E823 Advanced Time Series Analysis (Autumn 2024)

Instructor:

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Lecture Time:

Start: 02.09.; End: 05.12.
Monday: 3:30pm-5:00p in L7, 3-5, room P043
Thursday: 10:15am-11:45am in L7, 3-5, room 410

Course Description

The course will focus on multivariate time series models. After reviewing a few general concepts from probability theory and time series analysis, we will first deal with stable VAR models and their use for Granger causality, impulse response analysis, historical decompositions, and forecast error variance decompositions. To this end, we will also discuss important issues on asymptotic- and bootstrap-based inference.

Then, we deal with univariate unit root processes and introduce the relevant asymptotic approach for this set-up. In a next step, we turn to a treatment of multivariate unit root processes which are assumed to be integrated of order one, $I(1)$. Afterwards, we briefly introduce the concept of cointegration and learn how cointegration can be integrated into VAR framework leading to a so-called vector error correction model (VECM). As cointegration is not that popular anymore in empirical work, we will only summarize how to do appropriate inference in potentially cointegrated VARs with $I(1)$ variables.

If time permits, I would like to give an overview on estimating high-dimensional VARs and factor models in the last part of the course.

The course both addresses asymptotic analyses as well as implementation issues. Accordingly, tutorial sessions are also devoted to coding and empirical problems besides addressing theoretical problems.

In the last part of the course, participants introduce or discuss in more details (further) model classes by giving presentations and writing a paper. This year, I will provide a set of recent papers on network analysis using multiple time series approaches. This shall give an impression and overview on a recent strand in the literature.

Our course is complementary to the course offered by Matthias Meier. While the latter course focus on structural modeling approaches from an applied macro perspective, we take an econometric approach on multiple time series frameworks.

Pre-requisites

For participating in the course you have to pass Advanced Econometrics I-III. Accordingly, I expect participants to have a basic knowledge on univariate time series concepts, stable ARMA models, and unit root econometrics.

Lecture and Tutorial Sessions

Monday, 3.30-5pm, room P043 in L7, 3-5 and Thursday, 10:15-11:45am, room 410 in L7, 3-5.

Grading: Assignments, Presentations, Paper

Grading for this course will be based on three assignments (30%), one presentation (30%), and a paper (40%). The assignments will mostly involve theoretical questions but also cover empirical issues and practical implementations of the methods discussed in class. The grade for each assignment will be on a 0-10 scale: 10 excellent and 0 not handed in. The solutions and empirical output/programming code must be sent by email. Answers will be partly discussed in the tutorial sessions.

Presentations

The idea is that every participant acquires profound knowledge of a further model class or specific methods in the field of network analysis using multiple time series frameworks. We should discuss early on what is of most interest to you. I have reserved four slots for the presentations towards the end of the course.

Course Outline

1. Probability theory and time series analysis: a few concepts
2. Stable VARs: model framework, estimation, and specification
3. (Structural) VAR tools: Granger-causality, impulse response analysis, forecast error variance decompositions, historical decompositions
4. Bootstrap inference for impulse response analysis: bootstrap confidence intervals
5. Unit root econometrics
6. Multivariate I(1) processes
7. Cointegration, VEC models and inference in (potentially cointegrated) VARs
8. Estimation of high-dimensional VARs and dynamic factor models

Course Reading

Here, I only list the main references. I will provide detailed comments on the reading for each part of the course in separate documents. These also include additional references for a more detailed study of certain issues.

Brüggemann, R., Jentsch, C. and, Trenkler, C. (2016), Inference in VARs with conditional heteroskedasticity of unknown form, *Journal of Econometrics*, 191, 69-85.

Hansen, B.E. (2022), *Econometrics*, Princeton: Princeton University Press, Chs. 14-16.

Hamilton, J.D. (1994), *Time Series Analysis*, Princeton: Princeton University Press, Ch. 2-3, 5, 7-8, 15-20.

Kilian, L. and Lütkepohl, H. (2017), *Structural Vector Autoregressive Analysis*, Cambridge: Cambridge University Press, Ch. 2-4, 12.

Krampe, J., Kreiss, J., and Paparoditis, E. (2021). Bootstrap based inference for sparse high-dimensional time series models, *Bernoulli*, 27, 1441-1466.

Lütkepohl, H. (2005), *New Introduction to Multiple Time Series Analysis*, Berlin: Springer Verlag, Ch. 1-4, 6-9, 11-12, 15 Appendix D.

