Quantitative Research Methods

Boston University
Political Science 841
Fall 2025

Last revised: August 18, 2025

Professor: Taylor C. Boas
Email: tboas@bu.edu
Office location: 232 Bay State Rd., rm. 311B / on Zoom by appointment
Office phone: 617-353-4214
Office hours: Tuesday/Thursday, 2–3:30 on days with a lab or exam, 5–6:30 otherwise

Lecture location and time: Tuesday/Thursday 3:30–4:45, 232 Bay State Rd. rm. 102 (Anthropology seminar room)

- No meeting 9/11 or 10/14
- Meets 12/11 even though after the official end of classes

Lab location and time: 232 Bay State Rd. rm. 102 (Anthropology seminar room), 5–6:15, usually on Thursdays but sometimes on Tuesdays:

- Tuesday meetings: 9/2, 9/16, 9/23, 10/28
- Thursday meetings: 10/9, 10/16, 11/6, 11/13, 11/20, 12/4

Course Description

Quantitative research methods are important tools that political scientists and others use to test empirical claims about the world around us. This course offers an introduction to probability, descriptive statistics, hypothesis testing, and regression analysis, the foundations upon which nearly all quantitative analysis in social science builds. We will place emphasis both on theory, i.e., the concepts, logic, and mathematics underlying statistics, and applications, using software to analyze data and implement the techniques we have learned. We will also learn how to assess work done by other scholars that uses quantitative methods.

I do not assume that students have any prior mathematical background beyond (a) high school algebra, and (b) the material covered in the BU social science math boot camp. For more advanced topics from the boot camp that students may not have covered prior to BU, such as matrix algebra and calculus, we will review the relevant techniques in class before they are covered on homework and/or exams.

As this is a required course for political science graduate students, it necessarily serves different constituencies. For all students, this course will give you a basic understanding of the tools used for empirical research in much of the social sciences, allowing you to better comprehend articles published in top journals. It will prepare you for more advanced quantitative methods course in Political Science or other departments. For those who are skeptical of quantitative research, this course will help inform your skepticism, showing explicitly the assumptions required for hypothesis testing and regression analysis, why these assumptions are often not met in practice,

and what problems arise as a result. For those who find themselves inclined toward statistical analysis, this course will help teach you how to do good quantitative research rather than simply crunching numbers for numbers' sake. Finally, for those who are agnostic about quantitative methods, I hope to convince you that they should be part of your research toolkit!

Grade Breakdown

Weekly problem sets: 20%
Midterm 1: 20%
Midterm 2: 20%
Final exam: 25%
Final paper and presentation: 15%

Course Materials

Software

The required computer software for the course is R (http://www.r-project.org/), an open-source statistical analysis package that is becoming the standard for quantitative analysis in political science as well as other disciplines. We will also be making use of RStudio (https://www.rstudio.com), an interface that makes R more user-friendly. Both are available for free; you should download and install them on your computers. In addition to being free and open-source, R is powerful, flexible, and has a large user community with plenty of free advice and expertise available on the Internet. It is also the software used in other PO quantitative methods courses and in more advanced courses at ICPSR. We will learn R in weekly lab sessions, with lessons that parallel the lectures and readings.

Readings

The required textbooks for the course are:

> Richard J. Larsen and Morris L. Marx, *An Introduction to Mathematical Statistics and Its Applications*, 5th ed. (Prentice Hall, 2012).
>
> Will H. Moore and David A. Siegel, *A Mathematics Course for Political & Social Research* (Princeton, 2013).

More recent editions of the Larsen and Marx textbook have been published, but not much changes in statistics textbooks from year to year, so I've stuck with the 5th edition, which can easily be found online—just Google the title. Moore and Siegel is the textbook used in the BU social science math boot camp. It is accessible online via the BU library.

Most statistics textbooks cover a pretty standard set of topics, yet with different levels of mathematical sophistication. Larsen and Marx is a fairly math-oriented textbook. Depending on your background and learning style, you might want to supplement it by also reading on your

own from a different book. Here are some options I am familiar with. There are also countless others.

> David S. Moore, George P. McCabe, and Bruce Craig, *Introduction to the Practice of Statistics* (W.H. Freeman). Middle-of-the-road level of mathematical sophistication. I've used this textbook in the past, and if you buy the 7th edition, I can give you an old syllabus with reading assignments from this book that correspond to our topics.
>
> David Freedman, Robert Pisani, and Roger Purves, *Statistics* (W. W. Norton). Very little math; explains almost everything in words.

In addition to the assigned readings from the textbook, for most weeks of the course I have listed a political science journal article that uses one or more of the techniques being covered that week. Most of the time we will discuss these articles in class. The political science journal articles are all available electronically, typically via JSTOR; Google the title and you should be able to find them. When you read these, feel free to skim the literature review and theoretical set-up, but you should pay careful attention to the statistical analysis—more so than you would normally—and be prepared to discuss it.

