# UNIVARIATE AND MULTIVARIATE RISK MANAGEMENT USING R

# Instructors: Dean FANTAZZINI

- Course Objectives: The goal of this course is to introduce R programming for financial applications, focusing on univariate and multivariate volatility modelling, market risk management, and portfolio management. The course wants to bridge the gap between theory and practice and the applied aspects of financial models are emphasized throughout the course. The practical part contains many real-world cases for which R is an indispensible tool.
- **Prerequisites**: We assume that the students have a background in statistics, econometrics and basic time series analysis. An introduction to the basic concepts of financial modelling will be provided.
- Method of Grading: The final grade will be based on a written exam. A bonus point will be assigned to those fulfilling an optional home assignment.
- Total teaching hours: 16 (Dean Fantazzini)
- Teaching methods:
  - -4 teaching hours per week (1 meeting), conducted in the computer room;
  - Teachers' consultations;
  - Self study conducted with the course materials and in a computer room.
- Teaching Language: Russian and English.
- Timetable: Lectures: April 2018. Written Exam: middle of May 2018.

# Course Outline - Dean FANTAZZINI

## 1. (Brief) Review of ARIMA Processes [2 hours]

1.1 AR, MA, ARMA process

- 1.2 Integrated processes and Unit-Root Testing
- 1.3 ARIMA models and Box & Jenkins Methodology

#### References

- Sergey Aivazian (2014), Methods of Econometrics, Volume 1, Chapter 10.

## 2. Volatility Modelling and Market Risk Management using R [10 hours]

- 2.1 Risk measures
- 2.2 Univariate GARCH models
- 2.3 Multivariate GARCH models
- 2.4 Value at Risk using GARCH models
- 2.5 Backtesting VaR estimates

# References

- Danielsson, J., Financial Risk Forecasting, Wiley Finance, 2011: chapters 1-5, 8.
- McNeil, A., Frey, R., Embrechts, P., *Quantitative Risk Management: Concepts, Techniques, and Tools*, Princeton University Press, 2005: chapters 1-2, 4.
- Ruppert, D. (2010). Statistics and Data Analysis for Financial Engineering, Springer-Verlag: chapter 2,4-5, 18-19.
- Ghalanos, A. (2013), Introduction to the rugarch package, R vignette.
- Ghalanos, A. (2013), The rmgarch models: Background and properties, R vignette.

#### 3. Portfolio Management using R [4 hours]

- 3.1 Introduction to Markowitz portfolio theory
- 3.2 Mean-Variance portfolio: implementation in R
- 3.3 Markowitz tangency portfolio and Long-only portfolio frontier
- 3.4 Portfolio management using the R fPortfolio package
- 3.5 Empirical Case study: Dow Jones index

#### References

- Wurtz D., Chalabi Y., Chen W., Ellis A., *Portfolio Optimization with R/Rmetrics*, Rmetrics Association and Finance Online 2010: chapters 11-20.
- Wurtz D., Lam L., Ellis A., Chalabi Y., *Basic R for Finance*, Rmetrics Association and Finance Online 2010: chapters 30-33.
- Gilli M., Maringer D., Schumann E., Numerical Methods and Optimization in Finance, Academic press 2011: chapters 13.1-13.2.