Economics 424A: Computational Finance and Financial Econometrics
University of Washington
Spring 2018

Instructor: Yang Fan
Class Time and Location: Tuesday/Thursday 8:30AM-10:20AM, BNS 117
Instructor's Office: SAV 319A
Course Office Hours: MW 10-11AM
Email: yfan@uw.edu
Website: UW Canvas

Course Description

This course is an introduction to computational finance and financial econometrics - *data science applied to finance*. The course covers computer programming and data analysis in R, econometrics (statistical analysis), financial economics, microeconomics, mathematical optimization, and probability models. Medium-run output determination in which output is subject to supply constraints.

The emphasis of the course will be on making the transition from an economic model of asset return behavior to an econometric model using real data. This involves: (1) exploratory data analysis; (2) specification of models to explain the data; (3) estimation and evaluation of models; (4) testing the economic implications of the model; (5) forecasting from the model. The modeling process requires the use of economic theory, matrix algebra, optimization techniques, probability models, statistical analysis, and statistical software.

Course Objectives

- Understand basic financial theories of asset risk-return trade-off and portfolio optimization analysis.
- Apply econometric concepts of distributions, standard errors/confidence intervals, resampling methods, Monte Carlo simulations, and hypothesis testing to finance.
- Learn how to obtain, import, and manipulate financial data.
- Learn how to perform statistical analysis using R and excel.

Prerequisites

Formally, the prerequisites are Econ 300 and an introductory statistics course (Econ 311 or equivalent). Econ 482 (Econometric Theory) is not a prerequisite. More realistically, the ideal prerequisites are a year of calculus (through partial differentiation and constrained optimization using Lagrange multipliers), some familiarity with matrix algebra, a course in probability and statistics using calculus, intermediate microeconomics and an interest in financial economics (Econ 422: Investment, Capital, and Finance would be helpful).

Group Work

Working in groups is highly encouraged. Study groups is encouraged for weekly assignments and studying for exams. This class is multi-dimensional. (theory, application, software…etc). Having others in the class to depend beyond the instructor will be very helpful as students often learn these different components at different paces. Students are also encouraged to come to office hours in groups and even email (cc) in groups as well. However, please submit individual assignments and take all exams/quizzes separately.

Use of Technology in the Classroom

Be professional about the use of technology in the classroom. Cellphones should be on silent and out of sight. Do not be a negative externality on other students. Laptops should be only used for note taking. Audio recording of lectures is fine, just let me know at the start of the course.

Course Textbook:

- (Required) ***An Introduction to Computational Finance and Financial Econometrics with R***, by Eric Zivot, manuscript in preparation for publication by CRC Press. Updated: July 7, 2016. **(EZ)**
- (Required) ***Statistics and Data Analysis for Financial Engineering with R Examples***, by David Ruppert and David Matteson, Springer. The UW library has access to the e-book through SpringerLink. **(Ruppert)**
- (Recommended) ***Modern Portfolio Theory and Investment Analysis***, by Elton, Gruber, Brown, and Goetzmass, Wiley, New York. This text gives a very detailed treatment of portfolio theory. **(EG)**

Software

This course will use *R* for data analysis and statistical modeling as well as *Microsoft Excel* for spreadsheet modeling. Excel is included with Microsoft office and is available for free for UW students through UWare. R is a free open-source statistical modeling and graphical analysis language and is available from https://www.r-project.org. *R-Studio* (www.rstudio.org) is a free integrated development environment for R (runs on windows, MAC and LINUX).

We will be using several user-created packages (libraries of R functions) specifically designed for the analysis of financial time series data. R packages are maintained on the web and can be automatically downloaded from within R. The R package IntroCompFinR is the companion package for the book used in this class - An Introduction to Computational Finance and Financial Econometrics and is available on R-Forge (see link on Canvas). This package contains data for all of the examples in the book as well as useful functions for data, portfolio and risk analysis.

Grading

- Participation = 5%
- Homework and Lab = 20%
- Four Quizzes = 20%
- Midterm Exam = 30%
- Final Paper Draft (May 24th 2018) = 0%
- Final Paper = 25%

Participation (5%)

Participation benefits everyone. Participation helps the instructor gauge the level of understanding of the material in the classroom. Participation by a student can benefit all students by clearing up a confusing point during the lecture. Participation in the class also keeps the class lively by preventing the instructor from droning on. Student participation in the class will be graded and worth 5% of your overall grade. Participation includes answering questions in class, participating in classroom discussions, and asking questions in class. Participation does not include just showing up to class and turning in the assignment.

Homework and Lab (20%)

Weekly assignments will be assigned through canvas on Wednesdays and are due the following Wednesday prior to class. These assignments reflect the material that students are expected to learn or apply. They may be a combination of problem sets (more common in the early part of the course) and/or lab assignments. Please be neat in submitting your work. Group work is strongly encouraged but please submit individual assignments. Assignment grades will be based on a 10-point scale, 6 points to be awarded for completion. The remaining 4 points will be assigned based on the question that is graded.

Quizzes (20%)

Four announced quizzes will be given throughout the quarter. Each quiz will take between 20-25 minutes to complete. Your lowest score will be dropped and the remaining three quizzes will comprise 25% of your course score. Since a quiz is dropped, ***no makeup quizzes will be given.*** It is your responsibility to make sure you know when these quiz dates are. ***Tentative*** quiz dates are outlined in the weekly schedule, but quiz dates may change. If they do, they will be announced ahead of time in class and on the course webpage.