Stock, J.H. and Watson, M.W. (2016), Dynamic factor models, factor-augmented vector autoregressions, and structural vector autoregressions in macroeconomics. In *Handbook of Macroeconomics*, Volume 2, Chapter 8. Elsevier.

White, H. (2000), *Asymptotic Theory for Econometricians*, revised edn, San Diego: Academic Press

Lecture Plan

Here is a preliminary plan on how lectures, tutorials, and assignments are scheduled.

	Monday	Wednesday
Week 1: 02.09./05.09.	Lecture (Part 1)	Lecture (Part 1)
Week 2: 09.09./12.09.	Lecture (Part 1 & 2)	Lecture (Part 2)
Week 3: 16.09./19.09.	Lecture (Part 2)	Tutorial (PSet 1)
Week 4: 23.09./26.09.	Tutorial (PSet 1)	Lecture (Part 3)
Week 5: 30.09./ —	Lecture (Part 3)	Holiday
Week 6: 07.10./10.10.	Tutorial (Assign. 1, PSet 2)	Tutorial (Pset 2)
Week 7: 14.10./17.10.	Lecture (Part 3) Tutorial (Pset 3)	Lecture (Part 4)
Week 8: 21.10./24.10.	Lecture (Part 5)	Lecture (Parts 5 & 6)
Week 9: 28.10./31.10.	Lecture (Part 6)	Tutorial (PSet 4)
Week 10: 04.11./07.11.	Lecture (Part 7)	Tutorial (PSet 5, Assign. 2)
Week 11: 11.11./14.11.	Lecture (Part 8)	Lecture (Part 8)
Week 12: 18.11./21.11.	Lecture (Part 8)	Tutorial (Pset 6, Assign. 3)
Week 13: 25.11./28.11.	Presentations	Presentations
Week 14: 02.12./05.12.	Presentations	Presentations

Assignment 1: provided at 19.09., due at 30.09. at 10am via email
Assignment 2: provided at xx.xx., due at xx.xx. at 10am via email
Assignment 3: provided at xx.xx., due at xx.xx. at 10am via email

Papers for Presentations

Barigozzi, M. and Brownlees, C. (2019). NETS: Network estimation for time series. *Journal of Applied Econometrics*, 34(3): 347-364.

- Lasso estimation for sparse VAR models. Network analysis based on partial contemporaneous correlations and Granger Causality.

Barigozzi, M. and Hallin, M. (2017). A network analysis of the volatility of high dimensional financial series. *Journal of the Royal Statistical Society: Series C (Applied Statistics)*, 66(3): 581-605.

- Factor plus sparse VAR model framework. Consider FEVD- and Granger-causality-networks with respect to different model components.

Brownlees, C., Hans, C., and Nualart, E. (2021). Bank credit risk networks: Evidence from the Euro zone. *Journal of Monetary Economics*, 117(2): 585-599.

- Factor model with idiosyncratic component that has a sparse partial correlation structure representing a network. Lasso estimation.

Brownlees, C. and Meesters, G. (2021). Detecting granular time series in large panels. *Journal of Econometrics*, 220(2): 544-561.

- Factor model framework enriched by granular units whose idiosyncratic components influences other panel members.

Brownlees, C., Gudmundsson, G.S., and Lugosi,, G. (2022). Community Detection in Partial Correlation Network Models. *Journal of Business Economics and Statistics*, forthcoming.

- Introduces a class of partial correlation network models with a community structure for large panels of time series. Consider a generalised stochastic block model with latent groups such that correlation is higher within groups than between them.

Demirer, M., Diebold, F.X., Liu, L., and Yilmaz, K (2018). Estimating global bank network connectedness. *Journal of Applied Econometrics*, 33(1): 1-15.

- Extends Diebold and Yilmaz (2014) to high-dimensional VARs using Lasso as estimation approach.

Diebold, F.X. and Yilmaz, K. (2014). On the network topology of variance decompositions: Measuring the connectedness of financial firms. *Journal of Econometrics*, 182(1): 119-134.

- Seminal paper that interprets FEVDs as network weights. Considers small VARs.

Gudmundsson, G.S. and Brownlees, C. (2022). Detecting Groups in Large Vector Autoregressions. *Journal of Econometrics*, forthcoming.

- Introduces the stochastic block vector autoregressive model. The time series are partitioned into latent groups such that spillover effects are stronger among series that belong to the same group than otherwise.

Krampe, J., Paparoditis, E., and Trenkler, C. (2022). Structural inference in sparse high-dimensional vector autoregressions. *Journal of Econometrics*, forthcoming.

- Sparse VAR framework. Contains theory for inference on FEVDs