Generalized Roy Model and the Cost-Benefit Analysis of Social Programs." *The journal of political economy*, 123(2): 413–443.

Heckman, James J., and Edward J. Vytlačil. 2007. "Using the Marginal Treatment Effect to Organize Alternative Econometric Estimators to Evaluate Social Programs, and to Forecast their Effects in New Environments." *Handbook of Econometrics*, 6: 4875–5143. DOI: 10.1016/S1573-4412(07)06071-0.

Heckman, James J., and Edward Vytlačil. 2001. "Policy-Relevant Treatment Effects." *The American Economic Review*, 91(2): 107–111.

Heckman, James J., and Edward Vytlačil. 2005. "Structural equations, treatment effects, and econometric policy evaluation." *Econometrica*, 73(3): 669–738.

#### 5. Selection on Observables, Lalonde's Critique, Matching, Propensity Score Matching

\*\* Robert J. LaLonde. “Evaluating the Econometric Evaluations of Training Programs with Experimental Data,” *American Economic Review* 76(4): 604-620.

\*\* *CT* Chapter 25.

\*\* *AP* Chapter 3.

\*\* *WNE* Lecture 1.

\* Rosenbaum, Paul and Donald Rubin. “[Reducing Bias in Observational Studies Using Subclassification on the Propensity Score.](#)” *Journal of the American Statistical Association*, 1984, 79, 516–524.

\* Dehejia, Rajeev and Sadek Wahba. “[Causal Effects in Non-Experimental Studies: Reevaluating the Evaluation of Training Programs.](#)” *Journal of the American Statistical Association*, 94, 1999, 1053–1062.

\* Smith, Jeffrey and Petra Todd. “[Does Matching Overcome LaLonde’s Critique of Non-experimental Methods?](#)” *Journal of Econometrics*, 2005, 125, 305–353.

Arceneaux, Kevin, Alan Gerber, and Donald Green. “[Comparing Experimental and Matching Methods Using a Large-Scale Voter Mobilization Experiment.](#)” *Political Analysis*, 2006, 14, 37–62.

Shadish, William, M. H. Clark, and Peter Steiner. “[Can Nonrandomized Experiments Yield Accurate Answers? A Randomized Experiment Comparing Random and Nonrandom Assignments.](#)” *Journal of the American Statistical Association*, 2008, 103, 1334–1356.

Millimet, Daniel and Rusty Tchernis. “[On the Specification of Propensity Scores, With Applications to the Analysis of Trade Policies.](#)” *Journal of Business and Economic Statistics*, 2009, 27, 397–415.

## 5. DID, Fixed Effects, Synthetic Controls

\*\* *WNE* Lecture 10.

\*\* *CT* Chapter 25.

\*\* *AP* Chapter 5.

Card, David. “[The Impact of the Mariel Boatlift on the Miami Labor Market.](#)” *Industrial and Labor Relations Review*, 1990, 43, 245–257.

Card, David and Alan Krueger. "[Minimum Wages and Employment: A Case Study of the Fast-food Industry in New Jersey and Pennsylvania.](#)" *American Economic Review*, 1994, 84, 487–496.

\*Abadie, Alberto, Alexis Diamond and Jens Hainmueller. "[Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program.](#)" *Journal of the American Statistical Association*, 2010, 105, 493–505.

Currie, Janet and Duncan Thomas. "[Does Head Start Make a Difference?](#)" *American Economic Review*, 1995, 85, 341–364.

Ashenfelter, Orley, and Michael Greenstone. "[Using Mandated Speed Limits to Measure the Value of a Statistical Life.](#)" *Journal of Political Economy*, 2004, 112(1), S226–67.

Deschênes, Olivier and Michael Greenstone. "[The Economic Impacts of Climate Change: Evidence from Agricultural Output and Random Fluctuations in Weather.](#)" *American Economic Review*, 2007, 97, 354–385.

Kellogg, Ryan and Hendrik Wolff. "[Daylight Time and Energy: Evidence from an Australian Experiment.](#)" *Journal of Environmental Economics and Management*, 2008, 56, 207–220.

## 6. Clustering and Bootstrapping Standard Errors

\*\* *CT* Chapter 24.5.

\*\* *AP* Chapter 8.2.

\*\* Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan. "[How Much Should We Trust Differences-in-Differences Estimates?](#)" *Quarterly Journal of Economics*, 2004, 119, 249–275.

Cameron, Colin, Jonah Gelbach, and Doug Miller. "[Robust Inference with Multi-way Clustering.](#)" *Journal of Business and Economic Statistics*, 2011, 29, 238–249.

\*\* *CT* Chapter 11.

Efron, Bradley and Robert Tibshirani. "[Bootstrap Methods for Standard Errors, Confidence Intervals, and Other Measures of Statistical Accuracy.](#)" *Statistical Science*, 1986, 1, 54–75.

Cameron, Colin, Jonah Gelbach, and Doug Miller. "[Bootstrap-Based Improvements for Inference With Clustered Errors](#)." *Review of Economics and Statistics*, 2008, 90, 414–427.

## 7. Maximum likelihood Estimation

### A. Introduction to Maximum likelihood Estimation

\*\* *CT* Chapters 5.1 - 5.3, 5.6, 5.7

*JW* Chapter 13.

### B. Limited Dependent Variables Models

\*\* *CT* Chapters 14.1 - 14.5., 16

*JW* Chapter 15, 16.

Angrist, Joshua. "[Estimation of Limited Dependent Variable Models With Dummy Endogenous Regressors: Simple Strategies for Empirical Practice](#)." *Journal of Business and Economic Statistics*, 2001, 19, 2–16.

### C. Multinomial Discrete Choice (Discrete Choice with Individual Data)

\*\* *CT* Chapter 15.

\*\* *WNE* [Lecture 11](#).

*JW* Chapter 15.9.

\*\* *KT* Chapters 1, 2, 3, 5

## 8. Generalized Method of Moments

\*\* *CT* Chapter 6.

\*\* *WNE* [Lecture 15](#).

\*\* Nevo, Aviv. "A Practitioner's Guide to Estimation of Random-Coefficients Logit Models of Demand," *Journal of Economics & Management Strategy* (2000), 9, 4, 513-548.

\* Koichiro Ito and Shuang Zhang. “Willingness to Pay for Clean Air: Evidence from Air Purifier Markets in China,” NBER Working Paper, 22367, June 2016.

## 9. Numerical Optimization Methods

\*\* *CT* Chapter 10

\*\* *KT* Chapter 8