USC Marshall
School of Business

PRELIMINARY & SUBJECT TO CHANGE

FBE-499: QUANTITATIVE INVESTMENT ANALYSIS
Fall 2022
4.0 units
MW 4:00 p.m. - 5:50 p.m.

Instructor: Christopher S. Jones

Office hours (Zoom): Tuesdays 8:30a.m.-9:30a.m.
Thursdays 11:30a.m.-12:30 p.m.

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COURSE DESCRIPTION

Modern investment management is increasingly quantitative in nature, and investment strategies are more and more determined by the output of data-driven models rather than the subjective views of analysts and portfolio managers. In this course, we will learn how to build, test, and implement the types of models in use today by quantitative asset managers.

This course focuses on the prediction of asset returns, and to a lesser extent asset volatilities, with the goal of constructing profitable investment strategies. We will discuss what is already known about financial markets, but our focus will be on learning how to create knowledge rather than acquire it second-hand. This is a key difference relative to other investments courses (e.g., FBE 441), which familiarize students with summaries of existing studies rather than doing any deep data analysis themselves. In addition, this course is less about the construction of optimal portfolios than it is about finding specific investment strategies, with attractive risk/return properties, that are useful as components of a larger, more diversified portfolio. Put differently, in a typical investments course you would learning the skills necessary for a portfolio manager. In this course, we are learning the skills to be a buy-side quantitative researcher.

The sophisticated data analysis required to do quantitative investment research requires a knowledge of coding, and this course has a substantial programming component, which will be carried out in Python. That said, learning to code is not the main goal. The course will not provide students with a general knowledge of Python, but rather only the components of Python necessary to do the buy-side quant research that will be our focus. These components

are very different from those that a derivatives-focused course would use, and they are much more limited than those that a general programming course would cover.

In short, the course is intended to be highly complementary to those that already exist at USC and many other universities.

LEARNING OBECTIVES

Upon successful completion of this course, students will be able to:

1. Assess the performance of quantitative investing strategies.

2. Perform the statistical analysis and computer programming necessary for predicting the magnitude and volatility of asset price returns.

3. Propose and test new factors that affect the distribution of stock returns.

4. Present their investment ideas and results in a way that is understandable to the layperson and to the finance professional.

COURSE MATERIALS

There is no required textbook for the course. The videos that I am creating, to be watched outside of class, are a partial substitute. More significantly, there will be numerous required readings, listed below, as well as course notes that will be available on the course web site at least one week prior to the class in which they are scheduled to be discussed.

Readings are a mix of teaching notes, industry white papers, articles from practitioner-oriented journals such as the *Journal of Portfolio Management*, and some articles from academic-oriented journals like *Management Science*. White papers and articles from practitioner journals are usually written by practitioners for use by other practitioners. Articles from the premier finance journals are usually written by academics, but they are widely read by sophisticated industry people as well. These will be more challenging, but I will do my best to walk you through them. In some cases, teaching notes will help prepare you to tackle more difficult readings. In other cases, teaching notes will be the only reading on a particular topic.

There are many books that are potentially useful as references. A standard investments text such as the following will be useful for general background:

> *Essentials of Investments*, by Zvi Bodie, Alex Kane, and Alan Marcus, McGraw Hill

A Python reference will also be useful. The one I recommend to all students is

> *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython*, 2nd edition, by Wes McKinney, O'Reilly

Another that is free and relatively up-to date is

Introduction to Python for Econometrics, Statistics and Data Analysis, 4rd edition, by Kevin Sheppard, available at https://www.kevinsheppard.com/Python_for_Econometrics

Finally, each student will need to be able to bring a laptop to class. The laptop should be running Python 3.4 or higher and have the ability to run the Jupyter notebook. I strongly recommend the use of the Anaconda distribution and Anaconda Navigator.

PREREQUISITES

Note: The USC course registration system may allow students to enroll even if you do not meet the course's prerequisites. After you enroll in the course, I will ask you to submit a questionnaire on whether you meet the criteria below. Students failing to meet the criteria will be dropped from the course.

