Time Series Analysis

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Course home page: http://www.uni-tuebingen.de/uni/wwo/Grammig/veranstaltungengramm/zeitreihenanalyse05.html

• 2 h per week lecture + 2 h „exercise“ or PC lab (most likely blocked)
• Revise ~2 h + per week (Assignments)
• Exam: Either oral or written
  Material of lectures, reading list, chapters in textbooks
• Prerequisites: Undergraduate Math & Stats & Economics
• Take notes!
• Textbooks:

• Why follow the course?
Why follow the course? Time series techniques are essential in Economics & Finance

Finance
- Predictability of returns
- Testing and Estimating Asset Pricing models
- Properties of price formation processes

Economics
- Properties of macroeconomic time series
- Persistence of macro-shocks
- Testing economic theories (PPT, Expectation Hypothesis of Term Structure)
- Transmission of monetary policy
Agenda

◆ I. Basic concepts of time series analysis
◆ III. Modelling univariate time series (ARMA models)
◆ (IIIb. Regression analysis using stationary time series)
◆ IV. Structural Vector Autoregressive Systems (SVAR)
◆ V. Equilibrium Correction and Cointegration
◆ VI. Special topics (Estimation of continuous time processes, Volatility models, …) if we have the time…
for methods of analyzing economic time series with time-varying volatility (ARCH)
a) Daily close Dow Jones, from 08/23/1988 to 08/22/2000, daily frequency

b) Realisation of

\[
\frac{x_{t+\Delta t} - x_t}{x_t} = \mu \Delta t + \sigma \sqrt{\Delta t} \varepsilon_{t+\Delta t}
\]

\[\mu = 0.08\]

\[\sigma = 0.2\]

\[\Delta t = 1/250\]

\[\varepsilon_{t+\Delta t} \sim N(0,1)\]
a) Daily close Dow Jones, from 08/23/1988 to 08/22/2000, daily frequency

b) Realisation of

$$\frac{x_{t+\Delta t} - x_t}{x_t} = \mu \Delta t + \sigma \sqrt{\Delta t} \varepsilon_{t+\Delta t}$$

$$\mu = 0.08$$

$$\sigma = 0.02$$

$$\Delta t = 1/250$$

$$\varepsilon_{t+\Delta t} \sim N(0,1)$$
What is it? (3)

a) log of relative DAX change, from 01/02/1996 to 12/27/1996, daily frequency

b) Realisation of 
\[ x_{t+\Delta t} = \sigma \sqrt{\Delta t} \varepsilon_{t+\Delta t} \]

\[ \sigma = 0.2 \]

\[ \Delta t = 1/248 \]

\[ \varepsilon_{t+\Delta t} \sim N(0,1) \]
What is it? (4)

a) log of relative DAX change, from 01/02/1996 to 12/27/1996, daily frequency

b) Realisation of

\[
x_{t+\Delta t} = \sigma \sqrt{\Delta t} \varepsilon_{t+\Delta t}
\]

\[
\sigma = 0.047
\]

\[
\Delta t = 1/248
\]

\[
\varepsilon_{t+\Delta t} \sim N(0,1)
\]
a) Realisation of

\[ x_{t+\Delta t} - x_t = -\phi(x_t - \mu)\Delta t + \sigma \sqrt{x_t} \sqrt{\Delta t} \varepsilon_{t+\Delta t} \]

\[ \mu = 3 \]
\[ \phi = 0.99 \]
\[ \sigma = 1.4 \]
\[ \Delta t = 1/4 \]
\[ \varepsilon_{t+\Delta t} \sim N(0,1) \]

b) 3 month CHF LIBOR from 01/01/1974 to 01/01/2002, 3-month frequency
What is it? (6)

a) Realisation of

\[ x_{t+\Delta t} - x_t = -\phi(x_t - \mu)\Delta t + \sigma \sqrt{x_t} \sqrt{\Delta t} \varepsilon_{t+\Delta t} \]

- \( \mu = 3 \)
- \( \phi = 0.99 \)
- \( \sigma = 1.4 \)
- \( \Delta t = 1/4 \)
- \( \varepsilon_{t+\Delta t} \sim N(0,1) \)

b) 3 month CHF LIBOR from 01/01/1974 to 01/01/2002, 3-month frequency
What is it? (7)

a) Price-dividend ratio S&P500 from 12/31/1947 to 12/31/1996, annual frequency

b) Realisation of

\[ x_{t+\Delta t} - x_t = -\phi (x_t - \mu) \Delta t + \sigma \sqrt{\Delta t} \varepsilon_{t+\Delta t} \]

\[ \mu = 23 \]
\[ \sigma = 0.5 \]
\[ \phi = 0.9 \]
\[ \Delta t = 1 \]
\[ \varepsilon_{t+\Delta t} \sim N(0,1) \]
a) Price-dividend ratio S&P500 from 12/31/1947 to 12/31/1996, annual frequency

b) Realisation of

\[ x_{t+\Delta t} - x_t = -\phi(x_t - \mu)\Delta t + \sigma \sqrt{\Delta t} \epsilon_{t+\Delta t} \]

- \( \mu = 23 \)
- \( \sigma = 0.5 \)
- \( \phi = 0.9 \)
- \( \Delta t = 1 \)

\( \epsilon_{t+\Delta t} \sim N(0,1) \)
Assignments

Review statistical basics: (e.g. Hamilton, 1994, p.739 ff.)

Random Variables and distributions (distribution function, density function), especially Normal distribution.
Expectation Operator (mean, variance, higher moments) and properties of expectation operator

Joint distributions, covariance and correlation, Dependence and independence of random variables

Conditional probability and conditional distribution

Conditional expectation

Independence

Hypothesis testing (significance levels, type I and II errors, null and alternative hypothesis)

Estimation basics: Least Squares (one explanatory variable), law of large numbers, central limit theorems