ECON 424A Computational Finance And Financial Econometrics

Summer 2024

Instructor: Cindy Huang **Email:** cindycan@uw.edu
Time: T/Th 5:50-8:00pm, Asynchronous Recording **Location:** Online
Office: SAV 319A **Office Hours:** By email appointment
Zoom appointments:

- Zoom link: https://washington.zoom.us/j/6577796462

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. A free online version of this course was available on Coursera (Links to an external site.) from 2013-2015 and has been taken by over 100,000 students world-wide. Archived videos from this course are available here (Links to an external site.). Panopto videos of the summer 2015 offering of this course are available on the Panopto recordings page.

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.

Topics in financial economics that will be covered in the class include:

- asset return calculations
- risk concepts
- portfolio theory
- risk budgeting
- index (factor) models
- capital asset pricing model (if time permits)

Mathematical topics covered include:

- optimization methods involving equality and inequality constraints
- basic matrix algebra
- matrix differential calculus (sounds hard but it isn't)

Statistical (Econometric) topics to be covered include:

- probability and statistics with the use of calculus
- expectation, univariate and joint distributions, covariance, normal distribution, etc.
- Monte Carlo simulation
- time series models concepts and basic time series models
- descriptive statistics and data analysis
- estimation theory and hypothesis testing
- resampling methods (e.g., bootstrapping)
- linear regression
- data analysis and coding using the open source R programming language

This course is an elective for the Undergraduate Certificate in Economic Theory and Quantitative Methods and one of the core courses for the Certificate in Quantitative Managerial Economics. It is also included in the Advanced Undergraduate Economic Theory and Quantitative Methods Courses list for the Bachelor of Science degree in Economics.

A condensed (3 credit) version of ECON 424 is given in CFRM 462. Students entering the Professional MS in Computational Finance and Risk Management program or the Computational Finance Certificate program will benefit from being familiar with this ECON 424/CFRM 462 course material.

Prerequisites

Formally, the prerequisites are Econ 300 and an introductory statistics course (Econ 311 or equivalent). Econ 482 (Econometric Theory) and Econ 422 are not prerequisites but provide very useful background. 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 482 and 422 provide useful background for the course).

Grading Policy

- Labs (homework) 25%
    - Due every Tuesday by 11:59 pm PST (submitted online via Canvas).
    - Each homework is worth 4pts:
        - 2 points for completeness
        - 2 points for the accuracy on a question that is randomly chosen
    - Late policy: If the homework is submitted 12:00am or later (even if Canvas was going slow), 20% will be taken off the grade for that assignment. For every 24 hours past that time, an additional 20% will be taken off.
- Midterm 25%
- Final 25%
    - The exams are online, closed-book, closed-notes with your camera on. No cheat sheet will be provided.
    - Make-up exams: there are no makeup exams for this course. If you miss an exam, the grade on the other exam will be used. For example, if you miss the midterm, then your final grade will be used as both your midterm and final grade.
- Class Project 25%
    - W credit will be given if you receive a grade of 3.3 or higher on the class project.

Converting Final Percentage Grades to GPA

As required by the department, final grades will be curved to reach a median GPA around 3.3. To pass this course, you need to receive 60% or more. Normally, 95% and above is a 4.0, 90%-95% will receive 3.6 and higher, but it will depend on the class distribution.

Textbook

I. Required Texts

- *An Introduction to Computational Finance and Financial Econometrics with R*, by Eric Zivot, CRC Press forthcoming (someday). The book is under

continuous revision (the last draft is 2022) so please check for updates. Any newer version will be posted on Canvas.

- *Statistics and Data Analysis for Financial Engineering with Examples in R, Second Edition*, by David Ruppert and David Matteson, Springer-Verlag. Book website. (Links to an external site.) The UW library has access to the UseR series of books from Springer-Verlag. If you have a UW Net ID then you can get access to these ebooks through the UW library page. If you are connecting from a computer that is off-campus be sure to use the Off-Campus login link.

- *A Beginner's Guide to R (Links to an external site.)* by Alain Zuur, Elena Ieno, and Erik Meesters, Springer-Verlag. A direct link to *A Beginner's Guide to R* from the UW library is here (Links to an external site.).
- *R Cookbook (Links to an external site.)* by Paul Teetor, O'Reilly.

