Stellenbosch University Master's Course

Financial Econometrics

Course Outline

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1 Introduction

The aim of this course is to introduce students to quantitative finance using the statistical package R. We will be covering several core topics in financial econometrics and will discuss some of the latest techniques that are used in financial engineering. We will reference theory in some textbooks, notably Tsay (2014),Tsay (2012) and Ruppert (2011), with the emphasis of the course very much on the application side.

This is a highly specialized course that builds on the Master's Data Science course presented in the first semester, with the emphasis shifting to applied finance. Upon completion, students will have a practical set of tools that can be used in both research and applied investment and risk-analytic tools that will prove useful in future occupations.

The aim of this course is to be practical, with a strong theoretic base, and to provide students with a sense of what is expected of quantitative analysts in financial markets.

All class notes and additional information will be loaded onto the course's official website: https://www.fmx.nfkatzke.com/

2 Requirements

Students are required to meet the following requirements:

- Having comfortably passed the Data Science course
- Have a sound financial theory understanding, ideally having completed the elective *financial economics*
- Have some experience in coding in R, as we will solely be using it in our practical sessions.

3 Assessment

Students will be graded on their ability to master the concepts discussed in class and put in practice in the tutorials. As such, we will have a practical test written in the final quarter. Students will also be expected to conduct a formal write-up based on a topic which builds on one discussed in class or agreed upon with myself ahead of time. Students need to finalize a topic and communicate that to me in advance.

3.1 Mark allocation

- Practical Exam: 50%
- Written work: 50%

4 Topics

4.1 Session 1: Basic Statistical Properties and stylize facts of financial data

- Stylized financial concepts of financial returns series
- Asset return distribution
- Time-dependency

4.1.1 Practical 1: StaRting things out

- Introduction to the R package and getting started in R.
- Important: Students will be required to have their own laptops in class. This must be arranged ahead of time. This follows as we will be installing specific packages and programs that will be problematic on the University's computers.

4.1.2 Practical 2: financial data analysis in R

- Exploring financial data in R.
  - Histograms, QQplots, normality tests, etc.
  - Simple vs log Returns
  - Plotting capabilities of R

Readings: Tsay (2012, Chapter 1), Ruppert (2011, Chapter 2)

4.2 Session 2: Data exploration techniques

- Principal Component Analysis
- Exploratory and Confirmatory Factor Analysis

4.2.1 Practical 3: PCA and EFA analysis

- Exploring the PCA and EFA capabilities of R.
  - we will make use of several built-in features, as well as the `psych` package to offer means of exploring data characteristics.

Readings: Ruppert (2011, Chapter 4), Tsay (2014, Chapter 4)

4.3 Session 3: Portfolio Risk and Performance Analysis

- Discussion of portfolio performance and risk analysis.
  - Adjusted Sharpe Ratios, Downside Risk assessments and volatility measures.
- Historical, Parametric and Modified Value-at-Risk and Expected Shortfall (ES) measures

Readings: Tsay (2012, Chapter 7), Pfaff (2012, Chapter 6)

4.3.1 Practical 4: Portfolio returns and risk assessments

- Various portfolio return calculations, using both equal weighted, weighted as well as changing weighted portfolio returns.
- Portfolio VaR and ES measures
- Introduction to technical measures.

4.4 Session 4: Univariate Volatility modelling

- Discussion of second-order persistence models that allow modelling of volatility estimates
- Various forms of GARCH family of models discussed

Readings: Tsay (2012, Chapter 4), Hentschel (1995)

4.4.1 Practical 5: Univariate Volatility modeling

- Fitting GARCH models in R using `rugarch` package.
- Exploring graphing capabilities of volatility models in R.
- Forecasting Volatility
- Forward estimates of VaR estimates.

4.5 Session 5: Multivariate Volatility modelling

- Theory discussion of MVGARCH models
  - VECH, BEKK, DCC, ADCC, GOGARCH multivariate models

Readings: Tsay (2014, Chapter 7), Bauwens et al. (2006)

4.5.1 Practical 6: Multivariate Volatility modeling

- Fitting of DCC, ADCC and GOGARCH models.
- Applied to a multivariate series of data.

4.6 Session 6: Copula Estimations (time permitting)

- Theory discussion of Copula models

Readings: Ruppert (2011, Chapter 8)

4.6.1 Practical 7: Copula estimations

- Fitting of various copula model families

For all the sessions, class notes will be made available online and communicated to students ahead of time.

References

Bauwens, L., S. Laurent, and J. V. Rombouts (2006). Multivariate garch models: a survey. *Journal of applied econometrics 21*(1), 79–109.

Hentschel, L. (1995). All in the family nesting symmetric and asymmetric garch models. *Journal of Financial Economics 39*(1), 71–104.

Pfaff, B. (2012). *Financial risk modelling and portfolio optimization with R.* John Wiley & Sons.

Ruppert, D. (2011). *Statistics and data analysis for financial engineering.* Springer.

Tsay, R. S. (2012). An introduction to analysis of financial data with r.

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