Washington University in St. Louis
Department of Political Science

Pol Sci 582. Quantitative Political Methodology II: Maximum Likelihood

Spring 2006 Semester

Instructor
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Class Schedule
Monday 9:00-11:00 AM
Eliot 314

Course Description

In many political science applications the linear regression model is an inappropriate tool for answering substantive questions. This course serves as an introduction to a multitude of probability models that *are* appropriate when the linear model is inadequate. Many of these models can be estimated using the method of maximum likelihood. This course serves as an introduction to maximum likelihood estimation, and as a survey of models that are broadly applicable in the social sciences.

The purpose of the course is three-fold: (1) to prepare students to conduct applied research using appropriate statistical models; (2) provide a foundation in maximum likelihood estimation so students can investigate and implement other models from the statistics literature; and (3) provide students with the tools necessary to develop their own statistical models of political phenomena.

In the weekly class meeting the course will be conducted as lecture-based workshop. Throughout the semester the I will lecture on the key material from the readings, and answer student questions. We will also work through examples collaboratively. Our pace will be unpredictable. *The bulk of learning in the course will take place outside of the classroom by reading, practicing using statistical software, replicating the work of others, and doing problem sets.*

It should be noted that we will not cover some important topics, including: Bayesian inference, Markov chain Monte Carlo, multilevel models, time series analysis, latent variable modeling, simultaneous equation modeling, and other methods of classical inference (such as method of moments and general estimating equations). Many of these are covered in other courses at Washington University.

Requirements and Evaluation

The only prerequisite for this course is a course on linear models. For political science graduate students, Political Science 581 will suffice. Each student should thus be familiar with: basic probability theory, statistical inference, hypothesis testing, and least squares estimation. I will also assume a working knowledge of calculus and linear algebra.

The requirement for this course is simple: work diligently. This includes attending class, doing the readings carefully before the seminar meets, reading beyond the syllabus, working regularly on the problem sets, practicing using statistical software, and attending office hours as needed. Each student will spend many hours learning and using statistical software to estimate the models discussed in class. Because students have different backgrounds and interests, the amount of time necessary to master the material will vary. That being said, I am confident that every student can do so with concerted effort.

The formal requirements for the class are the following:

- **Weekly Problem Sets.** There will be weekly problem sets where you will be expected to solve problems, perform analysis, and do various computational work. Students are expected to go beyond the minimal requirements for these assignments, and read beyond the syllabus when appropriate. These are due in class, and will account for 25% of the final course grade.

- **Mid-Term Exam.** There will be a take-home examination the week of March 6. You should expect to spend no more than a day taking the exam. I will provide more details as the exam approaches. The exam will account for 20% of the final course grade.

- **Research Paper.** The remainder of the formal course evaluation will be a final research paper. Each student will produce a co-authored manuscript (or a solo-authored manuscript, with permission of the instructor) that applies or develops the appropriate statistical model to an important substantive problem. Students will choose their own topics, although it would make sense to choose something that might lead to a dissertation project. On April 17 you will turn in a draft of your paper, in duplicate. (There will be no class that day; we will make arrangements about who to turn the paper into later on.) The draft must include all analysis, tables, figures, and description of the results. The rest of the draft may be in detailed outline form, although it would be better to have it fully written. You also must turn in your dataset, or provide a web link, where the data necessary to fully replicate your study are available. Each student must turn in a copy of their co-authored paper. On April 20 I will give your paper and data to another student in the course. Each student will then be asked to replicate the other student's analysis, and write a memorandum to the other student (and the instructor) pointing how ways the paper could be made better, and detailing any difficulties with replicating the results. These memos will be graded on how helpful the comments are. These memos are due, in duplicate, on April 27. Final research papers are due at 5:00 PM on Friday, May 5. The memos will count for 15% of the final grade; the final paper the remaining 40%.

I will give no incompletes in the course. Honest.

Readings

The readings for the course will come from two required textbooks, two recommended textbooks, and a series of articles from political science, economics, and statistics journals.

The required textbooks are:

Long, J. Scott. 1997. *Regression Models for Categorical and Limited Dependent Variables.* Thousand Oaks, CA: Sage Publications.

Eliason, Scott R. 1993. *Maximum Likelihood Estimation: Logic and Practice.* Thousand Oaks, CA: Sage Publications.

Long (1997) is an excellent introduction to maximum likelihood and commonly used models. Eliason (1993), while somewhat dated, provides a nice practical introduction to maximum likelihood theory. I am also recommending two additional textbooks. The first is a gentle introduction to the R language; the other is a useful reference on statistical distributions.

Dalgaard, Peter. 2002. *Introductory Statistics with R.* New York: Springer.

Evans, Merran, Nicholas Hastings, and Brian Peacock. 2000. *Statistical Distributions.* New York: Wiley.

It will also be important to have a standard mathematical statistics text, and a linear models text, available for consultation, such as:

DeGroot, Morris H., and Mark J. Schervish. 2002. *Probability and Statistics*, Third Edition. Reading, MA: Addison-Wesley.

