Time Series Analysis: An Introduction for Social Scientists
ICPSR 2012

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Course description:

Statistical models can be applied to time series data-- chronological sequences of observations-- to examine the movement of social science variables over time (e.g., public opinion, government policy, judicial decisions, socioeconomic measures), allowing analysts to estimate relationships between variables and test hypotheses. This course introduces time series methods and their application in social science research. We will focus on conceptualization and practice, with some attention to the underlying statistical theory.

The course will provide a comprehensive discussion of the fundamental concepts in time series analysis, including: autoregressive, moving-average and unit-root processes; trending, cycling and structural breaks; weak dependence; and the two most important assumptions underlying time series models, stationarity and exogeneity. The lab component of the course will demonstrate the use of, and assumptions underlying, common models of time series data: autoregressive distributive-lag, moving average (autocorrelated error), differenced data, ARMA, equilibrium (error) correction, and vector autoregression models. These models will be demonstrated with the goal of giving participants the tools necessary to apply them to their own research.

A sound background in linear regression models is assumed but prior training in time series analysis is not required. The course will make use of basic algebra. The lab component of this course will employ Stata. Some familiarity with Stata would be helpful but for those without that familiarity, a crash course on Stata will be provided during the first class session.

Participants should be clear that this is a course on analyzing time series data. While a course on time series is a very useful precursor to learning panel data analysis, this course does not itself cover panel data analysis techniques.

Making Contact:

The best way to contact me is via e-mail. mark.pickup@gmail.com.

Course outline:

Day 1.
Introduction and a Review of Essential Mathematics and Statistical Theory

- Thinking time-serially (versus cross-sectional or panel data analysis)
- Notation
- Basic mathematics
- The Simple Linear Regression Model – A Review
- Basic statistical theory
    - probability, variance and covariance
- Classical linear modelling assumptions of OLS
- Limits and derivatives
- Endogeniety

- Lab: crash course in *STATA*

Day 2.
The Basics of Time Series analysis

- Endogeniety – omitted variable bias
- Static and Finite Distributed Lag models
- Classical and asymptotic linear modelling assumptions for OLS with time series
- Testing and correcting for serial correlation in errors
- Testing for heteroscedasticity and normality in errors

- Lab: examples of Static and Finite Distributed Lag models

Day 3.
Stationary Dynamic Time Series Models

- Trending (Part 1)
- Autoregressive (AR) processes
- The Autoregressive Distributed Lag (ADL) model
- The Lag Dependent Variable (LDV) model
- Conditions for Stability
- Conditions for Stationarity
- Moving average (MA) processes
- The ARMA model
- Maximum Likelihood Estimation - An Overview

- Lab: examples of LDV, ADL, MA models

Day 4.
Model Selection and Nonstationarity

- The Box-Jenkins approach for ARMA model selection
- Testing for unit root processes
- Random Walk Model
- Trending (Part 2)
- Differenced data models
- The ARIMA model

- Lab: examples of ARMA and ARIMA models

Day 5.
Introduction to More Advanced Time Series Models

- Cointegration
- Equilibrium/Error Correction models
- Introduction to Vector Autoregression Models

- Lab: examples of VAR and Error Correction models

Pre-workshop preparation:

Required: Wooldridge, Jeffrey. 2006. *Introductory Econometrics: A Modern Approach*. 3rd ed. Mason, Ohio: Thomson/South-Western, Appendix B.1- B.4.

Required: Gill, Jeff. 2006. *Essential Mathematics for Political and Social Research.* Cambridge: Cambridge University Press, 5.1-5.3

(It is also strongly advisable to get started with the required course readings.)

Participants will want to obtain two texts:

Wooldridge, Jeffrey. 2006. *Introductory Econometrics: A Modern Approach*. 3rd ed. Mason, Ohio: Thomson/South-Western.

Brandt, Patrick T., John T. Williams. 2007. *Multiple Time Series Models*. Thousand Oaks, California: Sage Publications, Inc., Chapters 1 and 2 (2.1-2.5).

Readings:
For some days, advanced readings are indicated. These are intended as further reading you can do after the workshop, if you wish to delve into a particular topic further.

Day 1.

Required: Wooldridge, Jeffrey. 2006. Introductory Econometrics: A Modern Approach. 3rd ed. Mason, Ohio: Thomson/South-Western, Chapters 2-4.

Day 2.

Required: Wooldridge, Jeffrey. 2006. Introductory Econometrics: A Modern Approach. 3rd ed. Mason, Ohio: Thomson/South-Western, Chapters 10-12.

Advanced: Enders, Walter. 1995. Applied Econometric Time Series. New York: Wiley and Sons, Chapters 1 (pgs. 1-36, 44-46).

Day 3.

Required: Harvey, Andrew. 1993. Time Series Models. Second edition. Cambridge Massachusetts: The MIT Press, Chapter 1 and Chapter 2 (not 2.6).

Advanced: Harvey, Andrew. 1993. Time Series Models. Second edition. Cambridge Massachusetts: The MIT Press, Chapter 3.

Advanced: Enders, Walter. 1995. Applied Econometric Time Series. New York: Wiley and Sons, Chapters 2 (pgs. 48-79).

Advanced: Keele, Luke and Nathan J. Kelly. "Dynamic Models for Dynamic Theories: The Ins and Outs of *the* Lagged Dependent Variables." *Political Analysis* 14:186-205.

Day 4.

Required: Wooldridge, Jeffrey. 2006. Introductory Econometrics: A Modern Approach. 3rd ed. Mason, Ohio : Thomson/South-Western, Chapter 18.

Required: Harvey, Andrew. 1993. Time Series Models. Second edition. Cambridge Massachusetts: The MIT Press, Chapters 5.

Advanced: Enders, Walter. 1995. Applied Econometric Time Series. New York: Wiley and Sons, pgs. 239-264.

Maddala, G.S. and In-Moo Kim. 1988. *Unit Roots, Cointegration, and Structural Change*. Cambridge: Cambridge University Press, Chapter 2.

Day 5.

Required: Beck, Nathaniel. 1991. "Comparing Dynamic Specifications: The Case of Presidential Approval." *Political Analysis* 3: 51-87

Required: Brandt, Patrick T., John T. Williams. 2007. *Multiple Time Series Models*. Thousand Oaks, California: Sage Publications, Inc., Chapters 1 and 2 (2.1-2.5).

Advanced: Banerjee, Anindya, Juan Dolado, John W. Galbraith and David F Hendry. 1993. Co-integration, Error-Correction, and the Econometric Analysis of Non -Stationary Data. Oxford: Oxford University Press: pgs. 46-55.

Advanced: Enders, Walter. 1995. Applied Econometric Time Series. New York: Wiley and Sons, pgs. 264-311.

Other interesting readings:

Freeman, John. 1983. “Granger Causality and the Time Series Analysis of Political Relationships.” *American Journal of Political Science* 27: 327-58.

Freeman, John, John Williams and T Lin (1989) “Vector Autoregression and the Study of Politics” *American Journal of Political Science* 33: 842-77

Freeman, John, Daniel Houser, Paul M. Kellstedt, John T. Williams. 1998. "Long-Memoried Processes, Unit Roots, and Causal Inference in Political Science" *American Journal of Political Science* 42: 1289-1327.

De Boef, Suzanna L. and Luke Keele. 2008. Taking Time Seriously." *American Journal of Political Science* 52(1):184-200.