ECON 424 A Sp 21: Computational Finance and Financial Econometrics

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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 from 2013-2015 and has been taken by over 100,000 students world-wide. Archived videos from this course are available here. 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.

Course Logistics

- Lectures are TTH from 8:30 to 10:20 AM, Remotely on Zoom, Recordings will be available in two or three days. Feel free to send me an email if the recordings are not available after two days.
- Please use the discussion board for homework questions. Students often email me regarding these questions. Very often several students have the same questions, and with the discussion board, everyone can see my responses.
- Office Hours:
    - Tuesday 1 - 2 pm
    - Wednesday 2 - 3 pm

    - Thursday 3 - 4 pm
    - https://washington.zoom.us/j/91235921033

Course Requirements

- Homework and Computer labs 25% (Best 7 out of 8 HWs): due every Thursday by 8 pm PST (submitted online via Canvas). If it is submitted at 8:01 pm 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.
    - Grading Policy (4 pts total):

      2 points for completeness: whether you finish all the questions.

      2 points for a question that is randomly chosen.
- 1 Midterm exam 25% (Tuesday, May 4th, Class time, take-home exam via Canvas)
- Class project 25% - (Due Friday, Jun 4, 2020, at 8 pm via Canvas). W credit will be given if you receive a grade of 3.3 or higher on the class project.
- Final Exam 25% (Tue, Jun 8, 10:30 AM – 12:20 PM, take-home exam via Canvas)

The homework, computer labs, and project comprise the core of the course and have been weighted accordingly for grading purposes. I believe that one cannot obtain an adequate knowledge and appreciation of model building, finance, and econometrics without "getting one's hands dirty" in the computer lab.

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).

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 Dec 3rd, 2020) so please check for updates.

- *Statistics and Data Analysis for Financial Engineering with Examples in R, Second Edition* by David Ruppert and David Matteson, Springer-Verlag. Book website. 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* 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.
- *R Cookbook* by Paul Teetor, O'Reilly.

Recommended Texts

- *Introductory Statistics with R, Second Edition* (Statistics and Computing, Paperback), by Peter Dalgaard, Springer-Verlag, New York.
- *R for Data Science*, by Garrett Grolemund and Hadley Wickam, O'Reilly.
- *Modern Portfolio Theory and Investment Analysis*, by E.J. Elton et al., Wiley, New York. This text gives a very detailed treatment of portfolio theory.
- *Financial Modeling*, by Simon Benninga. MIT Press. This textbook covers financial modeling using Microsoft Excel.
- *Statistical Analysis of Financial Data in R*, 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 and Microsoft Excel for spreadsheet modeling.

Excel is included with all versions of Microsoft office and is available on all PC computers around campus.

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. 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) 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. 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

https://www.washington.edu/cssc/for-students/student-code-of-conduct/

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