Carnegie Mellon University
Heinz College

Applied Econometrics I: 94-834 and 94-431
Course Syllabus
Fall Semester 2024

INSTRUCTOR

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COURSE ORGANIZATION

Class meets for lecture and discussion each Monday and Wednesday, August 26 through October 9. Classes are scheduled 3:30 – 4:50pm at HBH 1005. Recitations are scheduled for Fridays 2:00 – 3:20pm at HBH 1206.

Teaching assistant(s) will hold regular office hours, conduct recitations, and assist in grading assignments and exams. TA(s) will also be available for appointments at your mutual convenience. We will announce office hours and locations during the first week of class.

TAs: Qihui ("Annabel") Hu (qihuih@andrew.cmu.edu)
        Andre Ribeiro Cardoso (acardoso@andrew.cmu.edu)

PREREQUISITE

You are presumed to have a solid grounding in basic statistics, at the level of 90-707 (Statistical Reasoning), 90-711 (Statistical Reasoning with R), or 90-777 (Intermediate Statistics). We will make good use of the material covered in those courses.

READINGS

There is a set of readings from *Mastering Metrics: The Path from Cause to Effect* by Joshua D. Angrist and Jorn-Steffen Pischke (Princeton University Press, 2015). This is a relatively simple but sophisticated book. It is fun to read and is also very short (and inexpensive!). There is also a free short course online (still incomplete) related to the book: https://mru.org/mastering-econometrics-joshua-angrist. I use some of the short videos in our course as well – they are posted on Canvas, under "Lectures." If you like the style of the book we suggest you follow up with a more advanced book by the same

authors, *Mostly Harmless Econometrics* (Princeton University Press, 2009). Another excellent option is the book *Causal Inference: The Mixtape* (Yale University Press, 2021), by Scott Cunningham, which is available online at https://mixtape.scunning.com, and contains examples of codes to implement each methodology in the softwares R, Stata, and Python.

We will also be assigning papers from the academic literature for you to read. Some of these are listed below. Other papers may be added as the course progresses. You will be kept up to date on the Course Canvas web page.

You will likely find it useful to have a basic statistics textbook at hand. The book you used in your preparatory statistics class (90-707, 90-711, 90-777, or similar course) will be fine. In addition, many of you may find it helpful to have a standard econometrics textbook available to provide additional material on the topics we are covering. One good choice is *Introduction to Econometrics* by James H. Stock and Mark W. Watson (Pearson). You can buy a used version of the 1st or 2nd edition, which should be quite inexpensive at this point.

COURSE CONTENT AND OBJECTIVES

Econometrics has an important place in the data sciences. As your textbook authors say, the purpose of econometrics is to "untangle cause and effect in human affairs." Econometrics is essential for advancing understanding in the social sciences, conducting public policy evaluation, and assessing the impact of business practice.

Applied Econometrics I is the first course in a two-course sequence designed to teach the essentials of econometric methodology. **You should plan to take both courses.**

During the first course you will:

- Learn why *random assignment* is so useful for the purpose of sorting out cause and effect.
- Develop a clear understanding of *bivariate* and *multiple regression*, and come to appreciate the value and limitations of regression methods.
- Acquire an appreciation for the use of *instrumental variables* for the purpose of evaluating causality in complex real-world applications.

Applied Econometrics II follows up by pursuing those same topics in additional depth, and by treating other topics and applications. For instance, in that course you will:

- Learn how *regression discontinuity* is used to draw inferences about causal effects from rules constraining human behavior.
- Use *difference-in-differences techniques* to study causality when experiments happen naturally in society.

- Apply *event study analysis* and *synthetic control methods* to tackle causal questions when there are multiple natural experiments, or small sample sizes.

