

PLSC 309: Quantitative Political Analysis

Fall 2026 Semester

Instructor:	Yang Yang	Class:	Tue/Thu 1:35 – 2:50 p.m. ET
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1 Course Description

“I’m studying social sciences—not mathematics. Why do I need to learn quantitative analysis?”

Because many of the questions we care about—whether in politics, economics, public policy, business, health, or everyday life—are ultimately questions about evidence. Quantitative analysis provides a systematic way to collect, analyze, and interpret data so that we can evaluate claims, identify patterns, and make informed decisions. This course introduces the empirical research process used throughout political science and the social sciences, emphasizing how data can be used to answer substantive questions about the world.

The primary goal of this course is to equip you with the skills to properly answer questions and draw credible inferences about the political and social phenomena that interest you. To achieve this goal, we will learn how to generate hypotheses and design research in a way that allows us to answer research questions using quantitative data. We will then examine a range of statistical methods for analyzing data and testing hypotheses. Along the way, you will develop an understanding of the statistical concepts underlying these methods and gain hands-on experience using the statistical programming language R and the RStudio environment to manage, visualize, and analyze data. Throughout the semester, you will also design and carry out an independent research project on a topic of your own choosing.

The course material will not always be easy, but it should never feel overwhelming. My goal is to strike the right balance: the course should be challenging enough to help you develop rigorous scientific reasoning, but not so difficult that it becomes frustrating. By the end of the semester, I hope you will not only feel confident using quantitative methods, but also appreciate the beauty of scientific research. More importantly, I hope you will develop the analytical skills to think critically about empirical evidence, navigate an increasingly data-driven world, and build a solid foundation for your future academic and professional pursuits.

You do not need a strong background in mathematics, statistics, or R (or any other programming language) to succeed in this class.

2 Objectives

By the end of this course, you should be able to:

- Describe the empirical research process.
- Critically evaluate the research questions, methods, and findings of quantitative social science research.
- Explain how quantitative methods are used to describe data, test hypotheses, and estimate linear and logistic regression models.
- Apply these methods to answer empirical research questions using the statistical programming language R.
- Interpret and communicate findings from statistical analyses using tables, figures, and regression output.
- Design and complete an independent empirical research project.

3 Course Materials

1. (Required) Kellstedt, Paul M. and Guy D. Whitten. *The Fundamentals of Political Science Research*, 2nd Edition (hereafter, KW2) or 3rd Edition (hereafter, KW3).
2. (Optional): Scott Cunningham. *Causal Inference: The Mixtape*. ([Available free online](#). This book provides an accessible introduction to modern causal inference and is recommended for students interested in learning more about causal research designs beyond the scope of this course.)
3. In addition to the textbook, we will read several research articles from political science journals. Our goal is not to read every detail, but to understand what question the authors ask, what hypotheses they test, how they measure their variables, what empirical methods they use, and how they present and interpret their findings. All required or suggested articles will be available on Canvas.

4 Lecture Slides

Lecture slides will be posted **by 12:00 p.m. (ET)** on the day of each class and updated simultaneously on both Canvas and [GitHub](#).

The lecture slides provide the primary framework for the course and should be your main resource for reviewing class material and preparing for problem sets and the mid-term exam. The textbook complements the slides by offering additional background, explanations, and examples.

5 Technology and Software

The course relies heavily on using the computer and software. I will provide tutorials to install and run the programs. The tutorials will be available on Canvas.

1. Computer/Laptop. We will use computers in nearly every class. You are welcome to bring your own laptop or rent one from the Penn State library.
2. R is the programming language we will use for our analyses. You can download R from: <https://cloud.r-project.org/>. If you run into any problem when downloading or installing R, let me know immediately before our second class meeting.
3. RStudio is the software that provides the interface to look at code, output, and visualization. You must install R before RStudio. You can download RStudio from: <https://posit.co/download/rstudio-desktop/>. If you run into any problem when downloading or installing RStudio, let me know immediately before our second class meeting.

6 Other Resources

The following resources may be helpful.