Instruction in statistical computing in R will be based on customized lessons that parallel the topics in the course, rather than on a textbook. However, you might find it useful to consult the following as a reference:

> James E. Monogan III, *Political Analysis Using R* (Springer, 2015). http://link.springer.com/book/10.1007/978-3-319-23446-5.

Problem Sets

Problem sets, consisting of both math and computer exercises, will be assigned nearly every week and will be due the following week. A hard copy is preferred, but if you will not be in class that day, please take a photo or scan and email it to the professor. For math problems, it is fine to turn in handwritten work, but you are encouraged to learn LaTeX to type up the problem sets. LaTeX is required in some advanced courses and is the standard document preparation platform for quantitative work in political science.

Problem sets are graded on a check, check-minus, check-plus basis. It is impossible to learn statistics without practice, so these problem sets are very important. Working in groups is allowed and is often the best way to learn; however, each student must turn in their own write-up and list at the top of the paper who they collaborated with. If working in a group, make sure you understand all of the answers, because you will be on your own come exam time!

The week before each midterm exam, a problem set will be distributed but does not need to be turned in, since the due date would be the exam day. You should work through the problems and then check your answers against the solution sheet. This is the best way to study!

Final Paper and Presentation

In order to get practice using the techniques in the course to analyze data in your own area of interest, the final assignment asks you to write and present a short paper (5–10 pages) analyzing a data set of your choice using multiple regression. The assignment will be distributed in early November, as there are intermediate deadlines. The last class sessions are reserved for brief presentations of your research findings.

Exams

Two midterm exams will be held during class periods, approximately one-third and two-thirds of the way through the course. The final exam will be held during the scheduled exam period, as noted below. The exams are closed-book, but you will be allowed to bring in a single page (front and back) of notes. The exams are not cumulative—you will not have the same types of problems from midterm 1 on the subsequent exams—but statistics itself is cumulative, so you cannot forget what you learned in the first half of the course and still do well on the final.

The week after each midterm, the homework assignment will consist of correcting your mistakes and turning in a revised version. To facilitate this, I will return exams with errors highlighted or underlined, but I will not distribute a solution sheet until after the revisions are turned in. The revised exam will be graded the same as other homework and will not affect your midterm exam grade.

Academic Integrity

Students are expected to do their own work and to accurately and honestly give credit for information, ideas, and words obtained elsewhere. Plagiarism in written assignments and cheating on exams will be dealt with strictly according to the Academic Conduct Code. The career consequences of academic dishonesty at the graduate level can be particularly severe (just Google “Michael LaCour”). The thought should never even cross your mind.

For problem sets, using AI tools is discouraged. If you use AI tools, you must cite exactly how you used these tools. A proper citation includes the name of the tool, the URL, and the prompts you used to interact with it. Using text, code, or any other resource from AI tools, without complete citations, will be treated as a violation of the Academic Conduct Code. You cannot present the work of AI tools as your own work. I will not help you debug code that comes from AI. I will only help you with code written by humans.

As noted above, you are allowed to work in a group on problem sets as long as you list the names of the other students with whom you collaborated at the top of the assignment and you turn in your own write-up.

For exams, you will be allowed to use R on your laptops, but no other uses of your computer are permitted. The sheet of notes may not contain any worked-out problems from previous years’ exams. Any violations of these rules will be considered cheating.

Assignment Schedule

Here is the schedule of due dates for problem sets and exam revisions, subject to change:

Assignment	Due Date
Homework 1	Sept. 9
Homework 2	Sept. 18
Homework 3	Sept. 25
Homework 4	None
Exam 1 revisions	Oct. 9
Homework 5	Oct. 16
Homework 6	Oct. 23

Assignment	Due Date
Homework 7	None
Exam 2 revisions	Nov. 6
Homework 8	Nov. 18
Homework 9	Nov. 25
Homework 10	Dec. 9
Final paper	Dec. 12

Schedule and Readings

Sept. 2, 4: Introduction to Probability

Larsen and Marx, 2.1–2.5.

Moore and Siegel, 9

Christopher H. Achen, "Advice for Students Taking a First Political Science Graduate Course in Statistical Methods," *The Political Methodologist* 10, 2 (Spring 2002): 10–12.

Tuesday, Sept. 2: Lab 1: Introduction

Sept. 9, 16 (no class Sept. 11): Random Variables and Expectations

Larsen and Marx, 3.1, 3.3, 3.4, 3.5 (skip Example 3.5.2 and Theorem 3.5.2), 3.6 (stop at "Higher Moments").

