Advanced Econometrics: Time Series Models
Syllabus: Version 1 (January 25, 2021)

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Zoom lectures: Tue/Thu 10.40am–12.10pm
Office hours: By appointment
Website: https://princeton.instructure.com/courses/2055

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 auto covariance 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. There is no required textbook for the course. Handouts will be made available on the website. Attached to this syllabus is a list of optional readings that are useful for a deeper understanding of the material in the first half of the course.

Some students might find it useful to have a textbook as an additional reference. Good reference books include:


**Lectures.** The class will meet online on Zoom twice a week. Recordings of the meetings will be made available on the course website afterwards.

**Homework.** Problem sets will be posted on the course website approximately every one or two weeks. Problem sets should be submitted online in PDF form. Students are encouraged to collaborate on the problem sets, but answers and computer code must be typed up independently. The problem sets will be graded coarsely, i.e., a full score will be given as long as the work demonstrates dedication and thoughtfulness. We reserve the right to subtract points for sloppy exposition, including unreadable code. If you find a grading error, please resubmit your problem set along with a one-paragraph explanation; we reserve the right to re-grade the entire problem set.

**Exams.** The course will feature a midterm and a final exam. Both will be in the form of take-home exams to be submitted online. No collaboration is allowed on the midterm or final.

**Grading.** The final course grade will be a monotonic function of the simple average of the point scores in each half of the course. In each half, the point score is given by a weighted average of (i) the average problem set score (25% weight) and (ii) the midterm/final exam score (75% 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 2 (Tue): First class with M. Plagborg-Moller
Mar 11 (Thu): Last class with M. Plagborg-Moller
Date TBA: Take-home midterm exam
Mar 18 (Thu): First class with C. Sims
Apr 27 (Tue): Last class with C. Sims
Date TBA: Take-home final exam

Course outline: Feb 2 – Mar 11. The following outline is preliminary and may change without warning.

1. Refresher: Stationary models.
   i) Strict/covariance stationarity, projection.
   ii) Lag operators, linear filters, VARMA.
   iii) Wold decomposition.
   iv) Likelihood factorization, estimation.
   v) Model selection.

2. Spectral analysis.
i) Spectrum of linear filter.

ii) Estimation: sieve-VAR, periodogram smoothing.

3. Causal identification in macroeconomics.

   i) SVMA, SVAR, invertibility.

   ii) Identification through exclusion restrictions.

   iii) Local Projection versus VAR estimation of impulse responses.

   iv) Identification under potential non-invertibility.

   v) Identification using instruments/proxies.

   vi) Recoverability.

   vii) Partial identification through sign/magnitude restrictions.

   viii) Identification through non-Gaussianity/heteroskedasticity.

4. Inference with weakly dependent data.

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

   ii) Applications to GMM, moment matching.

   iii) Bootstrap.

5. Long-run variance estimation.

   i) VAR-HAC.

   ii) Spectral estimators.

   iii) Kernel estimators.

6. Dynamic factor models.

   i) State space approach.

   ii) Principal components.

   iii) Inference on number of factors.
Optional reading list

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, prediction, estimation

* Hayashi: chapters 6.1–6.4.

* Kilian and Lütkepohl: chapters 2.1–2.5.

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.

Herbst and Schorfheide: chapters 3.1–3.2.

Kilian and Lütkepohl: chapters 2, 5.

Model selection

* Kilian and Lütkepohl: chapter 2.6.

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 Causal identification in macroeconomics

Exclusion restrictions, instruments/proxies


Kilian and Lütkepohl: chapters 4, 7–12, 15.


**Invertibility, recoverability**


**Sign/magnitude restrictions**


Identification through non-Gaussianity/heteroskedasticity

* Kilian and Lütkepohl: chapter 14.


Applications


4 Inference with weakly dependent data

Abstract theory

* Hayashi: chapters 2, 6.5.
Brockwell and Davis: chapters 6–7.

Hamilton: chapter 7.


**GMM, moment matching**

* Hayashi: chapters 7.1–7.4.


**Bootstrap**

* Kilian and Lütkepohl: chapters 12.1–12.5.


**Applications**


5 Long-run variance estimation

**Theory**

* Hayashi: 6.5–6.6.

Brockwell and Davis: chapters 10.1–10.5, 11.6.


**Applications**


### 6 Dynamic factor models

**Estimation and inference**


**Determining the number of factors**


**Applications**