- **Installing R and RStudio:** Before the second class, please install both R and RStudio. You may follow a [Penn State installation guide](#), or use one of the following video tutorials:
 - macOS: [YouTube Installation Tutorial](#)
 - Windows: [YouTube Installation Tutorial](#)
- *R for Data Science (2nd Edition)*: This free online textbook by Hadley Wickham, Mine Çetinkaya-Rundel, and Garrett Golemund is an excellent reference for learning R, data wrangling, and data visualization throughout the semester: <https://r4ds.hadley.nz/>.
- **Political Science Data Sources.** The following websites provide a wide variety of publicly available datasets commonly used in political science research. You may find them helpful for your independent research project, although you are not limited to these sources.
 - **American Politics**
 - * American National Election Studies (ANES):
<https://electionstudies.org/>
 - * Cooperative Election Study (CES):
<https://cces.gov.harvard.edu/>
 - * MIT Election Data and Science Lab (Election Returns):
<https://electionlab.mit.edu/data>
 - * U.S. Census Bureau (State- and County-Level Demographic Data):
<https://data.census.gov/>
 - * Federal Election Commission (Campaign Finance Data):
<https://www.fec.gov/data/>

– **Comparative Politics**

- * Varieties of Democracy (V-Dem):
<https://www.v-dem.net/>
- * Comparative Political Data Set (CPDS):
<https://cpds-data.org/>
- * World Values Survey (WVS):
<https://www.worldvaluessurvey.org/>
- * Afrobarometer:
<https://www.afrobarometer.org/>
- * Asian Barometer Survey (ABS):
<https://www.asianbarometer.org/>

– **International Relations and International Political Economy**

- * NBER Guide to International Relations Data Sources:
https://data.nber.org/ens/feldstein/ENSA_Dataset_BlueTOC.pdf
- * Correlates of War (COW):
<https://correlatesofwar.org/>
- * World Bank Open Data and World Development Indicators:
<https://data.worldbank.org/>
- * AidData (Foreign Aid and Development Finance):
<https://www.aiddata.org/datasets>
- * ForeignAssistance.gov (U.S. Foreign Assistance):
<https://foreignassistance.gov/data>

7 Course Requirements

Grade Component		Points/Percentage	Due Date
In-class Participation		20	Every Class
Problem Sets (5)		35 (7 points each)	09/08, 09/22, 10/06, 11/03, 12/01
Midterm Exam		15	Tue 10/13
Final Project	Checkpoint 1	5	Tue 09/15
	Checkpoint 2	5	Tue 09/29
	Checkpoint 3	5	Tue 10/27
	Checkpoint 4	5	Tue 11/17
	Presentation	5	Tue 12/08 or Thu 12/10
	Written Paper and R script	5	Thu 12/17
Total Points/Percentage		100	

7.1 In-Class Participation (20%)

Attendance (10%). This class is taught in person every Tuesday and Thursday from 1:35 p.m. to 2:50 p.m. ET. Regular attendance is expected, as class meetings include lectures, lab sessions, and in-class activities that cannot be fully replicated outside of class.

If you are unable to attend class due to illness, a family or personal emergency, or other unavoidable circumstances, please notify me as soon as possible by **email**, preferably before class. Absences will generally be excused provided that they are communicated promptly and are not excessive. Excessive absences, whether excused or unexcused, may affect your attendance and participation grade.

Planned absences (e.g., university-sponsored activities or religious observances) should be communicated in email at least one week in advance whenever possible. Vacations and other discretionary travel are generally not considered excused absences.

Active Participation (10%). Active participation means contributing to the learning environment. This includes:

- Attending class prepared and on time;
- Participating in class discussions and activities;
- Asking thoughtful questions and responding to classmates when appropriate;
- Engaging in in-class exercises and R activities;
- Demonstrating respect for classmates and contributing to a positive classroom environment.

7.2 Problem Sets (35 %)

I will assign five problem sets over the course of the semester. These assignments will assess your mastery of the material in a setting that allows you to ask questions and seek help, both from your peers and from me, before you are asked to use these techniques in your own research project. These are due on Canvas at 11:59pm ET on the requested due date. The problem sets will be released one or two weeks before they are due.