Both *Applied Econometrics I* and *Applied Econometrics II* are "hands on" courses in which you will not only learn to read and interpret existing studies, but will also conduct econometric analyses of your own. The goal is to help you take your first few steps toward becoming a "Metrics Master"! One of those steps is becoming competent and confident in the use of R to conduct empirical analyses. If you would like additional practice, please work with the resources of the online book *Introduction to Econometrics with R* by Christoph Hanck, Martin Arnold, Alexander Gerber, and Martin Schmelzer, which is available at https://www.econometrics-with-r.org. If you would like to use Stata or Python instead, you must learn the implementation of the methodologies on your own with the examples provided in the online book *Causal Inference: The Mixtape* (Yale University Press, 2021), by Scott Cunningham, which is available at https://mixtape.scunning.com.

GRADING AND ACADEMIC INTEGRITY

Your grade depends on the extent to which you demonstrate the capacity to solve problems and think critically about econometric practice.

There will be five graded problem sets. You are encouraged to work in groups on the problem sets (and to visit TAs in groups). While the problems may be worked on in groups, you should hand in paper copies of the answers written *in your own words*. Problem sets are due at 3pm on September 4, 11, 23, and 30, and October 7. Only assignments that are submitted on time will be graded. However, as an accommodation, the lowest assignment grade will be dropped when calculating your final grade.

The final grade is based on two exams (30 percent for the first exam, 38 percent for the final exam), and problem sets (32 percent).

Class attendance at *all lectures and recitations* is expected. Please let your instructor know in advance if you are unable to attend.

Exams are scheduled for September 20 and October 11. Students may be excused from exams only if arrangements are made in advance or in the event of an emergency.

A grade of 0 will be assigned for any assignment or exam that does not conform to University policies regarding academic integrity, and other penalties may also pertain, including termination from enrollment at Carnegie Mellon. See the Heinz College Student Handbook.

CLASS POLICY ON LAPTOPS

Please use laptops in class only when requested by the instructor. For those of you who like to have typed material, we will provide all lecture slides on Canvas.

COVID-19 PROTOCOL

In order to attend class meetings in person, all students are expected to abide by all behaviors indicated in https://www.cmu.edu/coronavirus/students/index.html, including any timely updates based on the current conditions.

For this course, I will be recording class sessions and making them available to you for your personal, educational use. Recordings of class sessions are covered under the Family Educational Rights and Privacy Act (FERPA) and must not be shared with anyone outside your course-section. The purpose of these recording is so students in this course (and only students in this course) can watch or re-watch past class sessions. Feel free to use the recordings if you would like to review something we discussed in class or if you are temporarily unable to attend class.

THOUGHTS FOR THE SEMESTER

Your graduate-school experience might prove to be mostly enjoyable and carefree, but it is likely to entail stress as well. The University Provost provides the following thoughts for students. They seem very sensible to us:

Take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress.

All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services is here to help: call 412-268-2922 and visit their website at http://www.cmu.edu/counseling/. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.

We must treat every individual with respect*. We are diverse in many ways, and this diversity is fundamental to building and maintaining an equitable and inclusive campus community. Diversity can refer to multiple ways that we identify ourselves, including but not limited to race, color, national origin, language, sex, disability, age, sexual*

orientation, gender identity, religion, creed, ancestry, belief, veteran status, or genetic information. Each of these diverse identities, along with many others not mentioned here, shape the perspectives our students, faculty, and staff bring to our campus. We, at CMU, will work to promote diversity, equity and inclusion not only because diversity fuels excellence and innovation, but because we want to pursue justice. We acknowledge our imperfections while we also fully commit to the work, inside and outside of our classrooms, of building and sustaining a campus community that increasingly embraces these core values.

Each of us is responsible for creating a safer, more inclusive environment.

Unfortunately, incidents of bias or discrimination do occur, whether intentional or unintentional. They contribute to creating an unwelcoming environment for individuals and groups at the university. Therefore, the university encourages anyone who experiences or observes unfair or hostile treatment on the basis of identity to speak out for justice and support, within the moment of the incident or after the incident has passed. Anyone can share these experiences using the following resources:

Center for Student Diversity and Inclusion*: csdi@andrew.cmu.edu, (412) 268-2150*
Report it online (anonymous reporting platform)*: http://reportit.net username:* tartans *password:* plaid

All reports will be documented and deliberated to determine if there should be any following actions. Regardless of incident type, the university will use all shared experiences to transform our campus climate to be more equitable and just.

