Econometric Institute and Princeton University Press

organize the

Intensive PhD-course:

"Complete and Incomplete Econometric Models"

by

Professor John Geweke
University of Iowa

Tuesday, June 10 – Friday, June 13, 2008

This intensive four-day PhD course consists of three parts. The three lectures of prof. John Geweke constitute the main ingredient of this course. These will be preceded by a set of introductory lectures on modern Bayesian inference and simulation methods by prof. Herman K. van Dijk and dr. Lennart Hoogerheide. The third part of this course is a workshop where eight speakers will present recent developments in Bayesian inference.

Venue: Erasmus University Rotterdam, Burg. Oudlaan 50, J1-50
Please register by sending an e-mail to Elli Hoek van Dijke (hoekvandijke@few.eur.nl) before June 5.

Vereniging Trustfonds
Erasmus Universiteit Rotterdam

Lecture Scheme:

June 10

10.00-12.00 hours: Lecture by Herman van Dijk

13.00-15.00 hours: Lecture by Lennart Hoogerheide

June 11

10.00-12.00 hours: Lecture by Herman van Dijk

13.00-15.00 hours: Lecture by John Geweke

June 12

10.00-12.00 hours: Lecture by Lennart Hoogerheide &
David Ardia

13.00-15.00 hours: Lecture by John Geweke

June 13

9.00-17.00 hours: workshop with 8 speakers
keynote lecture by John Geweke

Outline of Lectures by John Geweke

June 11 Lecture: The Uses and Limitations of Complete Econometric Models

Bayesian statistics provides a unified and coherent approach to inference that, with the advent of simulation methods, is also very practical. The key to both its elegance and its applicability is the specification of the joint distribution for observables (data), unobservables (latent variables as well as parameters) and vectors of interest (e.g., things that will be observed in the future, and more generally anything that enters a loss function). If this distribution is extended to include all models that will be considered, there is also a tidy theory of model comparison and combination. This lecture will concentrate on some powerful practical tools for understanding models and their applicability that emerge from this framework, but have not yet been fully appreciated in applied econometrics. Examples include predictive likelihoods and prior predictive analysis. It will conclude by introducing both the limitations and potential of Bayesian methods when the investigator is entertaining but has not yet fully specified a model.

Background reading: The material presented at the introductory lectures bij Van Dijk and Hoogerheide, and some material on prior predictive distributions; see Geweke (2005), pp. 262-271, and Lancaster (2004), pp. 79-88.

Geweke, J. (2005). *Contemporary Bayesian Econometrics and Statistics*. John Wiley & Sons.

Lancaster, T. (2004). *An Introduction to Modern Bayesian Econometrics*. Blackwell Publishing.

June 12 Lecture: Incomplete Econometric Models and their Application

An econometric model can be incomplete for a variety of reasons. Examples include incomplete specification of the distribution of observables conditional on unobservables, and failure to specify part of the prior distribution. These situations arise when the investigator has begun to entertain but has not yet fully articulated a model. We will examine two types of situations that are common in econometric practice. The first arises when a model is intended to describe only certain properties of the data, for example low-order moments but not a full distribution. Since population moments are never observed, this presents a problem for inference. The lecture will show how such as incomplete

model can be combined with a second incomplete model to provide a fully Bayesian solution of commonly arising calibration problems. The second situation arises when all models under consideration appear to be poorly specified ex post – for example, none may account well for an aspect of the data considered to be important. We will consider posterior predictive analysis as a tool for discovering some of these problems, examine its limitations, and then introduce an alternative approach using an incomplete model to represent models not yet fully formulated.

Background reading: Geweke (2007, American Economic Review Papers and Proceedings), and the working paper "Models, Computational Experiments and Reality" by John Geweke, available at http://www.biz.uiowa.edu/faculty/jgeweke/papers.html

Geweke, J. (2007). Bayesian Model Comparison and Validation. *American Economic Review Papers and Proceedings*, May 2007, pp. 60-64.

June 13 Keynote: Bayesian Model Improvement

Bayesians undertake inference conditional on observed outcomes of random variables, and on a set of assumptions that fully specifies the joint distribution of these random variables and quantities of interest. What happens when the Bayesian not only believes (with George Box) that "All models are false" but that none of the models at his disposal is very good? Can they still be useful? This lecture takes up this problem in the context of constructing predictive distributions. It introduces the use of a portfolio of prediction models and develops the theory of an optimal prediction portfolio. The share of a model in an optimal portfolio has nothing to do with its posterior probability: in fact, models whose posterior probability becomes zero asymptotically still enter with weights that converge to positive numbers as sample size increases. Some examples using daily return financial data show that portfolios of prediction models can yield substantial improvements in prediction compared with conventional Bayesian model combination.