Fox, John. 1997. *Applied Regression Analysis, Linear Models, and Related Methods.* Thousand Oaks, CA: Sage.

All of these texts can be purchased from the bookstore or your favorite internet bookseller. In addition to the articles listed below, I may distribute additional readings in class.

Computation

All of the models covered in this class can be estimated using standard software packages.[1] This is quite an advantage; if I were teaching this course ten years ago, low-level computer programming would be required. I have chosen to remain catholic about the software students can use for their homework assignments. However, I will only be able to support two

[1] There are some limitations in some packages. SPSS, for example, does not implement many of these models. Stata seems to offer the broadest selection. R, while very flexible, requires some basic programming to be useful. Avoid SAS like the plague.

packages: Stata and R. Both of these packages contain most of the models necessary for this course, and provide programming functionality that allows the implementation of other, non-standard models. I encourage each student to choose a software package, and use the package throughout the semester to estimate each type of model. Highly motivated students should perform all work in both Stata and R.

Both Stata and R are available on Windows machines in the Social Science Computing Facility (SSCF) in Eliot Hall. If you want to become a serious Stata user, I strongly recommend that you purchase copies of the manuals. Stata has an excellent set of manuals: the *User's Guide* which details how the software is structured; the *Reference Manuals* which contain a detailed description of how each command works and each model is estimated; and the *Stata Programming Reference Manual* which is geared toward those who want to program their own maximum likelihood models. All of these can be purchased from Stata directly using the GradPlan.

R is the best package for graphical and exploratory data analysis, and is a powerful statistical programming language. R can be downloaded for free for Windows, Macintosh, Linux, and Unix operating systems from `http://www.r-project.org`. The R manual is also available for free on the web. The texts by Venables and Ripley (2002) and Dalgaard (2002) are also quite useful.

I intend to hold optional software sessions throughout the semester about some advanced features of the R language. Details will be forthcoming.

Course Topics and Schedule

The following is the list of topics I hope to cover in this course. Because the pace of the course will vary throughout the semester, I have chosen not to assign dates for the topics below. After the fourth topic the ordering of topics is fairly arbitrary. We will approach the material as slowly, or as quickly, as necessary, and will cover as much, or as little, as possible. Each week in class the readings for the following week will be assigned. The list of topics and assigned readings follow.

(1/23). **A Review of Linear Models**
Long (1997), Chapters 1-2.

(1/30). **Introduction to Maximum Likelihood Estimation (MLE)**
Eliason (1993), All.
Long (1997), Chapter 3.
Davidson and MacKinnon (2004), Chapter 10.
Aldrich (1997).

(_____). **Logit and Probit**
Long (1997), Chapters 3-4.

(_____). **Interpretation for Nonlinear Models**
King et al. (2000).

(_____). **Models for Ordinal Dependent Variables**
Long (1997), Chapter 5.
Winship and Mare (1984).
McKelvey and Zavoina (1975).

(_____). **Models for Nominal Dependent Variables: CL, MNL, and MNP**
Long (1997), Chapter 6.
Alvarez and Nagler (1998).
Quinn et al. (1999).

(_____). **Heteroscedastic Regression**
Franklin (1991).

(_____). **Interactions and and Model Specification**
Friedrich (1982).
Brambor et al. (2006).

(_____). **Event Count Models**
Long (1997), Chapter 8.
King (1988).
King (1989).
Zorn (1998).

(_____). **Model Comparison**
Clarke (2001)
Raftery (1995)
Kass and Raftery (1995)

(_____). **SUR, Bivariate, and Multivariate Probit**
Caldeira and Smith (1996).
Martin and Wolbrecht (2000).
Epstein, Martin, and Baldez, "Does the U.S. Constitution Need an Equal Rights Amendment?" Forthcoming, *Journal of Legal Studies*.

(_____). **Truncation**
Long (1997), Chapter 7.
Tobin (1958).

(_____). **Censoring and Selection**
Long (1997), Chapter 7.
Berk (1983).
Winship and Mare (1992).
Dubin and Rivers (1989).
Geddes (1990).

(_____). **Models for Pooled Cross-Sectional Time-Series Data**
Beck and Katz (1995).
Beck et al. (1998).
Steenbergen and Jones (2002).

(_____). **Survival Models**
Box-Steffensmeier and Jones (1997).
Box-Steffensmeier and Zorn (2001).

References

Aldrich, John. 1997. "R.A. Fisher and the Making of Maximum Likelihood 1912-1922." *Statistical Science* 12:162–176.

Alvarez, R. Michael, and Jonathan Nagler. 1998. "When Politics and Models Collide: Estimating Models of Multi-Candidate Elections." *American Journal of Political Science* 42(January):55–96.

Beck, Neal, and Jonathan N. Katz. 1995. "What To Do (And Not To Do) with Time-Series Cross-Section Data." *American Political Science Review* 89(September):634–647.

