Advanced Econometrics: Time Series Models
Syllabus: Version 2h (October 23, 2017)

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Lectures:    Mon/Wed 10.40am–12.10pm, JRR 198
Office hours: Wed 2.30–3.45, JRR 282 (Plagborg-Moller)

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. However, answers should be typed up independently, and large chunks of code must not be shared among students. 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 take-home midterm, as well as the option to take a final exam or write a research paper. The take-home midterm will be posted a week before fall recess and due right after fall recess. No collaboration is allowed on the midterm. The final exam will focus primarily but not exclusively on the second half of the course. Students may elect to substitute the final exam with a final course paper. The final paper can be empirical, theoretical, or a mix, but it must represent a contribution to the academic literature. Any
student who wishes to write a final paper must submit a proposal to the instructors before Thanksgiving, and the proposal must be approved by the instructors by the last day of class. The final paper is due on the same date as the final exam.

**Grading.** The final course grade will be a monotonic function of the weighted average of (i) the average problem set score (30% weight), (ii) the midterm score (20% weight), and (iii) the final exam score or final paper score (50% 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 needing accommodations because of a documented disability should notify the instructors as soon as possible. Failure to do so may result in the instructors’ inability to respond in a timely manner. All discussions will remain confidential, although the instructor may contact the Office of Disability Services to discuss appropriate implementation.

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

- Sep 13 (Wed): First class with M. Plagborg-Moller
- Oct 23 (Mon): Last class with M. Plagborg-Moller, take-home midterm posted
- Oct 25 (Wed): First class with C. Sims
- Oct 30 (Mon), Nov 1 (Wed): No class due to Fall recess
- Nov 6 (Mon): Midterm due in class
- Nov 21 (Tue): Deadline for submission of final paper topic (optional)
- Nov 22 (Wed): No class due to Thanksgiving recess
- Dec 13 (Wed): Last class, deadline for approval of final paper topic (optional)
- Exam period (date TBA): Final exam, due date for final paper (optional)
Outline of the first half of the course. The first half of the course (taught by M. Plagborg-Møller) will cover classic building-block tools in time series econometrics, while the second half (taught by C. Sims) will move toward the research frontier. The following outline, which covers only the first half 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) Impulse response functions.
   
   v) Prediction, Granger/Sims causality, likelihood factorization.
   
   vi) VAR estimation, inference, stationary asymptotics.
   
   vii) Bayesian VARs, Bernstein-von Mises theorem.
   
   viii) Wold decomposition.
   
   ix) 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) Testing for serial correlation.
   
   iii) Applications to GMM.
   
   iv) Bootstrap.

   
   i) Testing for structural breaks.
5. Long-run variance estimation.
   i) HAC kernel estimators.
   ii) Fixed-\(b\) asymptotics.
   iii) VAR-HAC.

   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.
   vi) Cointegration, VECM models (time permitting).
   vii) Müller-Watson long-run inference (time permitting).
Reading list for the first half 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

* Hayashi: chapters 7.1–7.4.


**Bootstrap**

* Kilian and Lütkepohl: chapters 12.1–12.5.


**Applications**


4 Functional Central Limit Theorem

Abstract theory

Davidson: chapters 26–30.

Hall and Heyde: chapter 4.


Structural breaks


**Applications**


5 **Long-run variance estimation**

* Hayashi: chapter 6.6.


Applications


6 Non-stationary models

Unit roots

* Hayashi: chapter 9.

Hamilton: chapters 15–17.


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**Detrending**


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**Cointegration**

* Hayashi: chapter 10.

* Lütkepohl: chapters 6–8.


**Long-run inference**


**Applications**


