University of Pennsylvania **Economics 722, Spring 2015**

Advanced Time-Series Econometrics

Instructor (Parts 1, 3):	Frank Schorfheide, Room 525, McNeil Building
	Email: *schorf@ssc.upenn.edu*
	Office Hours: Mondays 2:30-4:00 and by Appointment
Instructor (Parts 2, 3):	Francis DiTraglia, Room 535, McNeil Building
	Email: *fditra@econ.upenn.edu*
	Office Hours: Mondays 9:00-11:00a
Teaching Assistant:	Qiusha Peng
	Email: *qiusha@sas.upenn.edu*
	Office Hours: TBA

Scheduled Class Time and Organization: We will meet twice a week Tuesdays and Thursdays from 10:30a - 12:00n in Room 110, McNeil.

Course Description:

The course is designed as a sequel to Economics 706. Broadly speaking, we will study econometric models and methods that are useful to conduct substantive empirical research in macroeconomics. The first part of the course focuses on Bayesian analysis of vector autoregressions (VARs) and dynamic stochastic general equilibrium (DSGE) models. The second part of the course focuses on model selection as well as "big data" econometrics and machine learning.

Prerequisites: Economics 705 and 706 or equivalent graduate level econometrics.

Courseware: You can access the course materials via CANVAS. You can log-in from *http://upenn.instructure.com/*.

Cloud Computing: As part of this course, you will be given complimentary use of Amazon's Elastic Compute Cloud (EC2), courtesy of an AWS in Education Grant.

Course Requirements:

This is a research course! The goal is to lead students toward the current frontier in macroeconometrics and time series analysis.

- **Class Participation and Problem Sets [30%]**: There will be eight problem sets, assigned during the semester. Moreover, you are expected to carefully study the assigned readings and participate in classroom discussions.

- **In-Class Presentation [10%]:** We will assign you a current research paper related to the course topics. Most likely, this research paper will be an unpublished working paper. You have to write a referee report and give a 20-30 min presentation summarizing the main results in the paper.

- **Bug Squashing [5%]:** The first part of the course is based on a new book manuscript *Bayesian Estimation of DSGE Models*. You'll receive credit for pointing out errors and typos (in particular in formulas) and incomprehensible sentences.

- **Research Paper [55%]**: with strong econometric component (theoretical or empirical), related to one of the topics covered in class. A two page outline is due on May 15. The completed paper is due on on August 28. NO EXCEPTIONS!

  The paper does not have to constitute an original piece of research. For instance, it could be a replication of an existing empirical or Monte Carlo study; it could deviate from an existing study by using a different data set, e.g., data from a different country; it could be a Monte Carlo study that compares existing estimators or test procedures that have not been compared previously or it assesses these procedures under certain forms of misspecification (robustness analysis). The paper could also cover a topic in the area of theoretical econometrics.

- **Econometrics Workshop [extra credit]**: You are expected to attend the econometrics workshop, which takes place on Mondays from 4:30-6:00.

Please note: in order to receive credit you have to take the entire, full-semester course! Students who participate in class, submit decent solutions to all problem sets, and write a referee report and give a presentation on an assigned paper will receive a B- or a B at the end of the semester. To convert the B grade into an A grade, students must submit a research paper by August 28.

Course texts: Much of the first part of the course follows the book manuscript *Bayesian Estimation of DSGE Models* by Ed Herbst and Frank Schorfheide. The manuscript will be available through CANVAS. In addition there are two highly recommended texts: (1) *Oxford Handbook of Bayesian Econometrics* edited by J. Geweke, G. Koop, and H. van Dijk, 2011; and (2) *Contemporary Bayesian Econometrics and Statistics* by J. Geweke, 2005, Wiley & Sons.

For the second part of the course the recommended text is *Machine Learning: A Probabilistic Perspective* by Kevin Murphy, 2012. In addition we will refer to a long list of published articles and working paper in our lectures.

Course Outline and Schedule

Date	Topic
	Part 1: Bayesian Inference in VARs and DSGE Models
1) Th 01/15	Introduction to Bayesian Inference I: Linear regression model, point and interval estimates, comparison with frequentist inference.
2) Tu 01/20	Introduction to Bayesian Inference II: Testing, model selection, model averaging, direct sampling, importance sampling, rejection sampling
3) Th 01/22	Introduction to Bayesian Inference III: Some irregular cases: partial identification and unit roots.
4) Tu 01/27	Reduced-Form VARs: Direct sampling from posterior, Minnesota prior, data-driven hyperparameter selection, forecasting
5) Th 01/29	Structural VARs: Short-run and long-run identification schemes, sign restrictions, implementation of Bayesian inference.
6) Tu 02/03	Cointegration and Gibbs Sampling I: Bayesian inference in VARs with reduced-rank restrictions, convergence results and implementation issues for Gibbs samplers
7) Th 02/05	Cointegration and Gibbs Sampling II: Bayesian inference in VARs with reduced-rank restrictions, convergence results and implementation issues for Gibbs samplers
8) Tu 02/10	DSGE Modeling: Introduction, structure of DSGE models, solving linear and nonlinear rational expectation systems, likelihood evaluation
9) Th 02/12	Metropolis-Hastings Algorithm: Convergence results and applications to DSGE models.
10) Tu 02/17	Sequential Monte Carlo Methods: Convergence results and applications to DSGE models.
11) Th 02/19	Particle Filters for Nonlinear DSGE Models: Algorithms, convergence results, adaption.
12) Tu 02/24	Inference Based on Particle Filter Approximations: PMCMC and SMC^2
13) Th 02/26	DSGE Model Evaluation: Posterior odds comparisons, computation of marginal data densities, prior and posterior predictive checks

Date	Topic
	Part 2 (F. DiTraglia): Model Selection & "Big Data"
14) Tu 03/03	Computing for Econometrics I: Introduction to Version Control with `git`, `Rcpp` and `RcppArmadillo`
15) Th 03/05	Computing for Econometrics II: Linux command line basics, `tmux`, Parallel Programming in R, `StarCluster` and EC2 basics
	Spring Break!
16) Tu 03/17	Classical Model Selection I: AIC, TIC, Cross-Validation
17) Th 03/19	Classical Model Selection II: Corrected AIC, Mallow's C_p, Hannan-Quinn Information Criterion, Model Selection Asymptotics
18) Tu 03/24	Focused Model Selection: Triangular array asymptotics, Local Misspecification, the Focused Information Criterion
19) Th 03/26	Moment Selection: Review of GMM, GMM Information Criteria, Focused Moment Selection Criterion, Moment Average Estimators
20) Th 04/02	Multiple Testing / Forecast Evaluation
21) Tu 04/07	High-Dimensional Regression I: Review of QR decomposition and SVD, Shrinkage and the James-Stein Phenomenon, Ridge Regression, PCR
22) Th 04/09	High-Dimensional Regression II: LASSO, comparing Ridge and LASSO
23) Tu 04/14	Factor Models I: EM Algorithm, Classical Factor Analysis, PCA and PPCA, Dynamic Factor Models
24) Th 04/16	Factor Models II: Factors as IVs, FAVARS, Diffusion Index Forecasting
25) Tu 04/21	Bagging and Boosting (Time Permitting)
	Part 3 (F. DiTraglia and F. Schorfheide)
26) Th 04/23	Student Presentations I
27) Tu 04/28	Student Presentations II