Advanced Econometrics: Time Series Models
Syllabus: Version 5 (April 25, 2019)

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Lectures: Tue/Thu 10.40am–12.10pm, JRR 298
Office hours: Tue 1.30–2.30, JRR 282 (Plagborg-Moller)
Please sign up on http://wase.princeton.edu

Description. Concepts and methods of time series analysis and their applications to economics. Time series models to be studied include simultaneous stochastic equations, VAR, ARIMA, and state-space models. Methods to analyze trends, second-moment properties via the autocovariance function and the spectral density function, methods of estimation and hypothesis testing and of model selection will be presented. Kalman filter and applications as well as unit roots, cointegration, ARCH, and structural breaks models are also studied.

Prerequisites. ECO 517 and 518, or equivalent. Students from outside the Economics PhD program should contact the instructors to obtain permission to take the course.

Material. The course material is self-contained and there is no required textbook for the course. Handouts covering most of the material will be made available on the website. Some students might find it useful to have a textbook as an additional reference. Good reference books are:


This syllabus also includes a list of additional readings that are useful for a deeper understanding of the material. Many of these readings are available electronically.

**Homework.** Problem sets will be posted on the course website every one or two weeks. The due date will typically be one week after the assignment is posted. Problem sets should be printed out and handed in at the beginning of class on the due dates. Students are encouraged to collaborate on the problem sets, but answers and computer code must be typed up independently. Problem sets will be graded coarsely, i.e., a full score will be given as long as the work demonstrates dedication and thoughtfulness. The instructors reserve the right to subtract points for sloppy exposition, including unreadable code or poor document structure. If you find a grading error, please resubmit your problem set along with a one-paragraph explanation; the instructors reserve the right to re-grade the entire problem set.

**Exams.** The course will feature a final exam in the form of a 24-hour take-home exam. No collaboration is allowed on the final. Questions will be a mix of pen-and-paper exercises and coding.

**Grading.** The final course grade will be a monotonic function of the weighted average of (i) the average problem set score (40% weight) and (ii) the final exam score (60% weight).
**Code of conduct.** All course activities, including class meetings and homework assignments, are subject to the university’s academic code and code of conduct as detailed in the “Rights, Rules, Responsibilities” publication.

**Accommodations for students with disabilities.** Students must register with the Office of Disability Services (ODS) (ods@princeton.edu; 258-8840) for disability verification and determination of eligibility for reasonable academic accommodations. Requests for academic accommodations for this course need to be made at the beginning of the semester, or as soon as possible for newly approved students, and again at least two weeks in advance of any needed accommodations in order to make arrangements to implement the accommodations. Please make an appointment to meet with the instructor in order to maintain confidentiality in addressing your needs. No accommodations will be given without authorization from ODS, or without advance notice.

**Important dates.** These dates are preliminary. Changes will be announced via course email.

- Feb 5 (Tue): First class with M. Plagborg-Moller
- Mar 19 (Tue), Mar 21 (Thu): No class due to spring break
- Mar 26 (Tue): U. Müller takes over teaching
- Apr 23 (Tue): M. Plagborg-Moller resumes teaching
- May 2 (Thu): Last class
- May 13–14 (Mon): Final exam

**Outline for Plagborg-Moller’s part of the course.** The following outline, which covers only the first six and last two weeks of the course, is preliminary and may change without warning.

1. Stationary models.
   i) Covariance/strict stationarity.
   ii) Autocovariance function.
   iii) VARMA, stationarity, invertibility.
iv) Prediction, Granger/Sims causality, likelihood factorization.

v) VAR estimation, inference, stationary asymptotics.

vi) Bayesian VARs, Bernstein-von Mises theorem.

vii) Wold decomposition.

viii) Model selection.

2. Spectral analysis.

   i) Seasonality.

   ii) Approximation of arbitrary spectrum by AR/MA.

   iii) Periodogram smoothing.

3. Inference with weakly dependent data.

   i) Central Limit Theorem, martingale difference sequences, mixing.

   ii) Applications to GMM, moment matching.

   iii) Bootstrap.

4. State space models.

   i) Filtering, smoothing.

   ii) Linear case: Kalman filter, likelihood.

   iii) Estimation of DSGE models.

   iv) Regime switching (time permitting).

   v) Particle filter, Sequential Monte Carlo (time permitting).


   i) SVMA models.

   ii) Impulse responses, variance decompositions, historical decompositions.

   iii) Invertibility, SVAR models.

   iv) Local projection.

   v) Instruments/proxies, recoverability.

   vi) Set identification.
   
   i) Kernel estimators.
   
   ii) VAR-HAC.
   
   iii) Fixed-$b$ asymptotics.

   
   i) State space approach.
   
   ii) Principal components estimation.
   
   iii) Inference on number of factors.

8. Non-stationary models.
   
   i) I(1) processes, Beveridge-Nelson decomposition, VARIMA.
   
   ii) Spurious regression.
   
   iii) Bayesian vs. frequentist perspective.
   
   iv) Frequentist asymptotics for unit roots, local-to-unity.
   
   v) Detrending (time permitting).
   
   vi) Cointegration, VECM models (time permitting).
   
   vii) Müller-Watson long-run inference (time permitting).
Reading list for Plagborg-Moller’s part of the course

Introductory readings are listed first and marked with a star (*). Other readings are included for your reference. Original contributions are not always cited when good handbook/textbook references are available. The reading list is preliminary and may change without warning.

1 Stationary models

Models, inference, prediction

* Hayashi: chapters 6.1–6.4.

* Herbst and Schorfheide: chapters 3.1–3.2.

* Lütkepohl: chapters 2–3.

Brockwell and Davis: chapters 1.1–1.5, 2.1–2.9, 3.1–3.5, 5.1–5.5, 5.7, 11.1–11.4.

Hamilton: chapters 2–4, 10–12.

Kilian and Lütkepohl: chapters 2, 5.


Model selection


* Lütkepohl: chapter 4.

Brockwell and Davis: chapter 9.


**Applications**


### 2 Spectral analysis

**Representation theory and inference**

* Hamilton: chapter 6.

Brockwell and Davis: chapters 4, 10.1–10.5, 11.6.


**Applications**


3 Inference with weakly dependent data

Abstract theory

* Hayashi: chapters 2, 6.5.

Brockwell and Davis: chapters 6–7.


Hall and Heyde: chapter 3.

Hamilton: chapter 7.

GMM, moment matching

* Hayashi: chapters 7.1–7.4.


### Bootstrap

* Kilian and Lütkepohl: chapters 12.1–12.5.


### Applications


4 State space models

Linear state space models, DSGE estimation


* Herbst and Schorfheide: chapters 1–3.


Nonlinear filtering

Hamilton: chapter 22.4.


Markov Chain Monte Carlo


Herbst and Schorfheide: chapters 5, 8–9.


**Applications**


**5 Semi-structural identification and inference**

**Identification**


Kilian and Lütkepohl: chapters 4, 7–15, 17.


**Inference**


**Applications**


**6 Long-run variance estimation**

**Theory**

* Hayashi: chapter 6.6.


Applications


7 Dynamic Factor Models

Estimation and inference


Kilian and Lütkepohl: chapter 16.


Determining the number of factors


Applications


8 Non-stationary models

Unit roots

* Hayashi: chapter 9.

Hamilton: chapters 15–17.


**Detrending**


Cointegration

* Hayashi: chapter 10.

* Lütkepohl: chapters 6–8.


Long-run inference


Applications

