

# **Time Series Analysis**

## **Course Outline**

### **1. Introduction and Descriptive Methods**

#### **1.1 Introduction**

#### **1.2 Sample Moments**

#### **1.3 Classical Components Models**

#### **1.4 Trend Determination**

##### 1.4.1 Parametric methods

##### 1.4.2 Nonparametric methods

#### **1.5 Transformation of Time Series by Filtering**

#### **1.6 Seasonal Adjustment**

### **2. Models of Time Series**

#### **2.1 Stochastic Processes**

##### 2.1.1 Basic concepts

##### 2.1.2 Stationarity

##### 2.1.3 Ergodicity

##### 2.1.4 White noise processes

##### 2.1.5 Linear processes

#### **2.2 Moving Average Processes**

##### 2.2.1 The MA(1) process

##### 2.2.2 The MA(q) process

##### 2.2.3 The MA( $\infty$ ) process

#### **2.3 Autoregressive Processes**

##### 2.3.1 The AR(1) process

##### 2.2.2 The AR(p) process

#### **2.4 Inverse Filters**

#### **2.5 Mixed Autoregressive Moving Average Processes**

(Existence of stationary and causal solution, invertibility, computation of moments)

### **3. Forecasting and the Partial Autocorrelation Function**

#### **3.1 Introduction**

#### **3.2 General Results on Prediction**

- 3.3 Application to Stationary Processes
- 3.4 Forecasting a Stationary and Causal AR(p) Process
- 3.5 Forecasting a Stationary, Causal and Invertible ARMA(p,q) Process
- 3.6 Forecasting in Case of Unknown Parameters
- 3.7 The Partial Autocorrelation Function
- 4. Estimation, Specification and Validation of ARMA Models
  - 4.1 Estimation of Moments
  - 4.2 Estimation of AR(p) Models
  - 4.3 Estimation of ARMA(p,q) Models
  - 4.4 Model Specification
  - 4.5 Model Validation
    - 4.5.1 Descriptive/graphical analysis of residuals
    - 4.5.2 Diagnostic tests of residuals
    - 4.5.3 Stability analysis
    - 4.5.4 Recursive analysis
    - 4.5.5 Model reduction and selection
- 5. Models for Nonstationary Time Series and Unit Root Tests
  - 5.1 Introduction
  - 5.2 Trend Stationarity vs. Unit Root
  - 5.3 ARIMA and Seasonal ARIMA Models for Nonstationary Time Series
  - 5.4 Unit Root Tests
    - 5.4.1 Introduction
    - 5.4.2 Dickey-Fuller unit root test
    - 5.4.3 Augmented Dickey-Fuller unit root test
    - 5.4.4 Overview of other unit root tests
    - 5.4.5 Problems with statistical inference
- 6. GARCH Models for Clustered Volatility
  - 6.1 Introduction
  - 6.2 Autoregressive Conditional Heteroskedasticity (ARCH)
  - 6.3 Generalized ARCH Models
  - 6.4 Further Extensions
- 7. Multivariate Time Series Analysis
  - 7.1 Introduction
  - 7.2 Dynamic Structural Models and VAR's
  - 7.3 Stable VAR Processes
    - (including forecasting and parameter estimation)

#### **7.4 Structural Analysis**

(Granger causality, impulse response analysis)

#### **7.5 Cointegrated Processes**

(Cointegration, vector error correction model, specification of cointegration rank)

#### **7.6 Empirical Example**

## **Literature**

- Hamilton, J.D. (1994). *Time Series Analysis*. Princeton, University Press.
- Lütkepohl, H. (2005). *New Introduction to Multiple Time Series Analysis*. Springer-Verlag, Heidelberg.
- R. Schlittgen, R: and Streitberg, B.H.J. (1987, or later ed.). *Zeitreihenanalyse*. Oldenburg Verlag, München.