

Linear Models
Poli_Sci 405
Winter 2024

Class Time: Tuesday 9:00 – 11:50am
Classroom: 212 Scott Hall
Instructor: Saera Lee
Office: 231 Scott Hall
Office Hours: Wednesday 1:00 – 3:00pm, or by appointment.
Email: saera.lee@northwestern.edu
Lab: Frida 11:00 – 11:50am, 213 Locy Hall

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Office Hours: Friday 12:00-2:00 pm

Course Description

This course introduces students to linear regression models for the analysis of quantitative data and provides a basis of knowledge for more advanced statistical methods. After covering the classic normal linear regression model and its assumptions, we will explore the consequences and remedies for violations of these assumptions, including omitted variables, heteroscedasticity, autocorrelation, and endogeneity. We will also explore the use and interpretation of continuous, ordinal, nominal, and indicator variables as well as interactions between them. If time permits, we will also discuss missing data and basic models for limited dependent variables. Along the way and primarily in the lab session, students will learn the basics of data collection, organization, and management; measurement; data visualization and display, and univariate, bivariate and multivariate descriptive statistics.

The course assumes basic math literacy, including familiarity with probability theory, properties of estimators, rudimentary calculus, and linear algebra, as well as mastery of the basic statistics taught in POLI_SCI 403 or equivalent.

Required Texts

Dougherty, Christopher. 2011. *Introduction to Econometrics, 4th Edition*. New York: Oxford University Press.

Course Requirements

Homework Assignments (40%)

The best way to learn material is to use the estimators. Roughly weekly homework assignments will be distributed throughout the quarter. They require solving mathematical problems,

computer exercises, diagnosis and correction of regression assumption violations and applications in advanced topics. In these exercises, it is important to carry out multiple tests (and when possible, go beyond the scope of the lecture) and to discuss carefully the implications of the tests for statistical inference and substantive interpretation.

Quizzes (15%):

There will be three in-class quizzes. These will take 10-15 minutes and will involve short answer questions asking you for definitions or explanations of the ways different methods work. The emphasis will be on explanation through words rather than equations, though some of the latter may be useful for clarity. These will take place in Weeks 5 (Jan 30th), 7 (Feb 13th), and 10 (Mar 5th).

Final Project (45%):

Students will present a research presentation at the end of the quarter. The project will involve four components, due at various points in the quarter.

a. Proposal (5%)

The proposal for your final topic, due in week 5 (Feb 6th), will involve a short summary of your planned work, similar to conference abstract. You are not wed to this topic, but I want you to start thinking about it early on. This should discuss both the substance, appropriate data sources, and the method you will apply.

b. Outline (10%)

The outline, due in week 7 (Feb 20th), will represent a longer (about 1000-1500 word) description and overview of the method(s) and data you propose to use. This also should include literature review. More details will be discussed in class.

c. Presentation (20%)

At the end of the quarter (exact date and time TBA, but probably during our scheduled final exam slot), class members will present the results of their research projects to the department in presentation format. The focus of the presentation should involve either 1) the application of a suitable method to a substantive research question; 2) a detailed investigation of methods using with a critique of current studies. Please plan to be in town for this assignment.

Presentations must also meet the following criteria (adapted to the three options as appropriate):

- i. No fewer than 5 no more than 15 slides.
- ii. One slide must explain why the primary method allows an improvement over previous studies or how the primary method permits appropriate testing of novel hypotheses.
- iii. One slide must present a graphical (or tabular, but only if necessary) interpretation of the main result.
- iv. One slide must indicate the primary hypothesis being tested.
- v. One slide must clearly indicate the data and/or methods employed.

d. Replication Materials (10%)

Students will submit a complete set of replication materials for the analysis in the presentation through Canvas along with slides. These files must allow anyone to replicate your results without consulting you and should run on any computer with R installed. Students should use comments liberally to help users follow their code. At a minimum, replication materials should include:

- i. A README file that explains the various files included in your replication archive.
 - ii. Your lab book that you prepare over the course of the quarter documenting important data, coding, and statistical decisions that you make. You should work on this and be making notes over the course of the quarter.
 - iii. The R batch file that you used to construct your data set so that others can see your coding decisions.
 - iv. Any R programs that you wrote with appropriate documentation in a help file.
 - v. Your final data set (you do not need to supply the original, raw data set(s)).
 - vi. A R batch file to replicate all the results presented in your poster. All tables reported in the poster should be produced in a similar format in the replication file (i.e., multiple models combined in to one table rather than just reporting estimation output).
- See readings on replication and coding. Use the SPPQ guidelines (<https://journals.sagepub.com/author-instructions/spa>) when in doubt.