7.3 Midterm Exam (15 %)

The midterm exam will assess your understanding of the material covered during the first seven weeks of the course. It will be a 60-minute, in-person, open-book, hand-written exam. You may bring the course textbook and your own handwritten or printed notes. However, the use of any electronic devices, including laptops, tablets, smartphones, or other internet-enabled devices, is NOT permitted during the exam.

7.4 Final Project (30 %)

The final project is an independent empirical research project in which you will apply the concepts and methods learned throughout the semester to investigate a research question of your own choosing. The goal is to develop a complete quantitative research project, from formulating a research

question and developing a theory to collecting data, conducting statistical analyses, and communicating your findings in a professional research paper.

Rather than submitting only a final paper at the end of the semester, you will complete a series of checkpoints. These milestones are designed to help you make steady progress, receive feedback in time throughout the semester, and strengthen your final paper. Each checkpoint builds directly toward the completed research project.

Detailed instructions and grading criteria for each stage will be posted on Canvas. Unless otherwise noted, all checkpoints, the presentation materials, and the final paper must be submitted through Canvas by 11:59 p.m. on the assigned due date. **You are required to schedule at least two office hours meetings with me (one before and one after the midterm) to discuss your project and receive guidance.** During these meetings, we will review your research design—including your research question, theory, hypotheses, data sources, variable measurement, and model specification—and discuss any remaining questions before you begin data collection and analysis. **Appointments for these meetings should be scheduled through [Microsoft Bookings](#).**

Your final paper will be automatically checked for plagiarism using TurnItIn. To avoid plagiarizing, you must do all of the following each time you incorporate someone else's arguments or work or any information that is not common knowledge into your paper:

1. Either use quotation marks around the author's words or rephrase completely in your own words.
2. Include an in-text citation.
3. Have an entry in your References section at the end that matches the citation.

8 Grading Scale

A	=	93 to 100%
A–	=	90 to 92.99%
B+	=	87 to 89.99%
B	=	83 to 86.99%
B–	=	80 to 82.99%
C+	=	77 to 79.99%
C	=	70 to 76.99%
D	=	60 to 69.99%
F	=	below 59.99%

9 AI Use Policy

Students are encouraged to leverage AI tools such as ChatGPT to aid in finding errors in code, as well as explaining a given piece of R code. The goal is to enhance your learning experience and foster a deeper understanding of statistical analysis through technology. Any code you produce should

use the packages and functions covered in the tutorials. To ensure AI tools meet this requirement, always tell ChatGPT which packages or functions you want to use. ChatGPT is particularly effective at breaking down pieces of code and explaining what each function and argument is doing. If you are having trouble understanding why a chunk of code produces particular output, try asking ChatGPT.

While AI tools can be valuable aids in certain aspects of the learning process, it is crucial to maintain the integrity of individual learning and assessments. Therefore, AI should not be used to generate interpretations of output to answers questions in class exercises, problem sets, and your final project. Interpretations should reflect your independent understanding and application of statistical concepts learned in this course. Whether evidence of violations of this policy would be considered academic dishonesty and incur the plagiarism penalties discussed in the next section.

10 Course and University Policies

10.1 Academic Integrity

The Department of Political Science, along with the College of the Liberal Arts and the University, takes violations of academic dishonesty seriously. Observing basic honesty in one's work, words, ideas, and actions is a principle to which all members of the community are required to subscribe.

All course work by students is to be done on an individual basis unless an instructor clearly states that an alternative is acceptable. Any reference materials used in the preparation of any assignment must be explicitly cited. Students uncertain about proper citation are responsible for checking with their instructor.

In an examination setting, unless the instructor gives explicit prior instructions to the contrary, whether the examination is in class or take home, violations of academic integrity shall consist but are not limited to any attempt to receive assistance from written or printed aids, or from any person or papers or electronic devices, or of any attempt to give assistance, whether the one so doing has completed his or her own work or not. Lying to the instructor or purposely misleading any Penn State administrator shall also constitute a violation of academic integrity.