Midterm Exam (30%)

One midterm exam will be held in-class at an announced date. There are no make-up exams. In the rare circumstance of a student being hospitalized just prior to or during the exam due to an accident or other ailment, you can come speak to me individually. There are no *cheat-sheets*, *notes*, or *index cards* allowed on the exam. You will need a calculator but no cell phones are allowed.

Final Paper (25%)

A final research paper will comprise the remaining portion of your grade for the course. The research paper is designed for you to showcase the tools and techniques that you have learned throughout the course. It should be approximately 20-pages double spaced. Since this is a term-paper, the final version of your paper should be free of grammatical and spelling errors. The paper will be due on the Friday of finals week and replace the final exam for the course. ***A draft of your paper is required and is due on May 24th, 2018*** to satisfy the W-requirement for the course.

Disability Accommodation

If you have a documented disability and feel comfortable sharing that with me, please do so at the earliest time possible so that I can help make any necessary accommodations. For documented disabilities with necessary accommodations through Disability Resources for Students (DRS), come see me to make sure I have received the necessary paperwork so that I can better accommodate your needs.

Academic Conduct Policy

The Economics Department supports the University policies regarding academic honesty and classroom behavior. Students of the course are expected to adhere to the University of Washington's Policy on Academic Honesty that can be found at https://depts.washington.edu/grading/pdf/AcademicResponsibility.pdf.

Additional Resources:

The Economics Department offers several additional services to assist students in their Econ courses.

- EUB Tutoring Center - http://depts.washington.edu/ecnboard/eub-tutoring/
- English Language Learner Comprehension & Writing Center

Personal Tutors for hire – email econadv@u.washington.edu for additional information

Week 1	27-Mar	Tues	Course Introduction, Time-Value of Money and Financial Returns (1)	**Ruppert:** CH2 (Returns), CH 5 (Modeling Univariate Distributions) **EZ**: CH 1 (return calculations), CH 2 (Review of random variables) **EG**: CHs 1-3	
	29-Mar	Thurs	Time-Value of Money and Financial Returns (1); Univariate Random Variables (2)		
Week 2	3-Apr	Tues	Univariate Random Variables (2); Bivariate Random Variables (3)	**Ruppert:** CH 7 (Multivariate Statistical Models), Appendix (sec. 1-10, 12-15, 20) **EZ**: CH 2 (Review of random var.)	
	5-Apr	Thurs	Bivariate Random Variables (3); **QUIZ 1**		HW1 Returns Calculation
Week 3	10-Apr	Tues	Introduction to Time-Series (4)	**Ruppert:** CH 9 (Time Series) **EZ**: CH 4 (time series) and CH 3 (matrix algebra review)	
	12-Apr	Thurs	Matrix Algebra Review (5)		HW2 Probability, Statistics, VaR
Week 4	17-Apr	Tues	Descriptive Statistics (6); The Constant Expected Return Model (7)	**Ruppert:** CH 4 (Exploratory Data Analysis) **EZ**: CH 5 (descriptive statistics), CH 6 (CER model) , CH 7 (estimation of the CER model)	
	19-Apr	Thurs	The Constant Expected Return Model (7); **QUIZ 2**		HW3 Time-Series
Week 5	26-Apr	Tues	The Constant Expected Return Model (7); Bootstrapping Methods (8).	**Ruppert:** CH 6 (Resampling), Appendix (sections 11, 16 - 18) **EZ**: CH 8 (bootstrapping), CH 9 (hypothesis testing in the CER)	
	28-Apr	Thurs	**MIDTERM EXAM**		HW4 Time-Series and Descriptive Statistics
Week 6	1-May	Tues	Introduction to Modern Portfolio Theory (9)	**Ruppert:** CH 11 (Portfolio Theory) **EZ**: CH 10 (Intro to Portfolio theory) **EG:** CH 5 and 6 Notes* on using Excel's solver	
	3-May	Thurs			
Week 7	8-May	Tues	Modern Portfolio Theory and the Markowitz Algorithm (10)	**EZ**: CH 11 (portfolio theory with matrix algebra)	
	10-May	Thurs			HW5 Portfolio Theory
Week 8	15-May	Tues	MPT with No Short Sale Constraints (11); Statistical Properties of Efficient Portfolios (12)	**EZ**: CH 13 (statistical analysis of portfolios), CH 12 (portfolio risk budgeting) **EG**: CHs 6 and 7	
	17-May	Thurs	Portfolio Risk Budgeting (13); **QUIZ 3**		

Week 9	22-May	Tues	Portfolio Risk Budgeting (13)	**Ruppert:** CH 12 (Regression: Basics), CH 13 (Reg: Troubleshooting) **EZ**: CH 14 (single index model) **EG**: CHs 9	HW6 Portfolio Theory
	24-May	Thurs	The Single Index Model (14), **Paper Draft Due**		
Week 10	29-May	Tues	The Single Index Model (14); The Capital Asset Pricing Model (15)	**Ruppert:** CH 16 (CAPM) **EZ:** CH 15 (CAPM) **EG**: CH 13	
	31-May	Thurs	The Capital Asset Pricing Model (15); **QUIZ 4**		HW7 Single Index Model
Finals	**8-Jun**	**Fri**	**Final Research Paper Due**		