

Preliminary Course Outline and Reading List

This outline lays out the topics that we should try to cover in this course. Probably we can't cover them all. Parts of the outline are more detailed, with specific references, because they correspond to material from previous versions of this course. The less detailed parts of the outline will be filled in, and there may be some pruning of topics in the final version of the outline, which should be available at the first lecture.

Kallenberg (2002) is an advanced, thorough, account of probability and stochastic process theory. It assumes solid grounding in real analysis and measure theory. It is listed here only as a reference, for students whose mathematical background is strong and may want to pursue topics in this course at a more advanced or rigorous level. The Hamilton (1994) book covers many of the models used in time series econometrics and that we will deal with in this class. Hamilton proceeds more slowly through the material than we will in this class and he gives more emphasis to non-Bayesian asymptotic theory of inference than we will (and less to Bayesian inference). The Bauwens, Lubrano, and Richard (1999) book is closer in approach to this course than is Hamilton's but because of its variations in mathematical level and choice of topics only parts of it are assigned reading. The Hamilton book is recommended for purchase. The other two have been ordered at the PU store in small quantities for those who may be interested in them.

This course assumes that you are familiar with the basic ideas of Bayesian inference, at the level covered in the first part of ECO517 last year. If you have not had much previous exposure to Bayesian ideas, you might consult the web site for last year's version of 517 (<http://sims.princeton.edu/yftp/emet04>) and/or any of the books Schervish (1995), Robert (1994), Bernardo and Smith (2000), Lancaster (2004) and Gelman, Carlin, Stern, and Rubin (1995). They have somewhat different choices of topics and assume varying levels of mathematical background, with Schervish the most demanding and Lancaster or Gelman et al the least, in this respect.

There will be exercises that assume you are able to use a programming language like S, R, Matlab, or possibly Mathematica, to carry out matrix algebra calculations and to run iterative algorithms. R is free, open-source software. It is almost identical, as a language, to S, but has little or no graphical interface. S and Matlab are available on the departmental computer cluster and on the university's network servers `hats.princeton.edu` and `arizona.princeton.edu`. If you use, or want to try, R, good references are Venables and Ripley (2001) and Venables and Ripley (2002). A few copies of these are on order at the PU store.

1. Stochastic processes

- (a) Probability as (S, \mathcal{F}, μ) triple.
- (b) Conditional expectation, conditional probability

- (c) Discrete and continuous time processes
- (d) i.i.d discrete time processes
- (e) First finite-parameter family of processes: Discrete time Gaussian MA processes; their likelihood; uniqueness.
- (f) The Wiener process; the Poisson process.
- (g) Martingales, semi-martingales
- (h) Stochastic integrals
- (i) Second finite-parameter family of processes: Ornstein-Uhlenbeck continuous time processes; multivariate generalizations.

2. Fourier analysis

- (a) Convolution, or filtering, in continuous and discrete time
- (b) Continuous, discrete, and finite Fourier transforms
- (c) Lag operators, derivative operators and their Fourier transforms
- (d) The complex normal distribution
- (e) The complex-valued Wiener process
- (f) The complex-valued, conjugate-symmetric, 2π -periodic, Wiener process as the FT of a discrete-time i.i.d. process.
- (g) Third finite-parameter family of processes: Inverse FT's of periodic martingales with finitely many, known, jump points: periodic and quasi-periodic processes.

3. General Gaussian stationary processes

- (a) Autocovariance function
- (b) Spectral density
- (c) Ergodicity
- (d) Mixing conditions
- (e) Seasonality
- (f) Time aggregation

4. The ARMA family of processes

- (a) AR processes
- (b) MA processes
- (c) Density in the Gaussian stationary class
- (d) One-sided inversion of convolution operators.
- (e) Innovations, fundamental MA representation.
- (f) Linearly deterministic and linearly regular processes, the Wold decomposition

5. Inference for ARMA models: The Kalman filter.

- (a) Initialization

- (b) AR coefficients as states
- (c) Lagged innovations in MA models as states
- (d) The Kalman filter as a component of likelihood-based inference
- (e) Smoothing vs. filtering

6. High-order and multivariate AR models

- (a) Review of multivariate linear stochastic difference equations
 - i. Roots to qualitatively characterize models
 - ii. Impulse response functions
 - A. Impulse responses vs. ACF's as data summaries
- (b) Exogeneity, Granger causality, Wold and Granger causal orderings
- (c) Structural VAR's and identification
 - i. Delay restrictions
 - ii. Long run restrictions
 - iii. Restrictions on impulse responses
- (d) Stochastic volatility and GARCH
- (e) Factor models

(Hamilton, 1994, Chapters 10.1-10.3)

7. Importance Sampling, Metropolis-Hastings MCMC

- (a) Importance sampling and its pitfalls
- (b) Metropolis Markov Chains and their pitfalls
- (c) Metropolis-Hastings
- (d) "Gibbs" Sampling
- (e) Assessing convergence
- (f) Application to factor models, stochastic volatility

(Hamilton, 1994, section 12.3)

Gelman, Carlin, Stern, and Rubin (1995), Chapter 11

Notes: "Proof of Fixed Point Property for Metropolis Algorithm"

8. ARMA models nonlinear in parameters: Linearized DSGE models.

9. Hidden Markov chain and non-recurrent break models

- (a) Structural breaks
- (b) Regime shifts
- (c) Approximation to parameter change and stochastic volatility models

Hamilton (1994), Chapter 22
Chib (1996)

10. Modeling initial conditions and “trend”

- (a) High-order AR + conditioning on initial conditions + flat prior \Rightarrow belief in likely historical uniqueness of sample start date
- (b) Unit roots
- (c) Cointegration
- (d) Fractional integration
- (e) Realistic modeling of uncertainty about the long run vs. “removing trend”.

(Sims, 2000)
(Sims, 1989)
(Sims, revised 1996)
(Hamilton, 1994, section 19.1)

11. Dummy-observation priors for VAR’s

(Sims and Zha, 1998)
Notes: Dummy observation priors

12. Inference: formulating, using, testing restrictions or priors on VAR’s

- (a) Recursiveness restrictions
 - i. Exogeneity and likelihood structure
(Bauwens, Lubrano, and Richard, 1999, sections 2.6, 5.2.1-2)
- (b) Priors and restrictions for structural VAR’s
 - i. Litterman/Leeper/Sims/Zha
 - ii. Long run restrictions
 - iii. Priors on impulse responses
 - iv. Reduced form vs. structural parameters as space for prior
 - v. Error bands for impulse responses

(Hamilton, 1994, Chapters 11, and 9, section 12.2)
Notes: “Granger Causality” (There is some redundancy between these notes and the set below.)
Notes: Likelihood for VAR systems
Blanchard and Quah (1989)
Leeper, Sims, and Zha (1996)
Sims and Zha (1998)
Sims and Zha (1999)

13. Inference: Asymptotic theory

- (a) Central limit theorems and functional central limit theorems
- (b) Bayesian and sampling theory asymptotics: differences and connections
- (c) Asymptotics do not free us from assumptions
- (d) Asymptotics for nonstationary models

14. Panel data VAR's

Canova and Ciccarelli (2001)

15. Data summary vs. structure

- (a) Structural models vs. "reduced form" models
- (b) Calibration vs. "estimation"
- (c) Looking for a true model vs. characterizing flaws of false models

(Schorfheide, 2000)

(Sims, 1996)

(Rissanen, 2001, optional)

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