Syllabus for the course

"Time Series Analysis"

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ECTS	3
Contact hours	32
Self-study hours	82
Study year	1
Format	Full-time

Abstract: Time Series consist of values of a variable recorded in an order over a period of time. Such data arise in just about every area of science and the humanities, including econometrics and finance, engineering, medicine, genetics, sociology, environmental science. What makes time series data special is the presence of dependence between observations in a series, and the fact that usually only one observation is made at any given point in time. This means that standard statistical methods are not appropriate, and special methods for statistical analysis are needed. This course aims to provide you with a working knowledge of time series analysis methods as applied in economics, engineering and the natural and social sciences. The emphasis is on methods and the analysis of time series data using the R statistical software.

Course Plan and Learning objectives

Lesson 1: Time Series Basics

After successfully completing this lesson, you should be able to:

- Identify important features on a time series plot
- Identify and interpret an AR(1) model
- Interpret an ACF
- Identify a weakly stationary time series
- Identify when and how to take first differences

Lesson 2: MA Models, PACF

After successfully completing this lesson, you should be able to:

- Identify and interpret an MA(q) model
- Distinguish MA terms from an ACF
- Interpret a PACF
- Distinguish AR terms and MA terms from simultaneously exploring an ACF and PACF
- Recognize and write AR, MA, and ARMA polynomials

Lesson 3: ARIMA models

After successfully completing this lesson, you should be able to:

- Identify and interpret a non-seasonal ARIMA model

- Distinguish ARIMA terms from simultaneously exploring an ACF and PACF
- Test that all residual autocorrelations are zero
- Convert ARIMA models to infinite order MA models
- Forecast with ARIMA models
- Create and interpret prediction intervals for forecasts

Lesson 4: Smoothing and Decomposition Methods

After successfully completing this lesson, you should be able to:

- Identify and interpret additive and multiplicative decompositions
- Decompose a time series
- Apply a lowess smoother
- Apply a moving averages smoother
- Apply a single exponential smoother

Lesson 6: The Periodogram

After successfully completing this lesson, you should be able to:

- Create a periodogram in R
- Identify the dominant periods (or frequencies) of a time series

Lesson 7: VAR(p) Models and ARCH Models

After successfully completing this lesson, you should be able to:

- Model the variance of a time series
- Identify and interpret ARCH models
- Simultaneously model multiple variables in terms of past lags of themselves and one another

Lesson 8: Spectral Analysis

After successfully completing this lesson, you should be able to:

- Estimate the spectral density non-parametrically (Daniell kernel & modified Daniell kernel)
- Identify and interpret bandwidth
- Estimate the spectral density parametrically

Lesson 9: Fractional Differencing/Threshold Models

After successfully completing this lesson, you should be able to:

- Identify and interpret simple fractionally differenced models
- Recognize when to take first differences vs. fractional differences
- Identify and interpret ARFIMA models
- Apply different models within two intervals of a time series

Methods of Instruction

Learning activities of the course include lectures and practice sessions where you will apply the methodology covered in the lectures. Face-to-face class time will be divided into two parts. In the first part, methodological aspects of time series analysis will be illustrated with facilitated demonstrations, and then, students will apply the methodology over the real datasets and discuss analysis results to foster their understanding.
The main focus of the course will be on stationary and non-stationary time series models for seasonal and non-seasonal time series data. The contents will be explained with examples and online demonstrations in lectures. Because R software will be used for all analyses, a good knowledge of R is essential for this course. Practice sessions, assignments, and a project assignment will provide an opportunity to carry out analyses following a structured format and test your understanding of the topics covered in classes.

Grading System

Grading Task1: Assignments
Weighting 20%

Grading Task 2: Mid-Semester test
Weighting 20%

Grading Task 3: Project
Weighting 20%

Grading 4: Final Exam
Weighting 40%

Reading List

Harvey, A.C. (1993). Time Series Models.

Wei, W. S. (1994). Time Series Analysis: Univariate and Multivariate Methods.

Chatfield, C. (1996). The Analysis of Time Series: An Introduction.

Harvey, A.C. (1989). Forecasting Structural Time Series Models and the Kalman Filter.