Econ 226
Bayesian and Numerical Methods
James D. Hamilton, UCSD
Spring 2009

SCHEDULE

Class meets Tuesdays and Thursdays 8:00 - 9:20 a.m., Tuesday March 31 - Thursday June 4 in Econ 304
No class Thursday April 2 or Tuesday May 19
Office hours: Tuesdays 9:30 - 10:30 a.m. in Econ 307 and by appointment (jhamilton@ucsd.edu)

GRADES

Grades for the course will be determined as follows. 35% will be based on an in-class exam held on Thursday, May 7, 8:00 - 9:20 a.m. The remaining 65% will be based on either a second in-class exam (to be Thursday, June 11, 8:00 - 11:00 a.m.) or a paper (due Wednesday, June 10). Whether a student opts to take the exam or write a paper is up to the student. The paper would need to be an empirical project applying methods discussed in the course to an original research question.

BOOKS

Many of the readings can be found in the following three books:

Greenberg: Edward Greenberg, *Introduction to Bayesian Econometrics,* Cambridge University Press, 2008.

TSA: James D. Hamilton, *Time Series Analysis*, Princeton University Press, 1994.

SSM: Chang-Jin Kim and Charles R. Nelson, *State-Space Models with Regime Switching*, MIT Press, 1999.

In addition, copies of the slides used in some of the lectures will periodically be linked from the course web page (check for last-minute updates before class) at:

http://dss.ucsd.edu/~jhamilto/Econ226.html

COURSE OUTLINE

I. Bayesian econometrics

A. Introduction

Greenberg,, Chapter 2
TSA, Section 12.1
Morris H. DeGroot (1970), *Optimal Statistical Decisions*, McGraw-Hill, Chapter 6, and Sections 9.1-9.6
Bradley Efron and Carl Morris (1975) "Data Analysis Using Stein's Estimator and Its Generalizations," *Journal of the American Statistical Association* vol. 70, pp. 311-319

B. Bayesian inference in the univariate regression model

SSM, Sections 7.1 and 7.2
TSA, Section 12.2
Greenberg, Chapter 4

C. Statistical decision theory

Greenberg, Chapter 3
Mark J. Schervish (1995), *Theory of Statistics,* Chapter 3, Springer-Verlag.

D. Large sample results

Tony Lancaster (2004), *An Introduction to Modern Bayesian Econometrics,* Chapter 1, Blackwell.
Mark J. Schervish (1995), *Theory of Statistics,* Section 7.4, Springer-Verlag.

E. Diffuse priors

Mark J. Schervish (1995), *Theory of Statistics,* pp. 121-123, Springer-Verlag.
DeGroot, Morris H. (1970), *Optimal Statistical Decisions,* Chapter 10, McGraw-Hill.

F. Numerical Bayesian methods

Greenberg, Chapters 5-8
A.F.M. Smith and A.E. Gelfand (1992), "Bayesian Statistics Without Tears: A Sampling-Resampling Perspective," *American Statistician* vol. 46, pp. 84-88.
SSM, Sections 7.3 and 7.4
Siddhartha Chib and Edward Greenberg (1996), "Markov Chain Monte Carlo Simulation Methods in Econometrics," *Econometric Theory* 12, pp. 409-431.
Siddhartha Chib (1995), "Marginal Likelihood from the Gibbs Output," *Journal of the American Statistical Association,* 90, pp. 1313-1321.
James D. Hamilton, Daniel F. Waggoner, and Tao Zha (2007), "Normalization in Econometrics," *Econometric Reviews*, vol 26, no 2-4, pp. 221-252.

II. Vector autoregressions

A. Introduction

TSA, Section 11.6, pp. 324-336

B. Normal-Wishart priors for VARs

K. Rao Kadiyala and S. Karlsson (1997) "Numerical Methods for Estimation and Inference in Bayesian VAR-models," *Journal of Applied Econometrics* vol. 12, pp. 99-132.

John Geweke (1988), "Antithetic Acceleration of Monte Carlo Integration in Bayesian Inference," *Journal of Econometrics* vol. 38, pp. 73-89.

C. Bayesian analysis of structural VARs

Christopher A. Sims and Tao Zha (1998) "Bayesian Methods for Dynamic Multivariate Models," *International Economic Review* vol. 39, pp. 949-968.

D. Identification using inequality constraints

Harald Uhlig (2005), "What Are the Effects of Monetary Policy on Output? Results from an Agnostic Identification Procedure," *Journal of Monetary Economics*, 52(2), pp. 381-419.

E. Integrating VARs with dynamic general equilibrium models

Marco del Negro and Frank Schorfheide (2004), "Priors from General Equilibrium Models for VARS," *International Economic Review* 45, pp. 643-673.

F. Selecting priors for DSGEs

Marco del Negro and Frank Schorfheide (2008), "Forming Priors for DSGE Models (and How It Affects the Assessment of Nominal Rigidities)", *Journal of Monetary Economics,* 55, no. 7, pp. 1191-1208.

III. Linear state-space models.

A. State-space representation of a dynamic system

TSA, Section 13.1.

