

FAU – School of Business, Economics and Society
Chair of Statistics and Econometrics
Multivariate time series analysis
Summer 2022 – Syllabus

Lecture: Wednesday, 08:00-09:30, room LG 4.109.

Exercise: Friday, 09:30-11:00, room LG 5.154 (1 July and 15 July: room LG 3.154).

Final examination: tba (by examination office)

Instructor:

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Overview: This course is an introduction to commonly used methods in multivariate time series analysis. The course will give students the theoretical knowledge and practical skills to apply the covered techniques in a wide range of empirical applications, mainly in macroeconomics (e.g., identification of monetary policy shocks) and financial econometrics (e.g., jointly modeling the returns of a portfolio of assets).

The course starts with a review of univariate time series issues. Students will learn how to model time series processes using the ARIMA framework. Subsequently, the course covers the basics of multivariate probability distributions and moves on to vectorautoregressive (VAR) models. Such models describe the joint behavior of multiple time series. Students will learn how to specify and estimate VAR models and how to apply various approaches for identifying the effects of different structural economic shocks (such as monetary policy shocks or uncertainty shocks). The course will also treat methods that one can use if various time series trend together over time (e.g., different stock market indices or GDP and private consumption in a particular country). Finally, the course covers the basics of multivariate GARCH models, which one can use to describe the volatility of vectors of financial return series.

Students should have solid knowledge of the basics of statistics and econometrics and will profit from prior experience with R or other econometric software packages although we do not require any prior programming skills.

Grading: Written exam (60 minutes).

Course requirements: Course participants are strongly advised to ...

- **Attend.** You can only fully benefit from this course if you attend both lectures and exercises regularly because the course content is highly cumulative, meaning that later topics rely heavily on stuff covered in the previous weeks. VAR models are, for instance, straightforward generalizations of univariate time series models.
- **Prepare.** Ideally, do the assigned readings before the lecture and come to class prepared to discuss them and to ask questions that you have.

- **Follow the website.** I will make course material available through the course website on StudOn. I will also make announcements using this platform.
- **Code.** Your learning gains will be much, much higher if you regularly work on the R assignments, which ask to implement the material that we cover in the lectures. Do not underestimate how much coding an approach helps understanding it!

Course outline

<u>Topic 1:</u>	Properties of time series
<u>Topic 2:</u>	Univariate processes/ARIMA models
<u>Topic 3:</u>	Non-stationary time series and unit root tests
<u>Topic 4:</u>	Multivariate probability distributions
<u>Topic 5:</u>	The basics of vector autoregressive (VAR) models
<u>Topic 6:</u>	Estimation of VAR models
<u>Topic 7:</u>	Forecasting with VAR models
<u>Topic 8:</u>	Identification of structural VAR models
<u>Topic 9:</u>	Spurious regression and cointegration
<u>Topic 10:</u>	Vector error correction models (VECMs)
<u>Topic 11:</u>	Multivariate GARCH models

Main textbooks:

- Lütkepohl, H. (2005), *New Introduction to Multiple Time Series Analysis*, Springer.
- Kilian, L. and H. Lütkepohl (2017), *Structural Vector Autoregressive Analysis (Themes in Modern Econometrics)*, Cambridge University Press, Cambridge.
- Tsay, R.S. (2002), *Analysis of Financial Time Series*, Wiley.
- Verbeek, M. (2008), *A Guide to Modern Econometrics*, 3. Edition, Wiley.

R Software

R is a free software environment. You can download R using any of the links on the following website: <https://cran.r-project.org/mirrors.html>.

We recommend that you use RStudio to organize your codes. You can download a free copy of RStudio Desktop [here](#) (just use the download button that is most to the left).

We will use the first exercise session to explain how to install R/RStudio and to make sure that it works on everyone's laptop. The first exercise sessions cover the basics of programming in R.

There are also many excellent online courses for learning R available online which you might want to consult if you do have no prior experience with R at all. We recommend the following:

- A free course on [Coursera](#) offered by Johns Hopkins University;
- The book "R Programming for Data Science" by one of the authors of the Coursera course;
- Many tutorials on various aspects of R offered via the [swirl project](#);
- The course "[Topics in R Statistical Language](#)" offered by PennState University.

The most important thing to enhance your programming skills and to master the implementation of econometric methods is to write a lot of code.