M003	**Time series analysis**	L	P	S	ECTS
		2	0	2	6

Course objectives. The objective of this course is to make students familiar with the fundamental concepts of modelling time dependent phenomena with stochastic processes. Students will learn techniques for analysing dependence and appropriate model selection. Special attention will be put on the applications of time series models in finance, economics, climatology, biology and others. Through seminars students will master the techniques for solving concrete problems by using computers to build time series models.

Prerequisites. Probability.

Course content.

1. Introduction. Stationary processes. Examples. L^2 space.
2. Linear processes. MA processes. AR processes. ARMA processes. Nonstationarity and transformations (deterministic trend, differencing and ARIMA processes, power and log transformations).
3. Fitting of ARMA models. Constant mean estimation. Model identification. Parameter estimation (least squares method, maximum likelihood method). Diagnostics. Prediction and L^2 space. Prediction of ARIMA processes.
4. Seasonal models. Seasonal ARMA processes. Seasonal ARIMA processes. Fitting SARIMA models and prediction. Spectral analysis.
5. Multivariate time series. Conditional heteroskedasticity models (ARCH, GARCH). Other special models (models with long-range dependence, regression models with time series, insurance risk models).

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1.	Demonstrate properties of the models covered in the course.
2.	Mathematically prove the basis of procedures and formulae they use for inference.
3.	Recognize appropriate model for time series data based on the properties of stochastic process used as a model and by using transformations of the original time series data.
4.	Identify model and estimate parameters by using statistical estimation methods.
5.	Critically analyse the model, its usefulness, possible applications and limitations.
6.	Use computers and appropriate software as a tool for time series analysis.
7.	Critically study and apply new literature for time series analysis.
8.	Interpret results of the models and present created models and possible applications to amateurs and professionals.

RELATING THE LEARNING OUTCOMES, ORGANIZATION OF THE EDUCATIONAL PROCESS AND ASSESSMENT OF THE LEARNING OUTCOMES

TEACHING ACTIVITY	ECTS	LEARNING OUTCOME **	STUDENT ACTIVITY*	EVALUATION METHOD	POINTS	
					min	max
Attending lectures and exercises	1	1-8	Lecture attendance, discussion, team work and independent work on given tasks	Attendance lists, tracking activities	0	4

Homework	0,5	1-8	Solving theoretical and practical problems	Evaluation	0	4
Written exam (Mid-terms)	1,5	1-5	Preparing for written exam	Evaluation	20	40
Seminar	1	1, 3-8	Writing seminar, making and preparing presentation	Evaluation of seminar and presentation	10	12
Final exam	2	1-8	Revision	Oral exam	20	40
TOTAL	6				50	100

Teaching methods and student assessment. Lectures and seminars are obligatory. During the course, statistical software will be used (e.g. R). The exam consists of a written and an oral part and successfully defended seminar work. Upon completion of the course, students can take the exam. Successful midterm exam scores replace the written exam. The seminar consists of written report and oral presentation and is obligatory. Student may write homework during the course to improve their final grade.

Can the course be taught in English: Yes

Basic literature:

1. P.J. Brockwell, R.A.Davis, Introduction to time series and forecasting, Second edition, Springer Verlag, New York, 2002.
2. P.J. Brockwell, R.A. Davis, Time series: theory and methods, Second edition, Springer Series in Statistics, Springer-Verlag, New York, 1991.
3. J.D. Cryer, K-S. Chan, Time Series Analysis with applications in R, Fourth edition, Springer Verlag, New York, 2017.

Recommended literature:

1. G.E. Box, G.M. Jenkins, G.C. Reinsel, G.M. Ljung: Time series analysis: forecasting and control, Fifth edition, John Wiley & Sons, 2015.
2. J.D. Hamilton, Time Series Analysis, Princeton University Press, 1994.
3. H. Lütkepohl, New introduction to multiple time series analysis, Springer Science & Business Media, 2005.
4. T.C. Mills, The Econometric Modelling of Financial Time Series, Cambridge University Press, 1999.
5. K. Neusser, Time series econometrics, Springer Verlag, 2016.
6. R.H. Shumway, D.S. Stoffer, Time series analysis and its applications: with R examples, Third edition, Springer Verlag, 2011.
7. R.S. Tsay, Analysis of financial time series, John Wiley & Sons, 2005.