

Political Science 509: The Linear Model

Emory University, Spring 2005, Class No. 3305

Tarbutton Hall 111

TuTh 1:00p-2:15p

January 20, 2005

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Course Description & Objectives

This course covers basic techniques in quantitative political analysis. It introduces students to widely-used procedures for regression analysis, and provides intuitive, applied, and formal foundations for regression and more advanced methods treated later in the course sequence. Unlike POLS 508, this course will use rudimentary calculus and matrix algebra rather intensively, but prior knowledge of such methods (beyond basic high school algebra) is not obligatory. Rather, the course includes brief primers on those mathematical techniques. In terms of foundations, the course also covers some probability theory and the properties of estimators. As its core, the course uses these foundations to examine multivariate ordinary least-squares regression. The course covers model assumptions and techniques for addressing violations of those assumptions (e.g., heteroskedasticity, autocorrelation, multicollinearity), as well as issues of model specification, functional forms, measurement error, and endogeneity.

Requirements

Grades in the course will be based on the following items:

- **50%** — Homework. Twelve equally-weighted assignments, typically with a week from distribution to due date. Turn these in by the start of class. Unlike the 508 assignments, these will be graded; they may not be pass/fail. You may *talk* about the problems with your fellow students, but *do not copy* another person's homework; your submission must contain your own work. Please hand in homeworks in hard copy, rather than emailing them, unless otherwise approved.
- **50%** — Methods paper, 14-18 pages. This paper will demonstrate your technical mastery of the practical aspects of OLS regression in the context of a specific research problem of your own formulation. Choose a topic, develop a hypothesis, and test it quantitatively. The only twist here is that your dependent variable should be continuous rather than discrete, so that it is suitable for the kinds of techniques we will be learning in class. The format should be similar to a "research note" in *APSR* or *JOP*, but with greater emphasis on the technical details. A one-page synopsis describing the hypothesis to be tested and the dataset to be used is due on Tu, Feb 22, at the start of class. **Final version due Wed, May 4.** Paper [guidelines](#) may be found on the course web page.

Course Policies

Late assignments will be penalized. Each day the assignment is late will result in a drop of a letter grade, e.g., A to B, etc.

Reading Materials

Statistics texts are expensive, but they are the kind of book that you'll find yourself referring to frequently throughout your graduate years and beyond. The main texts, available in the Druid Hills bookstore in Emory Village, are:

- Jeffrey M. Wooldridge, *Introductory Econometrics: A Modern Approach*, 2nd ed. (Thomson South-Western, 2003). This is my favorite text *not* relying on matrix algebra. It is particularly good at spelling out the little steps needed to execute each test. In terms of topical coverage, it is especially useful in dealing with simple time series methods and with the usual violations/corrections in the panel data context. Very accessible.
- William Greene, *Econometric Analysis*, 5th ed. (Prentice Hall, 2003). A favorite among political scientists; has many practical applications and variations of the main models and tests (with somewhat more emphasis on cross-sectional sorts of problems), but uses matrix algebra as the primary exposition device, and does not spell out every single step in some cases. A difficult first-read.
- Early on in the course we will also use the monograph, Timothy M. Hagle, *Basic Math for Social Scientists: Concepts* (Sage, 1995).

We may also occasionally use selections from Peter Kennedy, *A Guide to Econometrics*, 4th ed. (MIT, 1998); John Fox, *Applied Regression Analysis, Linear Models, and Related Methods* (Sage, 1997); or other sources. Check [NetLibrary](#) for free online availability for some of these. (You can also navigate to this by searching for them through EUCLID.) Any other reading on the syllabus can be found in Woodruff's on-line reserve.

Like POLS 508, this course will rely on *Stata* as our chief statistical software. Just as before, you can buy your own personal *Stata* license if you wish. Call the *Stata* Corporation at 800-782-8272, saying that you are part of the "GradPlan III" for Emory University, if you want to place an order; or go to <http://www.stata.com/info/order/new/edu/gradplans/gp3-order.html>. *Stata* 8.0 is installed on Tarbutton's local network server, Soc-Sci, at [\\soc-sci.ss.emory.edu/polisci/apps/stata](http://soc-sci.ss.emory.edu/polisci/apps/stata).

Course Outline

Jan 20 (Th) &

- Jan 25 (Tu): (1) Introduction. Course administration. Math primer I: notation, sets, functions, limits, differential calculus.
- Hagle, 1-54.
 - Wooldridge, 675-695.
 - Optional: Fox, 521-523.

Jan 27 (Th) &

- Feb 1 (Tu): (2) Math primer II: more differential calculus, optimization, integral calculus.
- Hagle, 58-71.
 - Optional: Fox, 535-539.
- ⇒ [Homework # 1](#) distributed.

Feb 3 (Th) &

- Feb 8 (Tu): (3) Math primer III: probability theory and distributions, estimators and their properties.
- Wooldridge, 696-775.

- Greene, 845-896, esp. 885-896.
- Optional: [Kennedy](#), 1-29.
- Optional: Fox, 540-566.
- ⇒ Homework # **1 due** Th Feb 3.
- ⇒ [Homework # 2](#) distributed.

Feb 10 (Th) &

- Feb 15 (Tu): (4) The regression model. Estimation and inference.
- Wooldridge, 21-89, 95-187, 197-198.
 - Hagle, 54-56.
 - Optional: Greene, 7-71.
 - Optional: Fox, 85-94, 112-125.
 - ⇒ Homework # **2 due** Th Feb 10.
 - ⇒ [Homework # 3](#) distributed.

