Statistics 509:
Statistical Models and Methods for Financial Data

Winter of 2022 – Class 4:00-5:30pm MW - 260 Weiser

Instructor/GSI Information:

Instructor:	Brian Thelen - bjthelen@umich.edu
Lectures and Homework:	Posted on Canvas in Resources directory
Office hours:	(person) 5:30-6:30pm Mon, (virtual) 2:00-3:00pm Wed, or by appt
GSI's:	Shihao Wu - wshihao@umich.edu
Office hours:	Tues 6:30-8:30pm (1st hr in person and 2nd hr virtual)

Questions/Discussion: Piazza (on Canvas) will be available to ask questions and generate class discussion/responses. If preferred, can always email Prof Thelen or the GSI.

Textbooks:

Required: Ruppert, D. and Matteson, D. (2015) *Statistics and Data Analysis for Financial Engineering with R Examples*, Springer.

Prerequisites: Course prerequesites are Math 417 and Stat 425/426 (or equivalent). In particular, will utilize (i) Matrix algebra, (ii) Basic probability, (iii) Basic mathematical statistics, and (iv) Some programming knowledge.

Course Description: This course will cover the statistical models and methods that are relevant to financial data analysis. These include modeling and estimation of heavy tailed distributions, modeling and inference with multivariate copulas, linear and non-linear time series analysis (e.g., GARCH and its variations), and statistical portfolio modeling and analysis. Time permitting, optional topics include stochastic volatility models. Examples and data from financial applications will be used to motivate and illustrate the methods.

Outline of Topics to be Covered:

1. Preliminaries

Introduction to financial data and role of statistical analysis – special overview on stock/index returns, portfolio analysis, and risk management.

2. Modeling/Estimation of Heavy-Tailed Distributions - Univariate

Introduction to extreme-value distributions. Visualization and exploratory data analysis (EDA) techniques. Peak-over-threshold estimation techniques and applications to risk management.

3. Modeling and Inference with Multivariate Copulas.

Intro to general theory and specific parametric models (Gaussian/t-copulas and Archimedean). Estimation, goodness-of-fit, and applications to portfolio risk management.

4. Portfolio Models and Statistical Analysis

Basic models: Markowitz, Capital Asset Pricing Model (CAPM), and Multifactor models. Statistical estimation/analysis methods for each of these models and applications to portfolio management. Introduction to dynamic time-varying versions of basic models, and related estimation/analysis methods.

5. Intro to Linear Time-Series Analysis

Measures of Stationarity, Lags, Derivatives, and Serial Correlation; Introduction to Autoregressive (AR) and moving average (MA), and ARMA/ARIMA models and statistical methods for estimation and model selection, with applications to several financial data sets.

6. Nonlinear Time-Series Analysis

Intro to Threshold models and ARCH/GARCH Models and extensions of ARCH/GARCH (e.g., IGARCH, EGARCH, ARMA-GARCH). Statistical inference and model fitting. Applications to forecasting future returns and volatilities.

7. Cointegration

Cointegration analysis and its use to find portfolio trading strategies based on generalized pairs trading and mean-reversion.

8. Optional Topic: Stochastic volatility models

Basic models and estimation methods (quasi-likelihood and Bayesian sampling approach). Introduction to multivariate volatility models and related estimation methods.

Lectures: Lecture notes (with some missing examples and solutions) will be posted on the Canvas site – this will be done at least a day in advance of actual lecture.

Homework: There will be almost weekly problem sets – these will be posted on Canvas site in the Files directory. You will be allowed to drop 1 homework. Solutions for the homework problems will also be posted on the Canvas site. You will be allowed to work together, but you need to write up your own homework – also, there will be no late homework.

Computing Environment: This course will involve using the statistical language of R. R is freely available software that runs on UNIX, Mac, and Windows. No previous experience with R is required, though there may need to be some investment of time in the early part of the course for utilizing R. Additional background information is available on course site.

Exams: There will be a total of 2 exams - their dates/times are below. The exams will be open book (paper copies only) and open note. For each exam, there will be a review session – for first exam it will be in class on the Wednesday before, and for the second exam it will be scheduled for the evening of Wednesday/April 22. The second exam will cover only the second half of the course and is not comprehensive.

- Exam I: Thursday, February 24 - 7:00-9:00pm in room TBA
- Exam II: Friday, April 22 - 1:30-3:30pm in room TBA

IMPORTANT: If you need extra time due to a documented disability, please email me this information 2 weeks in advance along with the documentation.

Grading: Your grade is determined by a weighted combination of the homework and the exams according to the following weights:

Homework: 40%

Exams I and II: 30% each