Beck, Neal, Jonathan N. Katz, and Richard Tucker. 1998. "Taking Time Seriously: Time-series-cross-section Analysis with a Binary Dependent Variable." *American Journal of Political Science* 42(October):1260–1288.

Berk, Richard A. 1983. "An Introduction to Sample Selection Bias in Sociological Data." *American Sociological Review* 48(June):386–398.

Box-Steffensmeier, Janet, and Christopher J. W. Zorn. 2001. "Duration Models and Proportional Hazards in Political Science." *American Journal of Political Science* 45:972–988.

Box-Steffensmeier, Janet M., and Bradford S. Jones. 1997. "Time Is of the Essence: Event History Models in Political Science." *American Journal of Political Science* 41(October):1414–1461.

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

Caldeira, Gregory A., and Charles E. Smith, Jr. 1996. "Campaigning for the Supreme Court: The Dynamics of Public Opinion on the Thomas Nomination." *Journal of Politics* 58(August):655–681.

Clarke, Kevin. 2001. "Testing Nonnested Models of International Relations: Reevaluating Realism." *American Journal of Political Science* 45:724–744.

Dalgaard, Peter. 2002. *Introductory Statistics with R*. New York: Springer.

Davidson, Russell, and James G. MacKinnon. 2004. *Econometric Theory and Methods*. Oxford: Oxford University Press.

DeGroot, Morris H., , and Mark J. Schervish. 2002. *Probability and Statistics*. Reading, MA: Addison Wesley, third edition.

Dubin, James A., and Douglas Rivers. 1989. "Selection Bias in Linear-regression, Logit and Probit models." *Sociological Research and Methods* 18(2-3):360–390.

Eliason, Scott R. 1993. *Maximum Likelihood Estimation: Logic and Practice*. Thousand Oaks, CA: Sage Publications.

Evans, Merran, Nicholas Hastings, and Brian Peacock. 2000. *Statistical Distributions*. New York: Wiley.

Fox, John. 1997. *Applied Regression Analysis, Linear Models, and Related Methods*. Thousand Oaks, CA: Sage.

Franklin, Charles H. 1991. "Eschewing Obfuscation?: Campaigns and the Perception of U.S. Senate Incumbents." *American Political Science Review* 85(December):1193–1214.

Friedrich, Robert J. 1982. "In Defense of Multiplicative Terms in Multiple Regression Equations." *American Journal of Political Science* 26(November):787–833.

Geddes, Barbara. 1990. "How the Cases You Choose Affect the Answers You Get: Selection Bias in Comparative Politics." *Political Analysis* 2:131–150.

Kass, Robert E., and Adrian E. Raftery. 1995. "Bayes Factors." *Journal of the American Statistical Association* 90(June):773–795.

King, Gary. 1988. "Statistical Models for Political Science Event Counts: Bias in Coventional Procedures and Evidence for the Exponential Poisson Regression Model." *American Journal of Political Science* 32(August):838–863.

King, Gary. 1989. "Variance Specification in Event Count Models: From Restrictive Assumptions to a Generalized Estimator." *American Journal of Political Science* 33(August):762–784.

King, Gary, Michael Tomz, and Jason Wittenberg. 2000. "Making the Most of Statistical Analyses: Improving Interpretation and Presentation." *American Journal of Political Science* 44(April):347–361.

Long, J. Scott. 1997. *Regression Models for Categorical and Limited Dependent Variables*. Thousand Oaks, CA: Sage Publications.

Martin, Andrew D., and Christina Wolbrecht. 2000. "Partisanship and Pre-Floor Behavior: The Equal Rights and School Prayer Amendments." *Political Research Quarterly* 53:711–730.

McKelvey, William, and William Zavoina. 1975. "A Statistical Model for the Analysis of Ordinal Level Dependent Variables." *Journal of Mathematical Sociology* 4(Summer):103–120.

Quinn, Kevin M., Andrew D. Martin, and Andrew B. Whitford. 1999. "Voter Choice in Multi-Party Democracies: A Test of Competing Theories and Models." *American Journal of Political Science* 43(October):1231–1247.

Raftery, Adrian. 1995. "Bayesian Model Selection in Social Research." *Sociological Methodology* 25:111–196.

Steenbergen, Marco R., and Bradford S. Jones. 2002. "Modeling Multilevel Data Structures." *American Journal of Political Science* 45:218–237.

Tobin, James. 1958. "Estimation of Relationships for Limited Dependent Variables." *Econometrica* 26(January):24–36.

Venables, W. N., and B. D. Ripley. 2002. *Modern Applied Statistics with S*. New York: Springer, fourth edition.

Winship, Christopher, and Robert D. Mare. 1984. "Regression Models with Ordinal Variables." *American Sociological Review* 49(August):512–525.

Winship, Christopher, and Robert D. Mare. 1992. "Models for Sample Selection Bias." *Annual Review of Sociology* 18:327–350.

Zorn, Christopher J. W. 1998. "An Analytic and Empirical Examination of Zero-Inflated and Hurdle Poisson Specifications." *Sociological Research and Methods* 26(February):368–400.