London School of Economics

FM442 - Quantitative Methods for Finance and Risk Analysis

Classwork

The practical content of the course will be delivered in eight seminars. Each seminar consists of a notebook with the material that will be covered in the session and homework exercises that you are expected to solve on your own.

The course also includes a support notebook with discussion on more advanced R topics that can be useful for your assignments and final project.

All the material is available for download on Moodle and in the *Exercises* section of the *Financial Risk Forecasting* book page: https://www.financialriskforecasting.com/exercises/

Seminar One

- Familiarize ourselves with R and RStudio
- Learn some basic commands
- Download and import financial data
- Create a simple plot

Homework

- Download the stock prices and returns from Amazon and Apple between January 1st, 1990 and December 31st, 2010
- Load the data into R
- Create two variables "amazon" and "apple" that hold the downloaded data of each stock
- Do a simple plot for each of the stock's returns

Seminar Two

- Install and load packages in R
- Basic Data Handling
- Save created Data Frames
- Create, customize and export plots

Homework

- Open the data from Amazon and Apple from the previous seminar
- Use the dcast function to create RET and PRC data frames with the returns and prices
- Make sure your returns are compounded and not simple
- Save each data frame in your working directory
- Plot the returns and prices for each stock, well-labeled, using a 2x2 grid
- Export your plot

Seminar Three

- Learn how to work with statistical distributions
- Explore random numbers and the Monte Carlo simulation
- Visualize, analyse, and comment on the prices of a stock
- Perfrom graphical analyses and statistical tests

Homework

Elaborate a commentary on the price of the Amazon stock. To do this:

- Load the returns data frame you created in Seminar Two
- Plot the returns for Amazon
- Zoom into the dot-com years (2000-2002)
- Find the best and worst perfoming days, and find out what happened on those dates
- Compare the returns to a normal distribution graphically and using a test
- Plot the ACF of the returns and returns squared
- Use a 2x2 grid to elaborate four QQplots comparing the returns to a Student-T of 2, 3, 4 and 5 degrees of freedom

Seminar Four

- Build unvariate GARCH models
- Plot GARCH outputs
- Work with various specifications (ARCH, Student t, apARCH)
- Relax the GARCH stationarity condition
- Assess model quality using likelihood ratio tests and residual analysis
- Learn about half-life and GARCH simulations

Homework

Choose a stock between Amazon and Apple and:

- Fit a univariate GARCH(1,1) where conditional returns follow a normal distribution

- Fit a univariate GARCH(1,1) where conditional returns follow a T-distribuion
- Plot the estimated conditional volatilities against each other and comment
- Fit an ARCH(1,1) model and perform a LR test versus the GARCH(1,1)

Seminar Five

- Introduce multivariate volatility models
- Build a bivariate EWMA model
- Run DCC models with different specifications
- Compare models

Homework

- Load the Amazon and Apple returns
- Build a bivariate EWMA model for these stocks
- Build a loop that creates an EWMA for values of lamba = 0.9, 0.91, 0.92,... 0.99
- Create one plot for each stock with the estimated conditional volatilies for the different lambda
- Fit a DCC tapARCH model and calculate the conditional correlation
- Plot it and zoom into the dot-com bubble period (2000-2002)
- Comment any findings

Seminar Six

- Solve exam-like questions regarding risk measures
- Perform univariate and multivariate estimations of ES and VaR using Historical Simulation
- Experiment with different estimation windows for Historical Simulation VaR
- Build an EWMA VaR model

Homework

- Load the Amazon and Apple returns
- Perform a Historical Simulation VaR 99% forecast for each stock, use an estimation window of 1000 days
- Perform a Historical Simulation VaR 95% forecast for each stock, use an estimation window of 1000 days
- For each stock, plot the HS VaR forecast for both 95% and 99% in the same plot
- Comment

Seminar Seven

- Implement GARCH VaR
- Analyze and compare VaR forecasts between models
- Perform backtests with violation ratios
- Implement multivariate EWMA and HS VaR
- Perform stress-testing

Homework

- Use the six models covered (EWMA, HS300, HS1000, HS2000, GARCH300, GARCH2000) to backtest 1% VaR for both Amazon and Apple stocks individually.
- Perform a stress-test in the dot-com years (2000-2002)

Seminar Eight

- Use the Black-Scholes equation to price an option
- Simulate option prices with Monte Carlo
- Experiment with different simulation sizes
- Use analytical and simulation methods to get VaR
- Calculate VaR for an option
- Calculate VaR for a portfolio of stock and option

Homework

- Repeat the seminar for a Call option instead of a Put

Seminars Nine and Ten

Group project presentations