II. Recommended Texts

- *Introductory Statistics with R, Second Edition (Links to an external site.)* (Statistics and Computing, Paperback), by Peter Dalgaard, Springer-Verlag, New York.
- *R for Data Science* (Links to an external site.), by Garrett Grolemund and Hadley Wickam, O'Reilly.
- *Modern Portfolio Theory and Investment Analysis (Links to an external site.)*, by E.J. Elton (Links to an external site.) et al., Wiley, New York. This text gives a very detailed treatment of portfolio theory.
- *Financial Modeling (Links to an external site.),* by Simon Benninga. MIT Press. This textbook covers financial modeling using Microsoft Excel.
- *Statistical Analysis of Financial Data in R* (Links to an external site.), by Rene Carmona, Springer-Verlag, 2014. This is a great book but is a bit too advanced for this course. It is used at Princeton in their Master's Program in Financial Engineering. The UW library has access to the UseR series of books from Springer-Verlag. If you have a UW Net ID then you can get access to these ebooks through the UW library page.

Software

The course will utilize R for data analysis and statistical modeling.

R is a free open-source statistical modeling and graphical analysis language built upon the S language developed at Bell Labs and is available on many computers throughout the UW campus. It can be downloaded from www.r-project.org (Links to an external site.). There are versions available for the PC, Mac, and various forms of LINIX. The CSSCR lab, on the 1th floor of Savery Hall, has R on most of the PCs. I highly recommend using RStudio (www.rstudio.org (Links to an external site.)) as 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 with R. The R package **IntroCompFinR** is the companion package for Prof. Zivot's book *An Introduction to Computational Finance and Financial Econometrics with R* and is available on R-Forge here (Links to an external site.).

This package contains data for all of the examples in the book as well as a number of useful functions for data, portfolio, and risk analysis.

Academic Integrity

Academic integrity is the cornerstone of the Department's rules for student conduct and evaluation of student learning. Students accused of academic misconduct will be referred directly to the Office of Community Standards and Student Conduct for disciplinary action pursuant to the Student Conduct Code and, if found guilty, will be subject to sanctions. Sanctions range from a disciplinary warning, to academic probation, to immediate dismissal for the Department and the University, depending on the seriousness of the misconduct. Dismissal can be, and has been, applied even for first offenses. Moreover, a grade of zero can be assigned by the instructor for the course. Behavior that constitutes academic misconduct includes but is not limited to cheating on exams or quizzes (copying answers from others, using unauthorized materials, a student not taking their own quiz/exam, etc.), copying homework answers, plagiarism. You may read more at

https://econ.washington.edu/policy-academic-conduct (Links to an external site.)
https://www.washington.edu/cssc/for-students/student-code-of-conduct/ (Links to an external site.)
http://www.washington.edu/cssc/facultystaff/academic-misconduct/ (Links to an external site.)

Tentative Schedule

Week	Date	Day	Topics	Required Reading	Due 11:59pm
1	6/18	Tue	Return Calculations		
	6/20	Th	Probability Review		
2	6/25	Tue	Matrix Review		
	6/27	Th	Time Series		
3	7/2	Tue	Descriptive Statistics		Lab 1
	7/4	Th	**NO CLASS**		
4	7/9	Tue	GWN Model		Lab 2
	7/11	Th	GWN Model Estimation		
5	7/16	Tue	Bootstrap		Lab 3
	7/18	Th	**Midterm 5:50-8:00 pm EST (Online Via Zoom With Camera On)**		
6	7/23	Tue	Intro to Portfolio Theory		Lab 4
	7/25	Th	Portfolio Theory – Matrix		
7	7/30	Tue	Portfolio Theory – No Shorts		Lab 5
	8/1	Th	Risk Budgeting		
8	8/6	Tue	Rolling Analysis of Portfolios		Lab 6
	8/8	Th	Single Index Model		
9	8/13	Tue	CAPM		Lab 7
	8/15	Th	**Final Exam 5:50-8:00 pm EST (Online Via Zoom With Camera On)**		
	8/18	Sun	**Final Project Due 11:59 pm**		