30661-01 Advanced Time Series Analysis

Sylvia Kaufmann **FS25**

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, notation, probability axioms and review on probability distributions

2. Elements for the Bayesian approach

   Prior distribution, data likelihood, derivation of the posterior distribution, properties of the posterior distribution and prediction

3. Bayesian analysis of regression models

   Univariate time series model, Bayesian framework and posterior analysis, formulating prior distributions, multivariate models: vector autoregression (VAR)

4. Posterior approximation

   Monte Carlo approximation, Markov chain Monte Carlo: Gibbs and Metropolis-Hastings sampling, principles for MCMC simulations and diagnostics, posterior evaluations, credible intervals, model choice and (forecast) evaluation

5. Bayesian VAR modelling

   Minnesota prior, posterior update, interpretation and analysis of VARs: impulse responses and forecast error variance decomposition, structural identification

6. Hierarchical modelling and latent variables

   Shrinkage, t-distributed error terms, 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
Dates: 19.3., 26.3., 2.4., 9.4., 23.4., 7.5., 21.5.
Room: see here

Grade

Weight	
40%	Two assignments (team work of 3-5 persons) Deadlines: April 25, May 23
60%	Written exam (open book)