University of Pennsylvania **Economics 706, Spring 2017**

Time-Series Econometrics

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Scheduled Class Time and Organization: We will meet twice a week Tuesdays and Thursdays from 10:30a - 12:00n in Room 285, McNeil.
The teaching assistants will conduct a one hour discussion and review session once a week. Details will be announced.

Course Description:

The course provides an introduction to modern time series econometrics. The first part of the course deals with properties of dependent processes. This includes laws of large numbers and central limit theorems as well as properties of autoregressive (AR), moving average (MA), and ARMA processes. Most of the analysis will be conducted in the time domain, but the course also includes a brief excursion into the frequency domain. The second part focuses on statistical inference. We begin with the Bayesian estimation of AR models. After the midterm we will consider the analysis of linear state-space models, which encompass ARMA models, time-varying coefficient models, and factor models. Finally, we consider models with time-varying heteroskedasticity and extensions to vector processes.

Prerequisites: Economics 705 or equivalent graduate level econometrics.

Courseware: You can access the course materials via CANVAS. You can log-in from *http://upenn.instructure.com/*.

Course Requirements:

- **Problem Sets**: There will be 8 problem sets, assigned during the semester. The problem sets are designed to give you the opportunity to review and enhance the material learned in class. You are encouraged to form small study groups, however, each member of a study group has to submit his or her own write-up of the solution. These solutions must be submitted on the specified due dates. [20%]
- **Midterm Exam**: Thursday, March 2. [40%]
- **Final Exam**: Tuesday, April 25. [40%]

Course Readings: There is no one textbook that exactly matches the material covered in class. I will make my lecture notes available on CANVAS and post recommended readings. You can continue to use Hayashi (2000), which provides background reading for the material covered in lectures 2-7.

Some classic references for time series analysis are:

Time Series Analysis:

Brockwell, P.J. and R.A. Davis (1991): "*Time Series: Theory and Models*," Springer-Verlag.

Granger, C.W.J. and P. Newbold (1987): "*Forecasting Economic Time Series*," Academic Press.

Hamilton, James D. (1994): "*Time Series Analysis*," Princeton University Press.

Harvey, A.C. (1990): "*The Econometric Analysis of Time Series*," MIT Press.

Kim, C.-J. and C.R. Nelson (1999): "*State-Space Models with Regime Switching*," MIT Press, Cambridge.

Throughout this course, we will focus on Bayesian inference. In this regard, some useful reference are:

Gelman, Andrew, John B. Carlin, Hal S. Stern, and Donald B. Rubin (1995): *"Bayesian Data Analysis,"* Chapman & Hall, New York.

Koop, Gary (2003): *"Bayesian Econometrics,"* John Wiley & Sons.

Geweke, John (2005): *"Contemporary Bayesian Econometrics and Statistics,"* Wiley, New York.

Robert, Christian P. (1994): *"The Bayesian Choice,"* Springer-Verlag, New York,

Finally, here are three books with a specific focus on macroeconomic and financial applications:

Canova, Fabio (2007): *Methods for Applied Macroeconomic Research,* Princeton University Press.

DeJong, David and Chetan Dave (2007): *Structural Macroeconometrics,* Princeton University Press.

Campbell, J.Y., A.W. Lo, and A.C. MacKinlay (1997): "*The Econometrics of Financial Markets*," Princeton University Press.

Course Outline and Schedule

Date	Topic
1) Th 01/12	Introduction to Time Series Analysis: data Sources, trends, and temporal dependence
2) Tu 01/17	Dependent Processes I: population measures of dependency, covariance stationarity, WLLN and CLT for finite-order MA processes
3) Th 01/19	Dependent Processes II: Strict stationarity and ergodicity, Martingales and Martingale difference sequences
4) Tu 01/24	Dependent Processes III: Deterministic trend regressions with MA errors
5) Th 01/26	Stationary ARMA Models I: AR models, solving difference equations, autocovariance function
6) Tu 01/31	Stationary ARMA Models II: MA models, Wold decomposition, invertibility
7) Th 02/02	Stationary ARMA Models III: ARMA models, prediction
8) Tu 02/07	Spectral Analysis I: linear cyclical model
9) Th 02/09	Spectral Analysis II: stationary processes, filters
10) Tu 02/14	Trend-stationary and Non-stationary Models
11) Th 02/16	Estimation of AR Models I: likelihood function, Bayesian inference known variance.
12) Tu 02/21	Estimation of AR Models II: Bayesian inference unknown variance, marginal likelihood.
13) Th 02/23	Estimation of AR Models III: lag length selection, model averaging, adding deterministic trend components, forecasting
14) Tu 02/28	Forecast Evaluation: point forecasts, interval forecasts, density forecasts, real time data
15) Th 03/02	MIDTERM

Date	Topic
	Spring Break!
16) Tu 03/14	Linear State-Space Models I: Specification, Kalman filter, likelihood function
17) Th 03/16	Linear State-Space Models II: filtering versus smoothing
18) Tu 03/21	Gibbs Sampling I: introduction
19) Th 03/23	Gibbs Sampling II: estimation of linear state-space model
20) Tu 03/28	Applications I: ARMA model and time-varying coefficient model
21) Th 03/30	Applications II: factor models, GDP plus
22) Tu 04/04	Markov Switching Models: specification, likelihood, inference
23) Th 04/06	Structural Breaks Models: change-point models
24) Tu 04/11	Time-varying Heteroskedasticity I: ARCH and GARCH
25) Th 04/13	Time-varying Heteroskedasticity II: stochastic volatility
26) Tu 04/18	Vector Autoregressions I
27) Th 04/20	Vector Autoregressions II
28) Tu 04/25	FINAL EXAM