Syllabus
MFE 230E: Empirical Methods in Finance
Spring 2024

This version: March 16, 2024

Instructor: Michael Bauer
GSIs: Andrew Perry and Anand Bharadwaj
Course website: https://bcourses.berkeley.edu/courses/1530541
Final exam: May 14, 9:00–12:00

Course Schedule

Lecture:	Tue 8:00–10:00, Wed 10:00–12:00, F320
Python lab:	Wed 1:00–3:00pm, F320
GSI section:	Fri 9:30–11:00, F320

Office hours

Michael Bauer:	Wed 3:00–4:00pm, F320
Andrew Pery:	Fri 11:00–12:00, F320
Anand Bharadwaj:	Wed 4:00–5:00pm, F320

Communication

- **Please use our Slack channel for all communication:** #mfe230e_2024
- The bCourses e-mail inbox will not be monitored.

Course Objectives

- Understand theory and application of financial time series in depth.
- Learn how to apply these methods to financial data.
- Understand which models work well and which ones do not.
- Understand *why* models work well or don't work well (remember: *every* model is wrong!).
- Understand appropriate limits of econometric methods in finance.
- Develop a toolbox of econometric methods.

Prerequisites

- Intermediate probability and statistics
- Intermediate mathematics
- Working knowledge of Python
  (Prerequisites are equivalent to the material covered in the pre-program Statistics, Mathematics, and Python courses.)

Grading

- Final exam: 60%
- Problem sets: 30%
- Class participation: 10%

Problem Sets

There will be weekly problem sets. These problem sets are a crucial component of the course as you will apply what you have learned in the lectures. The homework sets will mostly consist of empirical exercises using real financial data. You will create your own library of Python code that will be helpful throughout your career in finance. Problem sets may be completed and submitted in groups (make sure that names of all group members are listed on the problem set). Only original material will be accepted, e.g., solutions with screen shots are not accepted.

Problem sets have to be submitted via bCourses before the deadline stated on the problem set. Late problem sets will not be accepted. If, for whatever reason, you cannot log into bCourses to submit a problem set, you need to e-mail the problem set to Andrew Perry before the deadline to receive credit and submit to bCourses later.

Most problem sets include questions that ask you to write your own Python code. In many cases, you will be asked to write your own routines rather than use packages (such as `statsmodels`). For example, if the problem set asks you to estimate a GARCH model by maximizing the likelihood function, you may not use the Python `arch` package, but need to write a routine that creates the likelihood function yourself. You may use a package to numerically maximize the likelihood function (e.g., `scipy.optimize`). If you are unsure about what packages you may use, please ask on the Slack channel!

"Midterm"

We will distribute a "midterm exam" at the end of week 4. The "exam" will not be graded and you do not have to hand in your solutions. I recommend that you take the midterm at home under "exam conditions" in no more than 90 minutes. Solutions will be posted on bCourses.

Class Participation

Class participation is crucial to the success of this class. You will get the most out of this course if you come to each lecture prepared and ask questions. We will cover a lot of material in a short amount of time and many of the concepts are challenging. We urge you to ask clarifying questions or ask us to explain a concept again. Remember, if you are confused, odds are that others are confused as well. Class participation will count 10% towards your final grade.

Python Lab

In the lab sessions, we apply the methods we cover in the lectures using real and simulated data. We will distribute Jupyter notebooks before each lab and then go through the code during the lab. Please bring a laptop with a working Anaconda distribution (Python 3.9x) to each lab. Please ensure that you can run the notebook on your laptop before the lab session, as we do not have

enough time to troubleshoot people's setup during the lab. It is also recommended to study the notebook *before* the lab session.

The document `Python for Haas MFE Students` (available on bCourses under `Files` in the folder `Python`) contains information about Python resources and instructions on how to install Python 3.9x using the Anaconda distribution. The document also lists packages that we will use throughout the class. I strongly recommend that you create a `conda` environment specifically for the class using the `mfe230e.yml` file (available on bCourses in the same folder). See `Python for Haas MFE Students` for instructions. Moreover, make sure that your laptop can connect to the internet (e.g., via the campus eduroam network, see https://technology.berkeley.edu/wi-fi.)

Exam

The exam is closed-book, but you can bring one double-sided cheat sheet and may use a financial calculator. You are not allowed to use any other materials during the exams, such as other textbooks, lecture notes, or problem set solutions. You may not bring a laptop, PDA, cell phone, or any other device that allows you to access the internet. Per MFE policy, all examinations will be videotaped to assure academic integrity.

Honor Code

All students agree to abide by the Berkeley Campus Code of Student Conduct and the supplemental MFE Code of Student Conduct, which you signed upon entering the program.

Lecture Slides and Other Course Material

The slides for the lectures will be posted on bCourses. All additional reading material will be announced before class and will also be available on bCourses.

Textbooks and Other Reference Material

Required: David Ruppert and David Matteson, *Statistics and Data Analysis for Financial Engineering with R Examples, 2nd edition*, Springer, 2015

Optional:

- James Hamilton, *Time Series Analysis*, Princeton University Press, 1994
  An invaluable (advanced) reference textbook for time series methods
- John Cochrane, *Time Series for Macroeconomics and Finance*, short online book available at
  https://www.johnhcochrane.com/research-all/time-series-for-macroeconomics-and-finance
  Very useful summary of time series tools used in finance
- Ruey Tsay, *Analysis of Financial Time Series*, 3rd ed., Wiley, 2010
  Strongly recommended but somewhat more advanced than Ruppert
- Campbell, Lo, MacKinlay, *The Econometric of Financial Markets*, Princeton, 1997
- John Cochrane, *Asset Pricing*, revised edition, Princeton, 2001
  Very good treatment of GMM and cross-sectional asset pricing tests
- Fumio Hayashi, *Econometrics*, 2001
  My favorite "general" econometrics textbook

- Shumway and Stoffer (SS): *Time Series Analysis and Its Applications, EZ Edition*, pdf available on bCourses (under CC BY-NC 4.0 license).
  Useful background text for time series
- The 2013 Nobel Prize in Economics was awarded to three finance researchers: Eugene Fama, Lars Hansen, and Robert Shiller. The research of all three laureates will be featured in this class. You should to watch their Nobel lectures (https://www.youtube.com/watch?v=WzxZGvrpFu4).

Popular books:

- Burton Malkiel, *A Random Walk Down Wall Street: The Best Investment Guide That Money Can Buy*
- Roger Lowenstein, *When Genius Failed: The Rise and Fall of Long-Term Capital Management*
- Andrew Ross Sorkin, *Too Big To Fail*
- Michael Lewis, *Liar's Poker*

Course outline

1. Linear time series models: ARMA models, stationarity, unit roots
2. Estimation of AR models
3. Generalized least squares, instrumental variables, vector autoregressions
4. Cointegration, present value relationships, market efficiency, tests of stock return predictability, analysis of the price-dividend ratio
5. Cross-section of stock returns: empirical tests of the CAPM, Fama-French models
6. Volatility: GARCH models, realized, implied, and stochastic volatility
7. Principal component models, factor models, Kalman filter, state-space models
8. Markov Chain Monte Carlo (MCMC), stochastic volatility