POL 9040: Time Series Analysis

University of Missouri

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W 3:00-5:30PM, Middlebush Hall 8

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Course Description

This course introduces you to a variety of statistical techniques relevant to analyzing time series data. Typically, this means addressing issues that are common to data that vary over time (such as autocorrelation and non-stationarity), and applying correct interpretation techniques. The objective is for you to become familiar enough with them to understand how, when and why to use them. Emphasis will therefore be on empirical applications.

This class requires you to learn how to use Stata since almost all of our applications can be done using it and many of them essentially require it (unless you want to write your own code). There may be instances where we utilize other statistical programs (such as R), but the vast majority will focus on Stata.

Required Books

- Pickup, Mark. *Introduction to time series analysis.* Vol. 174. Sage Publications, 2014

Other required readings will be available on Canvas (`canvas.missouri.edu`) or through jstor.

Course Requirements

Class Participation and Attendance (15%)

The quality of a graduate-level seminar in methodology depends to a large extent on the quality of the students. It is your responsibility, as well as mine, to come to class prepared to discuss the information and claims found in the readings and explore related research possibilities. If any of us shirk, we all lose. I expect no absences in the course, and I encourage you to discuss any circumstances with me that will preclude you from attending class. I also expect you to arrive on time. If you do need to miss class, please contact me ahead of time to let me know that you will not be able to attend and to make arrangements to complete an alternate assignment. A large portion of my overall evaluation of your performance in the course will depend on the quality of your seminar participation.

Grades for participation will be assigned at the end of the semester, but you may ask for feedback on your performance at any time. If you have concerns about the quality and quantity of your participation in the course, I hope you will speak to me. Remember, this is a seminar, so just showing up to class is not enough.

You must come to class prepared to participate in an informed discussion of the issues raised by the week's readings. If you just show up to class every week, but never say a word, you can expect to receive a D or lower for class participation (15% of your grade).

The following general grading scale will be used for participation and preparation:

- A: The student made a very strong contribution to the course. Class discussion, comments, and presentations reflected understanding and analysis of the material, and were constructive. Constructive means that a student does not simply identify a weakness or problem. Rather, constructive comments identify a problem and offer suggestions for how to address the weakness or problem.

- B: The student contributed meaningfully to the course. Class participation and/or presentations went beyond repeating the assigned material, perhaps identifying weaknesses in the current literature, but did not make many constructive suggestions about how weaknesses might be overcome or how the literature might be usefully extended in the future.

- C: The student did not contribute meaningfully to the seminar. Class participation and/or presentations were limited to repeating the assigned material rather than making connections or extensions.

- D or lower: The student attended class, but did not participate in discussions or present meaningful questions for academic debate.

Finally, because we will engage in vigorous academic debate during class, classroom etiquette is vital. Please work to ensure that you make comments in ways that invite discussion. Our classroom contains members with various life experiences, divergent perspectives, varying levels of experience with political science research, and different strategies for defending their views. Please state your opinions constructively and respectfully, listen carefully when your colleagues are speaking, and speak to me if you are offended by something that is said in class. If you do not follow these guidelines, your participation grade will be adversely affected.

Homeworks (45%)

At various times throughout the semester, I will assign homework. This is because the best way to learn the material is to actually use the models. Homeworks must be typed and handed in at the beginning of class. Late homeworks will be deducted 10% for each calendar day that they are late. Homeworks must be completed in LaTeX.

Option A: Examinations (40%)

If the student selects this option, they will take a midterm examination on Wednesday, October 9, and a final examination on Tuesday, December 10. I will distribute both exams on those days and the students will have one day to complete it and send it back to me (by midnight the next day). This is an open-book, open-note exam. However, at no point should you contact anyone other than the instructor for questions (even for clarification). Both exams are weighted equally (20% each).

Option B: Research Paper (40%)

Another option is an original research paper, involving the empirical testing of one or more hypotheses on a topic of substantive interest using appropriate time series methods.

The research paper should discuss the theoretical motivation for the proposed research, citing the relevant literature (at least 15 sources) to which the research seeks to contribute. It should clearly explain the original

theoretical argument made and explicitly posit the key testable hypotheses derived from this theory. The paper should also discuss the dependent variable(s) and central explanatory variables that would be employed in an empirical investigation of these hypotheses. In addition to submitting a written version, students will make a 12-15 minute presentation of their research paper to the class.

The final paper must be 18-25 pages in length, and should be comparable to an academic journal article in style. Please note that this must be an original paper for this course, and can not overlap in any substantial way with a paper written for another course; if there is any question please talk to me about it and bring me a copy of the other paper. The paper must be typeset using LaTeX.

There will be four components of research paper:

1. A two page proposal that is due by the beginning of class on Wednesday, October 16 (worth 5% of the course grade). An effective proposal will include the following sections: Background/literature in which the student identifies gaps in the literature and introduces the research question, Theory and Hypothesis where the student identifies the credible mechanism, develops the theory and derives testable hypotheses, Research Design where the student introduces the data source and tests for stationarity, and Potential Problems/Obstacles where the student can discuss areas in which he/she needs help.