Outline of four introductory lectures on modern Bayesian inference and simulation methods

by Herman van Dijk and Lennart Hoogerheide

Topic (1): Introduction to Bayesian inference

We will provide a concise introduction to Bayesian inference. We start with a motivation for Bayesian inference, consider Bayes' rule and important terminology (e.g. prior, likelihood, posterior, predictive density, Jeffreys' prior density). A clear comparison of classical and Bayesian inference is considered. Further, Bayesian model selection (highest posterior density region, posterior odds) and Bayesian forecasting will be discussed.
The concepts (such as the principle of "Bayesian learning") will be illustrated with basic econometric examples such as the linear regression model and simple time series models for US real GNP growth.

Topic (2): Monte Carlo integration – the importance of simulation methods in Bayesian inference

We will discuss the usefulness of Monte Carlo integration in the context of Bayesian inference. Several sampling methods will be considered. First, basic direct sampling methods (uniform sampling, inversion method, transformed sampling) will be briefly discussed. Next, attention will be paid to importance sampling, the Metropolis-Hastings algorithm, and Gibbs sampling (with data augmentation).
The application of these simulation methods will be illustrated in basic, canonical econometric models such as the probit/logit model.

Topic (3): Advanced concepts in simulation based Bayesian inference

We will consider methods that can be used to assess the convergence of simulation results. A related concept is the numerical standard error, which reflects the uncertainty that stems from using (pseudo-) random draws.
We further show that ill-behaved (or even improper) posteriors with non-elliptical shapes may appear in models where local non-identification of (some of) the parameters plays a role. This may cause several simulation methods to "crash" or converge extremely slowly.

A related topic is the choice of a prior in such a way that no ill-behaved posterior distribution results, i.e. the choice of a "regularization" prior.

These concepts are illustrated in canonical models such as the instrumental variables (IV) regression model and the mixture model, where another sampling method, the permutation sampling method, can be useful.

Topic (4): Recent results on simulation based Bayesian inference

We will pay attention to advanced, recently developed simulation methods, where the candidate density for importance sampling or the Metropolis-Hastings algorithm is chosen in a clever way. The use of a flexible functional form (a mixture of Student's t densities) or a radial transformation (similar to a transformation to polar coordinates) forms the basis of robust and quick simulation methods that yield reliable and precise results, using relatively few (pseudo-) random draws.
Further subjects may include the efficient computation of the Value at Risk (VaR) by importance sampling, the use of a Dirichlet process prior where the proper number of components in a mixture model is "automatically" determined by the data, and Bayesian inference in (non-linear) GARCH models.

Course material of lectures by Van Dijk and Hoogerheide:

The four lectures will (partially) be based on Hoogerheide, Van Dijk & Van Oest (2008) and Hoogerheide & Van Dijk (2008):

Hoogerheide, L.F., Van Dijk, H.K., Van Oest, R.D. (2008). Simulation Based Bayesian Econometric Inference: Principles and Some Recent Computational Advances. Forthcoming chapter in *Handbook of Computational Econometrics.*

Hoogerheide, L.F., Van Dijk, H.K. (2008). Possibly Ill-behaved Posteriors in Econometric Models: On the Connection between Model Structures, Non-elliptical Credible Sets and Neural Network Simulation Techniques. Tinbergen Institute report 08-036/4.

Further we refer to selected chapters of:

Geweke, J. (2005). *Contemporary Bayesian Econometrics and Statistics*. John Wiley & Sons.

Greenberg, E. (2008). *Introduction to Bayesian Econometrics*. Cambridge University Press.

Koop, G. (2003). *Bayesian Econometrics*. John Wiley & Sons.

Lancaster, T. (2004). *An Introduction to Modern Bayesian Econometrics*. Blackwell Publishing.

Evaluation if required: MPhil and PhD students affiliated with the Tinbergen Institute can submit an assignment in consultation with dr. L. Hoogerheide.

Price: € 300
Participation is free for PhD students affiliated with the Tinbergen Institute and the Erasmus Research Institute of Management.

Course Material: A reader with relevant journal articles, working papers and lecture notes will be provided.

Registration: Please register by sending an e-mail to Elli Hoek van Dijke (hoekvandijke@few.eur.nl) before June 5.