

## Econometrics: A Mathematical Approach

Syllabus: Version 3 (October 15, 2020)

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| Instructor:                  | Mikkel Plagborg-Moller (mikkelpm@princeton.edu)  |
| Online meetings:             | Mon/Wed 1.30–2.50pm (Princeton time)   |
| Assistants-in-Instruction:   | Abhishek Gaurav (agaurav@princeton.edu)<br>Rachel Fung (yfung@princeton.edu)<br>Yifan Yu (yifanyu@princeton.edu) |
| Undergrad Course Assistants: | Julie Kim (jekim@princeton.edu)<br>Alyssa Lau (axlau@princeton.edu)<br>Anlin Zhang (anlinz@princeton.edu)        |
| Web page:                    | <a href="https://princeton.instructure.com/courses/1331">https://princeton.instructure.com/courses/1331</a>      |

**Description.** This course is an introduction to econometrics. Econometrics is a sub-discipline of statistics that provides methods for inferring economic structure from data. This course has two goals. The first goal is to give you means to evaluate an econometric analysis critically and logically. Second, you should be able to analyze a data set methodically and comprehensively using the tools of econometrics.

**Prerequisites.** ECO 100, ECO 101, ECO 202 (or ORF 245), MAT 175 + elementary matrix algebra such as matrix addition, subtraction, multiplication and inversion. MAT 201 and 202 recommended, but not required.

**Lecture format.** The course will be taught remotely. Video lectures will be pre-recorded and posted on the course website. The website will indicate which videos correspond to the different weeks of the course. Some lectures may be accompanied by a voluntary, un-graded multiple choice quiz. In addition, there are two live online Zoom meetings scheduled each week. Monday meetings will review the most important material from the pre-recorded lectures. Wednesday meetings will serve as office hours and will end whenever there are no further questions from the audience. Attendance at the live meetings is encouraged but optional, and recordings will be made available on the website after each session.

**Readings.** Required texts:

- Stock and Watson, *Introduction to Econometrics*. Pearson; 4th edition. We will cover most of the first 13 chapters, as well as chapters 15, 18, and 19. If time permits, we will also cover parts of chapter 14.

Lecture slides will be posted on the course website. You are strongly encouraged to read along in the Stock & Watson textbook as well. It is especially useful to read the empirical examples in the book.

**Requirements/grading.**

Final exam: 50%.

- There will be a 3-hour take-home final exam. The exam will be posted online and answers must be submitted online.

Tests: 25%.

- There will be two take-home tests, each 80 minutes long. These will be posted online and answers must be submitted online. The average score on these tests will count toward 25% of your final grade. The tests are required. If you miss any of these tests, then the final will be reweighted appropriately, provided that this is endorsed by the relevant dean.

Problem sets: 25%.

- There will be a number of problem sets (approximately one per week, except in weeks with an online test), which will count toward 25% of your final grade. The problem sets are challenging and sometimes require you to think beyond what is on the lecture slides. You are encouraged to discuss problem sets with your classmates. Some problem sets should be typed up and handed in individually, while other problem sets may be handed in by groups of 3 or 4 students. The problem sets will indicate whether group answers are permitted. Groups will be pre-assigned based on time zones.

We will only accept late submission of problem sets due to (i) a documented illness or distressing experience, or (ii) a major event that cannot be rescheduled and that you let us know about well before the deadline. However, we will ignore the two lowest problem set grades.

We reserve the right to subtract points for sloppy exposition, including unreadable code or poor document structure. If you find a grading error, please resubmit your problem set or test along with a one-paragraph explanation. Re-grading will be done by the Instructor or Assistant-in-Instruction. We reserve the right to re-grade the entire problem set.

**Computer work.** Computer work is an integral part of econometrics, and the problems that will be assigned assume general computer literacy. Lectures, precepts, and problem sets will emphasize use of the software package Stata, but you may use other equivalent software packages for problem sets if you wish. You are expected to spend time during the first weeks to familiarize yourself with the necessary software.

**Timing of events.**

- Problem sets will generally be posted Mondays and must be uploaded to the course website by the start of the online meeting on the following Monday, unless otherwise specified.
- Precepts will start the first week. The first precept will be used to introduce Stata and review basic matrix algebra.
- The online tests are scheduled for October 5 and November 16.
- The final exam is scheduled for December 9.

**Code of conduct.** All course activities, including class meetings and homework assignments, are subject to the university's academic code and code of conduct as detailed in the "Rights, Rules, Responsibilities" publication.

**Accommodations for students with disabilities.** Students must register with the Office of Disability Services (ODS) ([ods@princeton.edu](mailto:ods@princeton.edu); 258-8840) for disability verification and determination of eligibility for reasonable academic accommodations. Requests for academic accommodations for this course need to be made at the beginning of the semester, or as soon as possible for newly approved students, and again at least two weeks in advance of any needed accommodations in order to make arrangements to implement the accommodations. Please make an appointment to meet with the instructor in order to maintain confidentiality in addressing your needs. No accommodations will be given without authorization from ODS, or without advance notice.

**Course outline.** The following outline is preliminary and may change without warning.

1. What is econometrics and why is it useful? (Stock and Watson, chapter 1).
2. Linear regression.
  - i) Regression with one regressor (Stock and Watson, chapters 4–5 and 18).
  - ii) General case (Stock and Watson, chapters 6–8 and 19.1–19.6).
  - iii) Assessing studies based on regression (chapter 9).
3. Panel data (Stock and Watson, chapter 10).
4. Binary choice (Stock and Watson, chapter 11).
5. Instrumental variables (Stock and Watson, chapters 12 and 19.7).
6. Experiments and quasi-experiments (Stock and Watson, chapter 13).
7. Introduction to time series (Stock and Watson, chapter 15).
8. Time permitting: Prediction with many regressors (Stock and Watson, chapter 14).

We will review probability and statistics (Stock and Watson, chapters 2–3) as needed along the way. The relevant topics include:

- Random variables, probability distributions, and densities. Expectations. Multivariate distributions, conditional distributions, and independence. Special distributions: Bernoulli, normal, chi-squared, F, and T.
- Large sample theory.
- Estimators and their properties. Confidence intervals and hypothesis testing.