TENTATIVE COURSE OUTLINE AND SCHEDULE

You should read the textbook carefully, and may find the following papers useful.

Topic 1. The Potential Outcomes Framework and Randomized Trials (3 lectures)

Core Ideas

- Angrist and Pischke, Introduction, Chapter 1, and Appendix to Chapter 1.[1]

Applications

- Alsan, M., O. Garrick, and G. Graziani, 2019, "Does Diversity Matter for Health? Experimental Evidence from Oakland," *American Economic Review*, 109(12): 4071-4111.

- Aron-Dine, A., L. Einav, and A. Finkelstein, 2013, "The RAND Health Insurance Experiment, Three Decades Later," *Journal of Economic Perspectives,* 27, 197-222.

- Bertrand, M. and S. Mullainathan, 2004, "Are Emily and Greg more Employable than Lakisha and Jamal? A Field Experiment on Labor Market Discrimination," *American Economic Review*, 94(4), 991-1013.

Topic 2. Regression Analysis (5 lectures)

Core Ideas

- Angrist and Pischke, Chapter 2 and Appendix to Chapter 2.[2]

Applications

- Ashenfelter, O., 2008, "Predicting the Quality and Prices of Bordeaux Wine," *Economic Journal*, 118(529).

- Barreca, A., Karen Clay, O. Deschenes, M. Greenstone, and J.S. Shapiro, 2016, "Adapting to Climate Change: The Remarkable Decline in the US Temperature-

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[1] You may want to supplement the Appendix to Chapter 1 with corresponding material in your basic statistics textbook. Also, I will be discussing some material from Stock and Watson.

[2] Again, you may find it helpful to supplement material from the Appendix with the treatment in a basic statistics textbook.

Mortality Relationship over the Twentieth Century," *Journal of Political Economy*, 124(1): 105-159.

- Dale, S. and A. Krueger, 2002, "Estimating the Payoff to Attending a More Selective College: An Application of Selection on Observables and Unobservables," *Quarterly Journal of Economics*, 1491-1527.

- Ferraro, P.J., J.J. Miranda, and M.K. Price, 2011, "The Persistence of Treatment Effects with Norm-Based Policy Instruments: Evidence from a Randomized Environmental Policy Experiment," *American Economic Review*, 101(3), 318-322.

- Neal, D.A. and W.R. Johnson, 1996, "The Role of Premarket Factors in Black-White Wage Differences," *Journal of Political Economy*, 104(5), 869-895.

Topic 3. Instrumental Variables (4 lectures)

Core Ideas

- Angrist and Pischke, Chapter 3 and Appendix to Chapter 3.[3]

Applications

- Angrist, J.D., and V. Lavy, 1999, "Using Maimonides Rule to Estimate the Effect of Class Size on Scholastic Achievement," *Quarterly Journal of Economics*, 114(2): 533-575.

- Angrist, J.D., S.M. Dynarski, T.J. Kane, P.A. Pathak, and C.R. Walters, 2010, "Inputs and Impacts in Charter Schools: KIPP Lynn," *American Economic Review*, 100(2), 239-243.

- Assunção, J., C. Gandour, and R. Rocha, 2023, "DETER-ing Deforestation in the Amazon: Environmental Monitoring and Law Enforcement," *American Economic Journal: Applied Economics*, 15(2): 125-56.

- Black, D., S. Sanders, E. Taylor and Lowell Taylor, 2015, "The Impact of the Great Migration on Mortality of African Americans: Evidence from the Deep South," *American Economic Review*, 105(2): 477-503.

- Epple, D. and B.T. McCallum, 2006, "Simultaneous Equation Econometrics: The Missing Example," *Economic Inquiry*, 44(2): 374-384.

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[3] In addition, there are many good econometrics textbooks that treat instrumental variables thoroughly, including the book mentioned above by Stock and Watson.