Course Policies:

Attendance

Attendance is expected.

Classroom Etiquette

During lectures and computing lab sessions, please be respectful of other students' opinions and phrase your contributions in a constructive manner.

Homework and assignments:

- a. You may discuss homework assignments with other students, including strategies about how to approach them, but you must write up your final submission completely on your own. Failure to adhere to this requirement will be considered academic misconduct.
- b. Homework and final projects are all due at the time specified. Any late homework or paper will have points deducted at the rate 10% of the total available points per calendar week for up to two weeks (after which you will receive a score of zero) unless arrangements are made *prior* to the due date.
- c. If you have a legitimate, personal reason for missing a scheduled assignment and cannot notify me in advance, please come talk to me as soon as possible afterwards and provide documentation.

Academic Integrity

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-procedures/academic-integrity/index.html>

Accessibility

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 university's 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.

Diversity, Equity, and Inclusion

Difference enhances both the teaching and learning experiences. The classroom is a space where all students are welcome, regardless of age, dis/ability, ethnicity, gender identity and/or expression, national origin, race, religious non/belief, sex, sexual orientation, socioeconomic status, religious non/belief, and alignment with other identities or contexts. Furthermore, if any student has a particular consideration, including learning and participation style, that affects their ability to meet course expectations, please see me as soon as possible.

I am personally committed to creating and maintaining an inclusive learning environment for each and every student. Please, do not hesitate to contact me with specific needs or concerns, and the sooner the better. Maintaining transparency (and communication in general) with your instructor is not only a good professional skill, but also a good way to develop a more one-on-one relationship. Furthermore, accommodations are far easier and effective to arrange when planned than when rushed. In short, I will make every effort to ensure students' equal access.

Course Recording

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.

Course Grading Scale

A = 93-100; A- = 90-92.9; B+ = 87-89.9; B = 83-86.9; B- = 80-82.9; C+ = 77-79.9; C = 73-76.9; C- = 70-72.9; D = 60-69.9; F < 60.

Resources:

The **Political Methodology Section** of the American Political Science Association was created to provide APSA members with an interest in political methodology with a forum in which to meet and discuss ideas. The section publishes a quarterly newsletter (*The Political Methodologist*), a quarterly journal on political methodology (*Political Analysis*), conducts a discussion list on topics relating to political methodology, and maintains an extensive electronic archive of papers, accessible via their homepage (<http://polmeth.wustl.edu/>)

The **Inter-University Consortium for Political and Social Research (ICPSR)** at the University of Michigan maintains an extensive archive of data in the social and behavioral sciences. Much of it is accessible via their homepage (<http://www.icpsr.umich.edu>).

Harvard University's Dataverse Project "increases scholarly recognition and distributed control for authors, journals, archives, teachers, and others who produce or organize data; facilitates data access and analysis for researchers and students; and ensures long-term preservation whether or not the data are in the public domain."

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). All Northwestern students are also eligible to access support at no cost through TimelyCare, a virtual mental health platform that provides counseling, health coaching and 24/7 on-demand services.

Additional information on the resources mentioned above can be found here:

<https://www.northwestern.edu/counseling/>

<https://www.northwestern.edu/religious-life/>

<https://www.northwestern.edu/care/>

<https://www.northwestern.edu/studentaffairs/timelycare.html>

Course Outline

Please note that the specifics of this course syllabus are subject to change in the case of unforeseen circumstances. Instructors will notify students of any changes as soon as possible. Students will be responsible for abiding by the changes.

1/9, Course Overview & Basic Concepts

Dougherty, R2-13

1/16, Simple Regression Analysis

Dougherty, Chapter 1

1/23, Properties of OLS Estimators & Gauss-Markov Theorem & Hypothesis Testing

Dougherty, Chapter 2

1/30, Multiple Regression Analysis & Dummy Variable & Interactions (Quiz)

Dougherty, Chapter 3 & 4.3 & 5

Recommended:

Friedrich, Robert J. 1982. "In Defense of Multiplicative Terms in Multiple Regression Equations." *American Journal of Political Science* 26(November):797-833.

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

2/6, Multicollinearity & Nonlinear Models & Transformations of Variables

Dougherty, Chapter 3.4 & 4.1 & 4.3

2/13, Model Misspecification(Quiz)

Dougherty, Chapter 6

2/20, Heteroscedasticity

Dougherty, Chapter 7

2/27, Autocorrelation

Dougherty, Chapter 12

3/5, Measurement Error and Binary Outcome Variables (Quiz)

Dougherty, Chapter 8 & 10