30661-01 Advanced Time Series Analysis

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Outline

The lecture introduces Bayesian econometrics, with a particular focus on time series analysis, from univariate to multivariate high-dimensional.

The primary goal in Bayesian inference is to derive the posterior distribution of an object of interest, being usually parameters or some latent variables. Therefore, in a first part we define the basic components specifying the Bayesian setup, the prior and the likelihood, and discuss principles of posterior updating. As for most econometric models the posterior distribution is not of a known standard form nor available in analytical form, the posterior distribution is approximated or estimated by sampling methods. We introduce two generic samplers based on Markov chain Monte Carlo (MCMC) simulation methods to estimate the posterior distribution: Metropolis-Hastings and Gibbs sampling.

Bayesian inference inherently lends itself to a probabilistic interpretation or discussion of model estimates. To quantify uncertainty, we derive procedures to obtain credible intervals, for parameters as well as (non)linear transformations of parameters. Finally, we also discuss approaches to perform model choice or (forecast) evaluation, like MCMC-based estimation of the marginal likelihood or K-fold cross-validation. The Bayesian approach circumvents estimation difficulties when either data is scarce or high-dimensional. To deal with these issues, we discuss ways of specifying informative prior distributions and prior distributions that induce shrinkage into parameters. In a last part, we introduce latent variables which allow extending models to regime-switching parameters or extracting a small number of common factors from high-dimensional datasets.

The lecture also includes the analytical discussion of time series models. We derive properties of the time series process, discuss stationarity and invertibility conditions, derive conditional and unconditional moments. As single parameters are not of prime interest, tools like impulse responses and variance decomposition are used to interpret multivariate time series models. We discuss various strategies of structural identification.

The lecture includes exercise sessions with applications in time series modelling.

Content

1. Introduction
   - Comparison between frequentist and Bayesian inference
   - Topics and notation
   - Review on probability distributions

2. Bayesian approach
    - Intuition: Probability to quantify uncertainty, inference based on probability rules
    - Prior distribution, likelihood and posterior distribution
    - Markov chain Monte Carlo methods, posterior evaluations
    - Credible intervals
    - Model choice and (forecast) evaluation
3. Informative prior distributions and latent variables
    - Minnesota prior distribution
    - Inducing shrinkage
    - Analytical framework: Kalman filter
    - Data augmentation

Literature

Gelman A., Carlin J.B., Stern H.S. and Rubin, D.R. (1995), *Bayesian Data Analysis*, Chapman and Hall, London.
Greenberg Edward, 2013, *Introduction to Bayesian Econometrics*, Cambridge University Press, Cambridge UK.
Hoff, Peter D. (2009), *A first Course in Bayesian Statistics*, Springer, New York.
Lütkepohl Helmut, 2006, *New Introduction to Multiple Time Series Analysis*, Springer, Berlin Heidelberg.
Neusser Klaus, 2016, *Time Series Econometrics*, Springer International Publishing AG Switzerland.

Popular scientific: Bertsch Mcgrayne Sharon, 2011, *The theory that would not die: how bayes' rule cracked the enigma code, hunted down russian submarines, and emerged from two centuries of controversy*, Yale University Press, New Haven & London.

Timetable

Wednesday 14.15-15-45, 16.15-17.45; S15 HG31.
Dates: 6.3.,20.3.,27.3.,10.4.,17.4.,8.5.,22.5.

Grade

Weight	
40%	Two assignments (team work of 3-5 persons) Deadlines: April 30, May 31
60%	Written exam (open book)