**2021 Doctoral Winter School**
**15 – 19 February**
16.00 – 20.00 (CET, Ljubljana)

# Applied Time Series Analysis and Forecasting (ECTS: 4)

VERBIC Miroslav, University of Ljubljana, School of Economics and Business, Slovenia

## Aims of the course:

In order to understand the complicated economic, financial and business environment it is vital to be able to competently quantify and analyse economic, financial and business data. Time series analysis is one of the most comprehensive approaches to achieve this goal. The purpose of this course is to address the linear regression model with particular focus on serial correlation, stationarity, integration and cointegration, and then introduce, based on this, three additional, specialized topics of time series analysis and forecasting: (1) the autoregressive moving average (ARMA) approach, (2) the vector autoregression (VAR) approach, and (3) the cointegration approach (VECM). The course is very much practically oriented; the methodological concepts are applied to real data through various examples and case studies in the fields of economics, finance and business.

Objectives and competences of the course are the following: (1) to improve and expand the knowledge of quantitative skills with time series regression methods; (2) to develop the capability to choose appropriate techniques for time series analysis of various relationships in economics, finance and business; and (3) to develop the capability to properly interpret the analytical results obtained or found in economics, finance and business. After completing this course, the student should be able to set up independently the research problem and perform the applied time series regression analysis.

## Course syllabus:

1 TIME SERIES REGRESSION ANALYSIS
- 1.1. Classical linear regression model and its extensions
- 1.2. Model diagnostics
- 1.3. Serial correlation
- 1.4. Stationarity and integration
- 1.5. Cointegration
- 1.6. Univariate and multivariate time series models

2 ARMA (BOX-JENKINS) ANALYSIS
- 2.1 Autoregressive processes
- 2.2 Moving average processes

2.3 Autoregressive moving average (ARMA) processes
2.4 Box–Jenkins approach
2.5 Extensions to ARMA models
2.6 Forecasting with ARMA models

3 VECTOR AUTOREGRESSION ANALYSIS
3.1 VAR modelling: Construction and estimation
3.2 Granger causality testing
3.3 Impulse responses and variance decomposition analysis
3.4 Sensitivity analysis in VAR modelling
3.5 Short–run and long–run SVAR models
3.6 Forecasting with VAR models

4 MODELLING LONG–RUN RELATIONSHIPS
4.1 Long–run relationships and cointegration
4.2 Error–correction model (ECM)
4.3 Engle–Granger two–step approach
4.5 Johansen vector error–correction (VECM) approach
4.5 Interpretation and hypothesis testing
4.6 Forecasting of long–run relationships

SESSION 1:
Classical linear regression model and its extensions, model diagnostics with focus on serial correlation and stationarity, integration and cointegration, additional practical demonstrations in Stata.

SESSION 2:
Univariate and multivariate time series models, autoregressive and moving average processes, ARMA processes, additional practical demonstrations in Stata.

SESSION 3:
Box–Jenkins approach, extensions to ARMA models, forecasting with ARMA models, VAR modelling with focus on construction and estimation, additional practical demonstrations in Stata.

SESSION 4:
Interpretation of VAR models, sensitivity analysis, SVAR modelling, forecasting with VAR models, long–run relationships and cointegration, additional practical demonstrations in Stata.

SESSION 5:
Error–correction model, Engle–Granger two–step approach, Johansen VECM approach, forecasting of long–run relationships, additional practical demonstrations in Stata

## Teaching methods/Online tools and software:

Online lectures will be held on ZOOM. The course consists of lectures with integrated computer exercises. Lectures use interactive teaching methods with MS PowerPoint presentations, PDF lecture notes and numerous demonstrations in Stata statistical software for data science. Methodological approaches that are taught at any given lecture are then further demonstrated with real data from economics, finance and business.

## Course materials/List of readings:

1. Brooks, C.: *Introductory Econometrics for Finance: Third Edition*. Cambridge: Cambridge University Press, 2014.
2. Hill, R. C., W. E. Griffits and G. C. Lim: *Principles of Econometrics: Fourth Edition*. Hoboken, NJ: John Wiley & Sons, 2011.
3. Pindyck, R. S. and D. L. Rubinfeld: *Econometric Models and Economic Forecasts: Fourth Edition*. Boston: Irwin/McGraw-Hill, 1998.

Lecture notes will be provided for course participants at the start of the course. No reading or extra preparation is required prior to the course.

## *Course leaders' biographical note:*

***VERBIC Miroslav*** *is Professor of Econometrics and Professor of Finance at the University of Ljubljana and Senior Research Fellow at the Institute for Economic Research in Ljubljana. He earned his MSc in Econometrics in 2006 at the University of Amsterdam, and his PhD in Economics in 2007 at the University of Ljubljana. He teaches econometrics at the graduate and undergraduate level at the University of Ljubljana, and abroad as a visiting professor. Since 2015, he has been an expert evaluator for Horizon 2020 of the European Commission's Research Executive Agency. His research interests include econometric modelling, general equilibrium modelling, asset pricing modelling, social security analysis, energy economics, welfare economics, and environmental economics. He is the author of five scientific monographs and more than fifty refereed scientific articles, published in prestigious international scientific journals. He is promoting his research activity in professional associations, such as Econometric Society, International Association for Research in Income and Wealth, and Royal Economic Society. He is engaged in several projects commissioned by the Slovenian government and the European Commission as either head or member of research team.*