In cases of any violation of academic integrity it is the policy of the Department of Political Science to follow procedures established by the College of the Liberal Arts. More information on academic integrity and procedures followed for violation can be found at: <http://laus.la.psu.edu/current-students/academics/academic-integrity/college-policies>. The University adheres to a strict policy regarding Academic Integrity (<https://undergrad.psu.edu/aappm/G-9-academic-integrity.html>). Any type of academic dishonesty will not be tolerated in this class. Become familiar with the policy as well as the University's policy on Sanctioning Guidelines for Violations of Academic Integrity (<https://undergrad.psu.edu/aappm/sanctioning-guidelines.html>). Any cheating or plagiarism will be met with a disciplinary review by the University. These actions may lead to probation, suspension, or expulsion.

Examples of plagiarism include, but are not limited to, the following:

- Using sources verbatim or paraphrasing without giving proper attribution (this can include phrases, sentences, paragraphs, and/or pages of work).
- Copying and pasting work directly from an online or offline source and calling it your own.
- Using information you find from an online or offline source without giving the author credit.
- Replacing words or phrases from another source and inserting your own words or phrases.
- Submitting a piece of work you did for one class to another class.

10.2 Accommodations for Students with Disabilities

Penn State welcomes students with disabilities into the University's educational programs. Every Penn State campus has an office for students with disabilities. The Penn State Educational Equity (<http://equity.psu.edu/student-disability-resources>) website provides contact information for Campus Disability Coordinators (<http://equity.psu.edu/student-disability-resources/campus-disability-coordinators>) at every Penn State campus. In order to receive consideration for reasonable accommodations, you must contact the appropriate disability services office at the campus where you are officially enrolled. You will participate in an intake interview and provide documentation. Documentation guidelines are available on the Applying for Services page (<http://equity.psu.edu/student-disability-resources/applying-for-services>) of the Student Disability Resources website. If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with an accommodation letter. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. You must follow this process for every semester that you request accommodations.

10.3 Reporting Bias-Motivated Incidents

Penn State takes great pride to foster a diverse and inclusive environment for students, faculty, and staff. Acts of intolerance, discrimination, or harassment due to age, ancestry, color, disability, gender, gender identity, national origin, race, religious belief, sexual orientation, or veteran status are not tolerated (Policy AD29 Statement on Intolerance [<https://policy.psu.edu/policies/ad29>]) and can be reported on the Report Bias page (<http://equity.psu.edu/reportbias/>) of the Educational Equity website.

10.4 Counseling and Psychological Service

Many students at Penn State face personal challenges or have psychological needs that may interfere with their academic progress, social development, or emotional wellbeing. The University offers a variety of confidential services to help you through difficult times, including individual and group counseling, crisis intervention, consultations, online chats, and mental health screenings. These services are provided by staff who welcome all students and embrace a philosophy respectful of clients' cultural and religious backgrounds, and who are sensitive to differences in race, ability, gender identity, and sexual orientation.

- [Counseling and Psychological Services](#) (CAPS) at University Park: 814-863-0395

- [Counseling Services at Commonwealth Campuses](#)
- Penn State Crisis Line (24 hours/day, 7 days/week): 877-229-6400
- Crisis Text Line (24 hours/day, 7 days/week): Text LIONS to 741741

10.5 Diversity, Inclusion, Respect

Penn State is “committed to creating an educational environment which is free from intolerance directed toward individuals or groups and strives to create and maintain an environment that fosters respect for others,” as stated in Policy AD29 Statement on Intolerance. All members of this class are expected to contribute to a respectful, welcoming, and inclusive environment and to interact with civility.

For additional information, see the following:

- [Penn State Affirmative Action Nondiscrimination Statement](#)
- [Policy AD 85 Sexual and/or Gender-Based Harassment and Misconduct, Title IX](#)
- [Policy AD91 Discrimination and Harassment, and Related Inappropriate Conduct](#)
- [Penn State Statement on Diversity, Equity, and Inclusion](#)
- [Penn State Values](#)
- [Penn State Principles](#)
- [All In at Penn State: A Commitment to Diversity and Inclusion](#)

10.6 Inclement Weather

According to updated university guidance for students, faculty and staff, “In the event that normal operations at a Penn State location are disrupted due to snow or other weather or emergency conditions, individuals are urged to avoid coming to campus, if possible, and those who must visit campus should remain alert and avoid sections of campus that may be covered in snow or ice.” Class cancellations will be dealt with on a case-by-case basis. Please note that in the event class is canceled, in-person meetings cannot be moved to synchronous remote meetings.