Feb 17 (Th):

- (5) Model fit and outliers. Dummy variables, interactions, regression graphs.
- Wooldridge, 182-256.
 - Optional: Fox, 267-287, 135-154.
 - Optional: [Kennedy](#), 221-232.
 - Michael S. Lewis-Beck and Andrew Skalaban, "When to Use R-Squared," *The Political Methodologist* 3:2 (1990), 9-11.
 - Gary King, "When *Not* to Use R-Squared," *The Political Methodologist* 3:2 (1990), 11-12.
 - Robert C. Luskin, "R-Squared Encore," *The Political Methodologist* 4:1 (1991), 21-23.
 - Robert J. Friedrich, "[In Defense of Multiplicative Terms in Multiple Regression Equations](#)," *American Journal of Political Science* 26 (November 1982), 797-833.
 - ⇒ Homework # **3 due** Th Feb 17.
 - ⇒ [Homework # 4](#) distributed.

Feb 22 (Tu) &

- Feb 24 (Th): (6) Math primer IV: matrix algebra.
- Hagle, 71-95.
 - Wooldridge, 776-786.
 - Greene, 803-845.
 - Optional: Fox, 524-534.
 - ⇒ Homework # **4 due** Th Feb 24.
 - ⇒ [Homework # 5](#) distributed.
 - ⇒ Paper **proposal due** Tu Feb 22.

Mar 1 (Tu) &

Mar 3 (Th): **No class** (International Studies Association Annual Meeting).

Mar 8 (Tu) &

- Mar 10 (Th): (7) The regression model in matrix form. Estimation and inference.
- Wooldridge, 787-801.
 - Greene, 7-71.
 - Optional: Fox, 204-218, 221-235.
 - ⇒ Homework # **5 due** Tu Mar 10.
 - ⇒ [Homework # 6](#) distributed.

Mar 15 (Tu) &

Mar 17 (Th): **No class.** Spring Break.

Mar 22 (Tu): (8) Multicollinearity.

- Wooldridge, 96-100.
- Greene, 56-59.
- Optional: Fox, 337-366.
- Optional: [Kennedy](#), 183-193.
- ⇒ Homework # **6 due** Tu Mar 22.
- ⇒ [Homework # 7](#) distributed.

Mar 24 (Th) &

Mar 29 (Tu): (9) Heteroskedasticity. The problem & diagnosis. GLS and robust SEs.

- Wooldridge, 257-288.
- Greene, 215-249, 198-211.
- Optional: Fox, 301-309, 320-321, 326-328.
- Optional: George W. Downs and David M. Roche, "[Interpreting Heteroscedasticity](#)," *American Journal of Political Science* 23:4 (November 1979), 816-828.
- ⇒ Homework # **7 due** Tu Mar 29.
- ⇒ [Homework # 8](#) distributed.

Mar 31 (Th) &

Apr 5 (Tu): (10) Autocorrelation. The problem, diagnosis, techniques, GLS and robust SEs.

- Wooldridge, 391-424.
- Greene, 250-282.
- Optional: Fox, 369-385.
- Optional: [Kennedy](#), 121-126.
- Optional: Frank R. Baumgartner, Bryan D. Jones, and Michael C. MacLeod, "[The Evolution of Legislative Jurisdictions](#)," *Journal of Politics* 62:2 (May 2000), 321-349.
- ⇒ Homework # **8 due** Tu Apr 5.
- ⇒ [Homework # 9](#) distributed.

Apr 7 (Th) &

Apr 12 (Tu): (11) Model specification. Linearity and data transformations.

- Wooldridge, 89-95, 100-101, 142-148, 198-200, 289-322.
- Greene, 116-161.
- Optional: Fox, 235-239, 59-74, 309-317.
- Optional: [Kennedy](#), 88-99.
- ⇒ Homework # **9 due** Tu Apr 12.
- ⇒ [Homework # 10](#) distributed.

Apr 14 (Th) &

Apr 19 (Tu): (12) Techniques for panel data.

- Wooldridge, 426-483.
- Greene, 283-338.
- ⇒ Homework # **10 due** Tu Apr 19.
- ⇒ [Homework # 11](#) distributed.

Apr 21 (Th) &

- Apr 26 (Tu): (13) Measurement error & endogeneity. Instrumental variables, concepts, adequacy, testing. Two-stage least squares.
- Wooldridge, 295-309, 484-524, optional 525-552.
 - Greene, 83-90, 378-400.
 - Optional: Fox, 130-133.
 - Optional: Steven D. Levitt, "[Using Electoral Cycles in Police Hiring to Estimate the Effect of Police on Crime](#)," *American Economic Review* 87:3 (June 1997), 270-290.
- ⇒ Homework # **11 due** Tu Apr 26.
- ⇒ [Homework # 12](#) distributed.
- Apr 28 (Th): (14) Introduction to maximum likelihood estimation. ML estimation of the linear model, with derived techniques.
- Greene, 468-524, esp. 492-496.
 - Optional: Fox, 566-574, 219-224, 321-324, 438-456.
 - Optional: Gary King, *Unifying Political Methodology: The Likelihood Theory of Statistical Inference* (Cambridge, 1989), 14-28, 59-94.
 - Optional: Charles H. Franklin, "[Eschewing Obfuscation? Campaigns and the Perception of US Senate Incumbents](#)," *American Political Science Review* 85:4 (December 1991), 1193-1214.
- May 2 (M): Homework # **12 due** by 1:00p.
- May 4 (W): **Paper due** by 1:00p.