Moore and Siegel, 10.1–10.2, 10.4–10.5, 10.7 (skip or skim 10.71–10.72)

Tuesday, Sept. 16: Lab 2: Classes, tables, mean/variance

Sept. 18, 23: Discrete Probability Distributions

Larsen and Marx, 3.2 (Binomial only), 4.1, 4.2 (stop at "Intervals Between Events").

Moore and Siegel, 10.6 (skim multinomial and negative binomial distributions)

Robert Weissberg, "Collective vs. Dyadic Representation in Congress," *American Political Science Review* 72, 2 (June 1978): 535–547.

Tuesday, Sept. 23: Lab 3: Probability functions, simulation

Sept. 25, 30: Continuous Probability Distributions and the Central Limit Theorem

Larsen and Marx, 4.3.

Moore and Siegel, 11.1–11.1.3, 11.2–11.2.2, 11.3 (Normal Distribution only)

Donald E. Stokes, "Party Loyalty and the Likelihood of Deviating Elections," *Journal of Politics* 24, 4 (Nov. 1962): 689–702.

Oct. 2: Midterm Exam

Oct. 7, 9: Confidence and Significance

Larsen and Marx, 5.1, 5.3, 5.4 (sections on "Unbiasedness," 313–316, and "Efficiency," 317–319), 6.1–6.3.

Michael Coppedge, "The Dynamic Diversity of Latin American Party Systems," *Party Politics* 4, 4 (1998): 547–568.

Thursday, Oct. 9: Lab 4: Work with existing data (ANES)

Oct. 16 (no class Oct. 14): Power and Error

Larsen and Marx, 6.4 (skip everything beginning with "Decision Rules for Nonnormal Data").

Robert D. Duval and Leonard Groeneveld, "Hidden Policies and Hypothesis Tests: The Implications of Type II Errors for Environmental Regulation," *American Journal of Political Science* 31, 2 (1987): 423–447.

Thursday, Oct. 16: Lab 5: More on data (Afrobarometer)

Oct. 21, 23: Inferences for Means

Larsen and Marx, 7.1–7.2, 7.4 (stop at "When the Normality Assumption Is Not Met"), 9.2.

Thad Dunning and Lauren Harrison, "Cross-Cutting Cleavages and Ethnic Voting: An Experimental Study of Cousinage in Mali," *American Political Science Review* 104, 1 (Feb. 2010): 21–39.

Oct. 28: Inferences for Tabular Data

Larsen and Marx, 7.5, 10.5 (skip "Testing for Independence: the General Case" and continue with Case Study 10.5.1).

Edward D. Mansfield and Jack Snyder, "Democratization and the Danger of War," *International Security* 20, 1 (Summer 1995): 5–38.

Tuesday, Oct. 23: Lab 6: t and χ^2 tests

Oct. 30: Midterm Exam

Nov. 4, 6, 11, 13: Simple Linear Regression

Larsen and Marx, 11.1, 11.2 (stop at "Nonlinear Models"), 11.3 (stop at "Drawing Inferences about E(Y|x)").

John Neter, et al., *Applied Linear Regression Models* (Richard D. Irwin, Inc., 1983). Chapter 6: "Matrix approach to simple regression analysis" (skip material on weighted least squares).

Moore and Siegel, 12 (review—covered in math boot camp)

Panagopoulos, Costas. 2013. "Extrinsic Rewards, Intrinsic Motivation and Voting." *Journal of Politics* 75, 1: 266–280.

Thursday, Nov. 6: Lab 7: bivariate regression

Thursday, Nov. 13: Lab 8: regression diagnostics, dummy variables

Nov. 18, 20: Multiple Regression

Eric A. Hanushek and John E. Jackson, *Statistical Methods for Social Scientists* (Academic Press, 1977). Chapter 5: "Multivariate Estimation in Matrix Form."

Douglas L. Kriner and Francis X. Shen, "Iraq Casualties and the 2006 Senate Elections." *Legislative Studies Quarterly* 32, 4 (November 2007): 507–530.

Thursday, Nov. 20: Lab 9: multiple regression

Nov. 25, Dec. 2: Violating Regression Assumptions

Peter Kennedy, *A Guide to Econometrics* (MIT Press, 1998). Chapters 3, 6, 7, 8, 9, 10, 11.

Dec. 4, 9: Interaction Terms and Maximum Likelihood Estimation

Brambor, Thomas, William Roberts Clark, and Matt Golder. 2006. "Understanding Interaction Models: Improving Empirical Analyses." *Political Analysis* 14: 63–82.

Christenson, Dino P., and David M. Glick. 2014. "Chief Justice Roberts's Health Care Decision Disrobed: The Microfoundations of the Supreme Court's Legitimacy." *American Journal of Political Science* 59, 2: 403–418.

Thursday, Dec. 4: Lab 10: interaction terms

Dec. 11 (we meet the 11th despite being after the end of classes): Final project presentations

Thursday, Dec. 18, 3–5 p.m.: Final exam