11 Course Outline

Week 1: Introduction

- **August 25** (Tuesday)
Introduction to the course; review of the syllabus; the scientific study of politics.
 - Required: this syllabus
 - Suggested: KW2/KW3 (pp 1-7, 16-20)

- **August 27** (Thursday)
Research process: research questions, theory, hypotheses, and empirical design and evidence; introduction to R and RStudio.

– Required: KW2 (skim pp. 7-9, 24-26, 29-35, and 44-46.) or KW3 (skim pp. 7-10, 25-27, 31-42.)

Week 2: From Concepts to Data

- **September 1** (Tuesday)
Concepts, measures, and variables; types of variables (nominal, ordinal, continuous, and discrete variables); data structures (cross-sectional, time-series, and panel data); data sources.

– Required: KW2 (skim pp. 95-109, 111-117, 26-29.) or KW3 (skim pp. 92-98, 125-133, 111-122, 27-31.)
- **September 3** (Thursday) - **No Class**
Instructor traveling to APSA Conference.

Week 3: Fundamentals of Probability and Statistics I

- **September 8** (Tuesday)
Random variables; expectation as a measure of central tendency; variance and standard deviation as measures of dispersion; covariance and correlation as measures of association.

– Required: KW2 (pp. 120-122) or KW3 (pp. 136-139)

Due: Problem Set 1

- **September 10** (Thursday)
Population, random samples, and random sampling; estimands, estimators, and estimates; properties of estimators; interval estimation and confidence intervals; central limit theorem.

– Required: KW2 (skim pp. 129-130, 133-143.) or KW3 (skim pp. 143-145, 148-159.)

Week 4: Fundamentals of Statistics II

- **September 15** (Tuesday)
Hypothesis testing: null hypothesis, alternative hypothesis; Type I and Type II errors; test statistics; test level; rejection region; p values.

– Required: KW2 (skim pp. 145-168.) or KW3 (skim pp. 161-184.)

Due: Checkpoint 1

- **September 17** (Thursday)
Review of the fundamentals of probability and statistics.

Week 5: Simple Linear Regression I

- **September 22** (Tuesday)

What is OLS? How does it work?

Regression and the conditional expectation function; the best linear predictor and the linear regression line; introduction to the ordinary least squares (OLS) estimator.

– Required: KW2 (pp. 171-176.) or KW3 (pp. 188-194.)

Due: Problem Set 2

- **September 24** (Thursday)

How do we interpret OLS estimates?

OLS estimation of the intercept and slope; fitted values and residuals; interpretation of regression coefficients; units of measurement and substantive effects.

– Required: KW2 (pp. 176-177.) or KW3 (pp. 194-195.)

Week 6: Simple Linear Regression II

- **September 29** (Tuesday)

How well does the OLS model fit the data?

Algebraic (numerical) properties of OLS; decomposition of variation (TSS, ESS(MSS), RSS); goodness of fit and the coefficient of determination (R^2).

– Required: KW2 (pp. 178-181.) or KW3 (pp. 195-199.)

Due: Checkpoint 2

- **October 1** (Thursday)

How certain are we about OLS estimates?

Sampling distributions of OLS estimators; standard errors; hypothesis tests and confidence intervals for regression coefficients; statistical and substantive significance.

– Required: KW2 (pp. 182-189.) or KW3 (pp. 199-207.)

Week 7: Simple Linear Regression III

- **October 6** (Tuesday)

When can we trust OLS estimates?

OLS assumptions: linearity in parameters, random sampling, variation in X, zero conditional mean, homoskedasticity (constant error variance), and normality of errors.

Statistical properties of OLS: unbiasedness, efficiency, and consistency.

Main sources of bias in OLS estimation: measurement error, reverse causality, selection bias, and omitted variable bias.

- Required: KW2 (pp. 189-194.) or KW3 (pp. 207-212.)

Due: Problem Set 3

- **October 8** (Thursday)
Midterm review.

