**University of Pennsylvania** **Economics 722, Spring 2017**

# Advanced Time-Series Econometrics


**Instructor (Parts 1, 3)**: Frank Schorfheide, Room 525, McNeil Building
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Office Hours: Mondays 2:30–4:00 and by Appointment

**Instructor (Parts 2, 3)**: Francis DiTraglia, Room 535, McNeil Building
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Office Hours: Mondays 1:00–3:00pm and by Appointment


**Scheduled Class Time and Organization**: We will meet twice a week Tuesdays and Thursdays from 1:30p - 3:00p in Room 169, 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/*.

**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 [15%]:** 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 Most likely, this research paper will be an unpublished working paper.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.

- **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 12. The completed paper is due on on August 31. 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 Readings**: the following books are recommended:

**Part 1:**

Herbst, Edward and Frank Schorfheide (2015): *Bayesian Estimation of DSGE Models*, Princeton University Press.

Geweke, J., G. Koop, and H. van Dijk (2011, eds.): *Oxford Handbook of Bayesian Econometrics,* Oxford University Press.

**Part 2:**

Murphy, Kevin (2012): *Machine Learning: A Probabilistic Perspective*

In addition we will provide lecture notes and refer to a long list of published articles and working papers in our lectures.

## Course Outline and Schedule

| Date | Topic |
|---|---|
| | Part 1: Bayesian Inference in VARs and DSGE Models |
| 1) Th 01/12 | Introduction to Bayesian Inference I: Linear regression model, point estimation |
| 2) Tu 01/17 | Introduction to Bayesian Inference II: Interval estimation, model selection and averaging |
| 3) Th 01/19 | Introduction to Bayesian Inference III: Importance sampling. |
| 4) Tu 01/24 | Introduction to Bayesian Inference IV: Irregular cases: partial identification and unit roots. |
| 5) Th 01/26 | Reduced-Form VARs: Direct sampling from posterior, Minnesota prior |
| 6) Tu 01/31 | Reduced-Form VARs: data-driven hyperparameter selection, forecasting, VAR model extensions |
| 7) Th 02/02 | Reduced-Form VARs: data-driven hyperparameter selection, forecasting, VAR model extensions continued, Gibbs sampling |
| 8) Tu 02/07 | Structural VARs: Short-run and long-run identification schemes, sign restrictions, implementation of Bayesian inference. |
| 9) Th 02/09 | DSGE Modeling: Introduction, structure of DSGE models, solving linear and nonlinear rational expectation systems, likelihood evaluation |
| 10) Tu 02/14 | Metropolis-Hastings Algorithm: Convergence results and applications to DSGE models. |
| 11) Th 02/16 | Sequential Monte Carlo Methods: Convergence results and applications to DSGE models. |
| 12) Tu 02/21 | Particle Filters for Nonlinear DSGE Models: Algorithms, convergence results, adaption.<br>Inference Based on Particle Filter Approximations: PMCMC and $SMC^2$ |
| 13) Th 02/23 | 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 02/28 | Computing for Econometrics: Creating R Packages, Rcpp, Parallel R |
| 15) Th 03/02 | Model Selection I: AIC, TIC, Corrected AIC |
| | **Spring Break!** |
| 16) Tu 03/14 | Model Selection II: Mallow's $C_p$, Cross-validation, Time Series Examples |
| 17) Th 03/16 | Model Selection III: Focused Info. Criterion, Asymptotic Properties |
| 18) Tu 03/21 | Moment Selection I: Consistent Moment Selection, Andrews (1999) etc. |
| 19) Th 03/23 | Moment Selection II: Focused Moment Selection/Averaging, Inference |
| 20) Tu 03/28 | High-Dimensional Regression I: James-Stein, Ridge Regression, PCR |
| 21) Th 03/30 | High-Dimensional Regression II: LASSO |
| 22) Tu 04/04 | Factor Models I: Factor Analysis vs. PCA, High-dim. Factor Models |
| 23) Th 04/06 | Factor Models II: Diffusion Index Forecasting |
| 24) Tu 04/11 | Factor Models III: Factor Choice, Factors as IVs, Factor-Augmented VARs |
| 25) Th 04/13 | Multiple Testing / Tests of Predictive Accuracy (Time Permitting) |
| 26) Tu 04/18 | Additional Machine Learning Topics (Time Permitting) |
| | Part 3 (F. DiTraglia and F. Schorfheide) |
| 27) Th 04/20 | Student Presentations I |
| 28) Tu 04/25 | Student Presentations II |