2. A draft of the paper to be distributed to the other students in the course (via email) by 3:00pm on Wednesday, November 27 (worth 5% of the course grade).

3. Participation in the Mini-Conference on Wednesday, December 4. Each student selecting this option will make a presentation and serve as a discussant/reviewer for another paper (worth 10% of the course grade). An effective presentation will include the following elements:

   - introduce research question
   - place your research in the context of the literature
   - derive hypotheses
   - describe your research design (be sure to discuss the time series properties and appropriate methods)
   - present your empirical results
   - list major conclusions and implications.

   I will provide more in-depth description of the requirements for the Reviews at a later date, but they should include an overall summary and then comments/criticisms arranged into three topics: aesthetics, empirical and theoretical.

4. A revised final version of the research paper to be turned in (email is fine) by 3:00pm, December 11. Additionally, the student must email me the data set and replication materials by the due date (altogether, this component is worth 20% of the course grade).

The paper will be graded on the quality of the empirical analysis, proper interpretation, and exploration of the results in the best manner to test the hypotheses. These papers will be expected to conform to the submission standards of the *American Journal of Political Science* and research reports must be completed in LaTeX.

Grammatical mistakes in any of the assignments will NOT be tolerated. Any student turning in an assignment with grammatical mistakes will have the assignment returned without a grade. The student will have one opportunity to improve and resubmit the work with a grade penalty in a time frame decided by me.

Final class grades will be assigned with the following grading scale:

A+ = 97.0 - 100
A = 90.0 - 96.99
B+ = 87.0 - 89.99
B = 80.0 - 86.99
C+ = 77.0 - 79.99
C = 70.0 - 76.99
D+ = 67.0 - 69.99
D = 60.0 - 66.99
F = 0 - 59.99

Other Considerations

Academic Integrity

Academic integrity is fundamental to the activities and principles of a university. All members of the academic community must be confident that each person's work has been responsibly and honorably acquired, developed, and presented. Any effort to gain an advantage not given to all students is dishonest whether or not the effort is successful. The academic community regards breaches of the academic integrity rules as extremely serious matters. Sanctions for such a breach may include academic sanctions from the instructor, including failing the course for any violation, to disciplinary sanctions ranging from probation to expulsion. Any efforts to pass off someone else's ideas as your own is considered plagiarism! When in doubt about plagiarism, paraphrasing, quoting, collaboration, or any other form of cheating, consult the course instructor.

Plagiarism (or cheating in any way) will not be tolerated. Any student plagiarizing will receive an automatic "0" for that assignment, no exceptions!

ADA Statement

If you anticipate barriers related to the format or requirements of this course, if you have emergency medical information to share with me, or if you need to make arrangements in case the building must be evacuated, please let me know as soon as possible.

If disability related accommodations are necessary (for example, a note taker, extended time on exams, captioning), please register with the Disability Center (`http://disabilitycenter.missouri.edu`), S5 Memorial Union, 573- 882-4696, and then notify me of your eligibility for reasonable accommodations. For other MU resources for persons with disabilities, click on "Disability Resources" on the MU homepage.

Class Schedule

We will spend as much time as necessary on each topic for this course. Because I am unable to predict in advance how long each topic will take, the schedule below is only a rough guideline. Our last class of the semester—on December 11—will be our mini-conference where everyone presents one of their research reports.

Topics

- Preliminaries

  - Review of Gauss-Markov assumptions
  - Simulations/Monte Carlo Analysis
  - Review of matrix algebra
  - Readings:
    * King, Gary, Michael Tomz and Jason Wittenberg. 2000. "Making the Most of Statistical Analysis: Improving Interpretation and Presentation." *American Journal of Political Science* 44.2: 341-355.
    * Philips, Andrew. "Monte Carlo Analysis" (Download available at www.andyphilips.com)
    * As needed, one or more introductions to matrix algebra. For example:
      · Chapter 3 of Gill, Jeff. *Essential mathematics for political and social research.* Cambridge: Cambridge University Press, 2006.
      · Appendix B of Gujarati, Damodar N. *Basic econometrics*, 4th Edition. Tata McGraw-Hill Education, 2003.

- Time Series Basics

  - Introduction to data structure and notation
  - Theory vs. nuissance
  - Stationary time series and unit roots
  - (Pre-)specifying the dependence structures (e.g., lags, network, etc.)
  - Detecting/diagnosing autocorrelation
  - Readings:
    * Chapters 1 and 2 of Pickup, Mark. *Introduction to time series analysis.* Vol. 174. Sage Publications, 2014.

- The ARIMA Approach

  - The Box-Jenkins approach to time series
  - AR and MA processes
  - Model estimation and evaluation
  - Readings:
    * Chapter 13 of Asteriou, Dimitrious and Stephen G. Hall *Applied Econometrics*, 2nd edition. Palgrave, 2011.
    * Clarke, Harold D., William Mishler, and Paul Whiteley. "Recapturing the Falklands: models of Conservative popularity, 1979–83." *British Journal of Political Science* 20.1 (1990): 63-81.

