PADERBORN UNIVERSITY
The University for the Information Society

W4451 - Financial Econometrics and Quantitative Risk Management
Project II

Lecturer:	Prof. Yuanhua Feng
With:	Bastian Schäfer
Project issue:	03.08.2021
Project due:	06.09.2021

- There are four problems with a total of 50 points, points awarded for each part are indicated in squared brackets.

- Please refer to the provided guidelines on PANDA for your work on the project and the form and contents of the report.

- Submit your project report, the code and all (digital) sources according to the guidelines on PANDA into the provided upload section.

1   Introduction to Time-Series Analysis

1.1 Summarize chapters 1-3 in your own words on about 2 pages. Use at least one other source beside lecture or tutorials. Provide at least one suitable graphs to support your statements, produce this graph in R. [8]

1.2 Answer **ONE** of the following questions:

   a) From a time-series Y_t, we obtain:

$$\sum_{t=1}^{500} y_t = 744.09$$

$$\sum_{t=1}^{500} (y_t - \overline{y})^2 = 183.52$$

$$\sum_{t=1}^{499} (y_t - \overline{y})(y_{t+1} - \overline{y}) = 34.61$$

$$\sum_{t=1}^{498} (y_t - \overline{y})(y_{t+2} - \overline{y}) = -97.56$$

   Fit an AR(2)-model with mean to the observations, report the complete model along with the estimated error term variance σ_ε^2. Please provide all your calculations. [4]

   b) On PANDA, you find the data set "W4451 - Project 2 - AR sim.csv", which contains observations of an AR model. Use the BIC to determine the best model order for $p = 0, \ldots, 10$ and estimate the model using the optimal order. Report the model as well as the BIC values. [4]

[Total: 12 Points]

2 Financial Time Series

2.1 Summarize chapters 5-8 in your own words on about 2 pages. Use at least one other source beside lecture or tutorials. Provide at least one suitable graphs to support your statements, produce this graph in R. [8]

2.2 Consider the GARCH(1,1) model

$$Y_t | \mathcal{F}_t \sim N(0, h_t)$$
$$h_t = 1 + 0.3 Y_{t-1}^2 + 0.67 h_{t-1}$$

and answer **ONE** of the following questions:

a) Show that the GARCH-model is stationary and test if it has a finite fourth moment. Calculate the unconditional variance as well as the fourth moment, if they exist. [4]

b) Simulate 500 values the GARCH-model with $N(0,1)$ innovations. Plot a reproducible sample of your simulation for the volatility $\sqrt{(h_t)}$ and the simulated "returns" Y_t. [4]

[Total: 12 Points]

Hint: For the simulation in 2.2 b) please use 'set.seed(xxxxxxx)' at the beginning of the simulation, where you can use the student number of any team member. This will ensure that you can repeatedly obtain the same simulated time series. You can also try to change the value in 'set.seed(xyz)' in order to obtain different simulated time series.

Hint: You may use a loop to simulate the Y_t values in the GARCH-model, by just applying the exact formulas and use `rnorm` for iterated draws from the normal distribution.

3 Risk Management

3.1 Find 4 time-series of daily stock prices with the following properties:

- All time series should include 2 years (of your choice) of observations and cover the same years.
- They should include the same number of daily observations.
- They should be in the same currency
- It is helpful, if they are from the same stock exchange or from exchanges of the same country.

Display the stock price time-series and list your companies along with a brief description. [5]

3.2 Compute and display the returns for each of the time-series. Find the best GARCH(p,q) and APARCH(p,q) for $p, q = 1, 2$ for each of the time series and report an optimal GARCH and APARCH model of a company of your choice. [4]

3.3 Calculate the 0.95 VaR and ES for both models and all companies and add the values to the plot of the return series. [4]

3.4 Count the number of exceptions (point-over-threshold) for both models and all companies. Use the traffic-light approach to indicate whether the number of exceptions falls in the green, the yellow or the red zone and list them in a table. [5]

[Total: 18 Points]

4 High-Frequency Financial Data

4.1 Find a high-frequency or ultra-high-frequency financial time-series on 3 consecutive days. Plot all three time-series on a single page. [4]

4.2 Calculate the HF-returns for each of the three days, display the return series and calculate the realized volatility for each of the three days. [4]

[Total: 8 Points]