MFE @ Baruch College – Statistics Refresher Seminar

Syllabus - Summer 2015

Instructor: Radoš Radoičić
Office: VC 6-254
Phone: +1-646-312-4169
Email: rados.radoicic@baruch.cuny.edu
Class location and times: Room 6-215, August 10, 11, 12, 13, 17, and 18 (6 sessions), 6-9pm

Textbooks:

(1) Ruppert, D., Statistics and Data Analysis for Financial Engineering, *Springer*, 2010.

Other reference books (in no particular order):

(1) DeGroot, M. H. and Schervish, M. J., Probability and Statistics, *Addison-Wesley*, 3rd edition, 2002.
(2) Kutner, M., Nachtsheim, C., and Neter, J., Applied Regression Models, *McGraw Hill/Irwin*, 4th edition, 2004.
(3) Hayashi, F., Econometrics, *Princeton University Press*, 2000.
(4) Tze Leung Lai and Haipeng Xing, Statistical Models and Methods for Financial Markets, *Springer*, 2008.
(5) Tsay, R. S., Analysis of Financial Time Series, *Wiley-Interscience*, 2nd edition, 2005.

Teaching Assistant: Professor Feng Chen will answer questions on QuantNet and grade your assignments. Email: feng.chen@baruch.cuny.edu

Course Policy: Homework will be assigned every lecture and due the following lecture. You are encouraged to work on the homework with your colleagues, but everyone will submit individual homeworks. No late homeworks are accepted. An in-class Final Exam will be given on August 18. The final exam will have two parts: the R programming part and the written part.

Grading: The course if graded on a Pass/Fail basis. Sixty percent is needed to pass the course. Homeworks form 60% of your grade, while the Final Exam is 40% of your grade.

Content: The course is a graduate level introduction to statistical methods and models of importance to quantitative finance. It will provide basic background in statistics/econometrics, which includes multivariate regression, maximum likelihood estimation, statistical inference, resampling, principal component analysis (PCA), and the basic time series analysis. We will also describe applications of these methods to portfolio theory and dynamic models of asset returns and their volatilities. A useful by-product of this course is a thorough preparation for potential statistics interview questions, as well as for the MFE courses, such as MTH 9875, MTH 9891, MTH 9893, MTH 9894, and MTH 9895.

(1) Lecture 1: 08/10
- Exploratory data analysis (histograms, kernel density estimation, order statistics, quantiles, normality tests, boxplots, data transformation)
- Modeling important probability distributions: chi-squared, student t-, Fisher, heavy-tailed (Laplace, Pareto, mixture models), multivariate normal, Wishart distribution; skewness, kurtosis.
- Maximum likelihood estimators (Fisher information, asymptotic inference)
- *Reading material:* Chapters 4, 5, 7, instructor's notes.

(2) Lecture 2: 08/11
- Confidence intervals, hypothesis testing (t-, F-, likelihood ratio, Goodness-of-fit, independence tests, Kolmogorov-Smirnov tests)
- Fitting univariate and multivariate distributions to financial data, analysis of the fit
- *Reading material:* Chapters 4, 5, 7, instructor's notes.

(3) Lecture 3: 08/12
- Linear regression: ordinary least squares (OLS), B(L)UE (Gauss-Markov), joint distribution of estimators, confidence/prediction intervals, hypothesis testing; Cramer-Rao inequality
- Regression with interest rate data: ANOVA, model selection, residual diagnostics, collinearity and variance inflation, leverages, Cook's D
- *Reading material:* Chapters 12, 13, instructor's notes.

(4) Lecture 4: 08/13
- (Univariate) time series modeling: stationarity, (AR)(MA) models, parameter estimation, forecasting, model selection, non-stationarity (de-trending, differencing, unit-root, ARIMA), (P)ACF plots, seasonality, Box-Cox transformation; multivariate time series
- Systematic study of CPI, inflation, log return data, default probabilities
- *Reading material:* Chapters 9, 10, instructor's notes.

(5) Lecture 5: 08/17
- Resampling/bootstrapping (with applications in regression models)
- Markowitz portfolio theory, resampling in portfolio management
- Capital asset pricing model (CAPM), estimation of Beta
- Principal component analysis (PCA), PCA on yield curves, factor models, fitting the Fama-French model on equity return data
- Estimation of covariance matrix of asset returns
- *Reading material:* Chapters 6, 11, 16, 17.

(6) Lecture 6: 08/18
- Final Exam
- (if time permits) Copulas: Gaussain, t-, Archimedean, Frank, Clayton, Gumbel; rank correlation; calibrating copulas; fitting copulas to return data
- (if time permits) Applications in risk management (estimation of VaR and ES)
- (if time permits) (E)(G)ARCH, ARMA-(E)GARCH, forecasting future returns and volatilities
- (if time permits) *Reading material:* Chapters 8, 18, 19.