- Time Series Models

  - ARIMA vs. Standard regression approaches
  - Traditional treatments of autocorrelation
  - Equation balance, Cointegration, ECMs
  - Readings:
    * Chapters 4 and 6 of Pickup, Mark. *Introduction to time series analysis.* Vol. 174. Sage Publications, 2014.

* Achen, Christopher H. Unpublished. "Why lagged dependent variables can suppress the explanatory power of other independent variables." Ann Arbor 1001.2000 (2000): 48106-1248. (download available at http://www-personal.umich.edu/ franzese/Achen.2000.LDVstealingExplanPower.pdf)

* Keele, Luke, and Nathan J. Kelly. "Dynamic models for dynamic theories: The ins and outs of lagged dependent variables." *Political analysis* 14.2 (2005): 186-205.

* De Boef, Suzanna, and Luke Keele. "Taking time seriously." *American Journal of Political Science* 52.1 (2008): 184-200.

* Philips, Andrew Q. Forthcoming "Have your cake and eat it too? Cointegration and dynamic inference from autoregressive distributed lag models." *American Journal of Political Science* .

* Pickup, Mark and Paul M. Kellstedt. Working Paper. "Equation Balance in Time Series Analysis: What It Is and How to Apply It."

* Wilkins, Arjun J. Forthcoming. "To Lag or Not to Lag?: Re-Evaluating the Use of Lagged Dependent Variables in Regression Analysis." *Political Science Research and Methods.* 6.2: 393-411.

- Model Estimation and Interpretation

  - Total effects (e.g., long run) calculation

  - Graphical displays of model results

  - Readings:

    * Williams, Laron K. and Guy D. Whitten. "But Wait, There's More! Maximizing Substantive Inferneces from TSCS Models." *Journal of Politics.* 74.3: 685-693.

    * Jordan, Soren and Andrew W. Philips. "Cointegration Testing and Dynamic Simulations of Autoregressive Distributed Lag Models" *Stata Journal.* Forthcoming.

- Time and Space Dynamics

  - Pooling Assumptions

    * Stimson, Stimson, J.A., 1985. "Regression in space and time: A statistical essay." *American Journal of Political Science*, pp.914-947.

- Panel Heterogeneity

  - Heterogeneous Intercepts

    * King, G., 2001. Proper nouns and methodological propriety: Pooling dyads in international relations data. *International Organization*, 55(2), pp.497-507.

    * Green, D.P., Kim, S.Y. and Yoon, D.H., 2001. Dirty pool. *International Organization*, 55(2), pp.441-468.

    * Clark, T.S. and Linzer, D.A., 2015. "Should I use fixed or random effects?" *Political Science Research and Methods*, 3(2), pp.399-408.

    * Bell, A. and Jones, K., 2015. "Explaining fixed effects: Random effects modeling of time-series cross-sectional and panel data." *Political Science Research and Methods*, 3(1), pp.133-153.

  - Heterogeneous Slopes

    * Steenbergen, M.R. and Jones, B.S., 2002. "Modeling multilevel data structures." *American Journal of Political Science*, pp.218-237.

    * Franzese, R.J., 2005. "Empirical strategies for various manifestations of multilevel data." *Political Analysis*, 13(4), pp.430-446.

    * Beck, N. and Katz, J.N., 2007. "Random coefficient models for time-series—cross-section data: Monte Carlo experiments." *Political Analysis*, 15(2), pp.182-195.

- – Heterogeneous Disturbance Structures
  - ∗ Beck, N. and Katz, J.N., 1995. "What to do (and not to do) with time-series cross-section data." *American Political Science Review*, 89(3), pp.634-647.
  - ∗ King, G. and Roberts, M.E., 2015. "How robust standard errors expose methodological problems they do not fix, and what to do about it." *Political Analysis*, 23(2), pp.159-179.

- Limited Dependent Variables

  - – Binary Outcomes - Time Dependence
    - ∗ 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(4): 1260-1288.
    - ∗ Carter, David and Curtis Signorino. 2010. Back to the Future: Modeling Time Dependence in Binary Data. *Political Analysis* 18(3): 271-292.
    - ∗ Williams, Laron K. 2016. "Long-Term Effects in Models with Temporal Dependence." *Political Analysis* 24: 243-262.
    - ∗ Williams, Laron K. 2018. "Temporal Dependence and the Sensitivity of Quantities of Interest: A Solution for a Common Problem." *International Studies Quarterly* 62: 892-902.

  - – Binary Outcomes - Panel
    - ∗ Beck, N. and Katz, J.N., 2001. Throwing out the baby with the bath water: A comment on Green, Kim, and Yoon. *International Organization*, 55(2), pp.487-495.
    - ∗ Cook, S.J., Hays, J.C. and Franzese, R.J., 2018. Fixed effects in rare events data: a penalized maximum likelihood solution. *Political Science Research and Methods*, pp.1-14.