Week 8: Midterm Exam and Multiple Linear Regression I

- **October 13** (Tuesday) - **Midterm Exam**
- **October 15** (Thursday)
Why do we need multiple linear regression? How does it work?
The multiple linear regression model; OLS estimation; partial effects and ceteris paribus (holding other variables constant); coefficient interpretations; goodness of fit and adjusted R^2 .

- Required: KW2 (pp. 197-217.) or KW3 (pp. 215-242.)

Week 9: Multiple Linear Regression II

- **October 20** (Tuesday)
What variables should we include or exclude in a multiple linear regression model?
Confounders (omitted variable bias), mediators, and colliders; multicollinearity
- Required: KW2 (pp. 238-244.) or KW3 (pp. 263-270.)
- **October 22** (Thursday)
What if regressors are not continuous or have nonlinear effects?
Categorical variables, reference category; interaction terms, quadratic terms.

- Required: KW2 (pp. 220-232.) or KW3 (pp. 246-258.)

Week 10: Data Wrangling and Visualization

- **October 27** (Tuesday)
Cleaning and transforming data; selecting observations and variables; creating and recoding variables.
- **October 29** (Thursday)
Combining datasets; reshaping data between long and wide formats; creating effective data visualizations; producing publication-quality regression tables.

Due: Checkpoint 3

Week 11: Panel Data

- **November 3** (Tuesday)
Fixed effects estimation.

Due: Problem Set 4

- **November 5** (Thursday)
Lagged explanatory variables; clustered standard errors.

Week 12: Special Topics in Regression

- **November 10** (Tuesday)
Log-linear, linear-log, and log-log regression models.

Due: Checkpoint 4

- **November 12** (Thursday)
Logistic regression.

Week 13: Intro to Causal Inference

- **November 17** (Tuesday)
Correlation vs. causation; estimation vs. identification; fundamental problem of causal inference; the potential outcomes framework, estimand (average treatment effect), assumptions;
- **November 19** (Thursday)
Causal inference with observational data: instrumental variable (IV), regression discontinuity design (RDD), and difference-in-differences (DID).

– Optional: [Angrist \(1990\)](#); [Lee \(2008\)](#); [Enikolopov, Petrova and Zhuravskaya \(2011\)](#)

Thanksgiving Break

- No classes.

Week 14: Intro to Computational Social Science

- **December 1** (Tuesday)
Machine learning: supervised learning (classification, prediction), unsupervised learning (clustering, dimensionality reduction).

Due: Problem Set 5

- **December 3** (Thursday)
Applications of computational methods in political science.

– Optional: [Cantú \(2019\)](#), [Jiang and Yang \(2026\)](#)

Week 15: Final Project In-Class Presentations

- **December 8** (Tuesday)
Group 1 **Presentations**.
- **December 10** (Thursday)
Group 2 **Presentations**.

Week 16: Final Project Submission

- No classes.

Due: Final Project (December 17, 2026, at 11:59 p.m. EST).

Acknowledgments. This syllabus and many of the accompanying lecture slides draw on materials developed by previous instructors of PLSC 309, including Brandon Bolte, Suzanna Linn, Ilayda B. Onder, Yang Song, William Tyler Suman, and Lingbo Zhao. I am grateful for their generosity in sharing their teaching materials. I have also adapted ideas from publicly available teaching materials developed by scholars in quantitative methods, including Brandon Stewart and Scott Cunningham.

References

- Angrist, Joshua D. 1990. "Lifetime Earnings and the Vietnam Era Draft Lottery: Evidence from Social Security Administrative Records." *The American Economic Review* 80(3):313–336.
- Cantú, Francisco. 2019. "The Fingerprints of Fraud: Evidence from Mexico's 1988 Presidential Election." *American Political Science Review* 113(3):710–726.
- Enikolopov, Ruben, Maria Petrova and Ekaterina Zhuravskaya. 2011. "Media and Political Persuasion: Evidence from Russia." *American Economic Review* 101(7):3253–85.
- Jiang, Junyan and Songpo Yang. 2026. "Portraits of Power: Facial Appearance and the Tacit Domain of Political Selection in China." *American Political Science Review* p. 1–22.
- Lee, David S. 2008. "Randomized experiments from non-random selection in U.S. House elections." *Journal of Econometrics* 142(2):675–697.