B. Kalman filter

TSA, Section 13.2

C. Using the Kalman filter

TSA, Sections 13.3-13.6

Maximo Camacho and Gabriel Perez-Quiros (2008) "Introducing the Euro-Sting: Short Term Indicator of Euro Area Growth," working paper, Bank of Spain (http://www.bde.es/informes/be/docs/dt0807e.pdf)

D. Bayesian analysis of linear state-space models

SSM, Chapter 8

E. Solutions to linear rational expectations models

Olivier Jean Blanchard and Charles M. Kahn (1980), "The Solution of Linear Difference Models under Rational Expectations," *Econometrica* 48, pp. 1305-1317.

Robert G. King and Mark W. Watson (1998), "The Solution of Singular Linear Difference Systems under Rational Expectations," *International Economic Review* 39, pp. 1015-1026.

Paul Klein (2000), "Using the Generalized Schur Form to Solve a Multivariate Linear Rational Expectations Model," *Journal of Economic Dynamics and Contro*, 24, pp. 1405-1423.

Christopher Sims (2001), "Solving Linear Rational Expectations Models," *Journal of Computational Economics*, 20(1-2), pp.1-20.

F. Using the Kalman filter to estimate dynamic stochastic general equilibrium models

Frank Smets and Raf Wouters (2003), "An Estimated Dynamic Stochastic General Equilibrium Model of the Euro Area," *Journal of the European Economic Association* 1, pp. 1123-1175.

Jean-Philippe Laforte (2007), "Pricing Models: A Bayesian DSGE Approach for the US Economy," *Journal of Money, Credit and Banking,* 39, pp. 127-154.

Christopher Otrok (2001), "On Measuring the Welfare Cost of Business Cycles," *Journal of Monetary Economics* 47, pp. 61-92.

Frank Smets and Raf Wouters (2005), "Comparing Shocks and Frictions in USW and Euro Area Business Cycles: A Bayesian DSGE Approach," *Journal of Applied Econometrics* 20, pp. 161-183.

Marco del Negro, Frank Schorfheide, Frank Smets, and Rafael Wouters (2007), "On the Fite of New Keynesian Models," *Journal of Business and Economic Statistics* pp. 123-143.

IV. Markov-switching models

A. Introduction to Markov-switching models

Marcelle Chauvet and James D. Hamilton (2006), "Dating Business Cycle Turning Points," in *Nonlinear Analysis of Business Cycles*, edited by Dick van Dijk , Costas Milas, and Philip Rothman

TSA, Chapter 22

B. Bayesian analysis of Markov-switching models

SSM, Chapter 9

Filardo, Andrew J., and Stephen F. Gordon (1998), "Business Cycle Durations," *Journal of Econometrics*, 85, pp. 99-123

C. State-space models with Markov switching.

SSM, Chapter 10

D. Panel models with Markov switching

James D. Hamilton and Michael T. Owyang (2009), "The Propagation of Regional Recessions," working paper.

V. Estimation of continuous-time models

Ola Elerian, Siddhartha Chib and Neil Shephard , "Likelihood Inference for Discretely Observed Nonlinear Diffusions,"*Econometrica*, (2001), 69, 959-994

VI. Spatiotemporal models

Christopher K. Wikle, L. Mark Berliner, and Noel Cressie, "Hierarchical Bayesian Space-Time Models," *Environmental and Ecological Statistics,* (1998), 5, pp. 117-154.

Jonathan R. Stroud, Peter Müller, and Bruno Sansó, "Dynamic Models for Spatiotemporal Data," *Journal of the Royal Statistical Society, Series B*, (2001), 63, part 4, pp. 673-689.

Christopher K. Wikle, Ralph F. Milliff, Doug Nychka, and L. Mark Berliner, "Spatio-Temporal Hierarchical Bayesian Modeling: Tropical Ocean Surface Winds," *Journal of the American Statistical Association,* (Sept. 2000) 96, pp. 382-397.

VII. Time-varying variances

A. Overview

TSA, Chapter 21

Hamilton, James D. (2009), "Macroeconomics and ARCH," forthcoming in *Festschrift in Honor of Robert F. Engle*, edited by Tim Bollerslev, Jeffry R. Russell and Mark Watson

B. Extensions

TSA, Chapter 21

C. Markov-switching GARCH

Hamilton, James D., and Raul Susmel (1994), "Autoregressive Conditional Heteroskedasticity and Changes in Regime," *Journal of Econometrics* 64, 307-333.

Gray, Stephen F. (1996), "Modeling the Conditional Distribution of Interest Rates as a Regime-Switching Process," *Journal of Financial Economics* 42, 27-62.

Haas, Markus, Stefan Mittnik, and Marc Paolella (2004), "A New Approach to Markov-Switching GARCH Models," *Journal of Financial Econometrics* 2, 493-530.

D. Stochastic volatility

Kim, Sangjoon, Neil Shepherd, and Siddhartha Chib (1998), "Stochastic Volatility: Likelihood Inference and Comparison with ARCH Models," *Review of Economic Studies,* 65, 361-393

Siddhartha Chib, Federico Nardari and Neil Shephard (2002), "Markov Chain Monte Carlo Methods for Stochastic Volatility Models", *Journal of Econometrics*, 108, 281-316

VIII. Model selection

Greenberg, Sections 3.2.4 and 7.1.2.

Schwarz, Gideon (1978), "Estimating the Dimension of a Model," *Annals of Statistics* 6, 461-464.

Cavanaugh, Joseph E., and Andrew A. Neath (1999), "Generalizing the Derivation of the Schwarz Information Criterion," *Communications in Statistics: Theory and Methods*, 28, 49-66.