For all students, the prerequisites are BUAD 310 in addition to either BUAD 215, 306, or 308. I expect all students taking this course to understand the basic math of investing. This includes but is not limited to (1) calculating rates of rate of return from stock prices and dividends, (2) computing portfolio returns as weighted averages of individual asset returns, (3) the dividend discount model, and (4) the mathematics of short selling and leverage.

In terms of statistics, I expect that all students will have a high level of comfort with (1) basic statistics like mean, variance, covariance, etc., (2) the implementation of and assumptions behind OLS regression, and (3) statistical hypothesis testing.

I encourage all students contemplating the course to make an appointment with me if they are unsure about whether they meet these requirements.

COURSE FORMAT

The course will meet twice per week, following the schedule typical for a 4-unit elective. In addition, a moderate amount of material will be pre-recorded, to be viewed online prior to class. Much but not all of this is related to Python coding. If you have not coded in Python before or are missing a prerequisite, then expect to watch 45 minutes of videos per week outside of class. In some cases, a list of discussion questions will be distributed prior to the week in which the videos are to be watched. Be prepared to answer these questions in class.

The main purpose of the videos is to cover material that some but not all of the students have already seen in other courses. Having this material online will allow students to absorb lecture material at their own pace. Students will have a variety of different backgrounds and prior coursework, which will determine in part how difficult these lectures will be to understand.

GRADING

The course will include a midterm, a final exam, six problem sets, and a final project.

The first three problem sets are to be done individually. Subsequent problems sets and the final project are to be done in groups of 2-4 students. The same group should work together for all assignments and the final project. At the beginning of the semester, I will ask students to propose their own teams, though I reserve the right to modify the membership of teams that are too unbalanced in terms of prior knowledge and experience.

The overall course grade is determined by the following percentages:

Midterm exam	20%
Final exam	25%
Problem sets	20%
Final project	25%
Class participation	10%

Prior to computing the course grade, I standardize midterm and final grades by subtracting the mean and dividing by the standard deviation. Other components of the course grade are not standardized but are rescaled to be between 0 and 1.

The midterm and final will focus on the financial concepts covered but will also include basic programming concepts. The midterm will be held during class on 10/?/2022. The final will be on 12/?/2022 from ?:00am to ?:00pm. Makeup exams are available for students with a valid medical excuse or who get prior approval from me.

Homework assignments will generally require the submission of a single Jupyter notebook file. These assignments will be graded with some allowance for errors. Grades will be determined by three factors. One is the completeness of the assignment. A problem set that is finished with good effort will not be overly penalized if it contains a reasonable number of mistakes. The second factor is performance in answering questions in class related to the homework. Some of your assignments will allow you to be creative, and the class will benefit from a coherent explanation of how you approached the assignment and what your results were. Note that these questions will be posed to individuals, not to teams, so each team member must be prepared to discuss. The final factor in your problem set grade is a peer evaluation. This is described in more detail in the appendix below. All problem sets will count equally towards this part of your grade.

The final project consists of the design, research, testing, and implementation of an original quantitative investment strategy. Aim for a report of 10-20 pages in addition to the submission of all Python code used in the report. As with homework, your project grade will be determined by several factors. This includes the quality of your report in terms of both the concept and the execution. (The final project should be correct!) It also includes a final presentation, in which each member of the team should expect to be asked a number of questions about the project. Finally, it includes a peer evaluation.

For both the problem sets and final projects, peer evaluations will only affect your grade if there is a consensus that a team member contributed significantly less or more to the group effort. In most cases, I expect all team members to receive equal scores. If a consensus exists that the contributions of the team members differed significantly, scores will differ by no more than 25%.

The class participation score will be determined primarily based on contributions in discussions of videos and readings. Participation credit can be earned by asking good questions or responding to the questions of others (including myself). Participation credit can also be earned by doing the same things in the online discussion forum. I also encourage all students to raise topics in class that are related to quantitative investing but not otherwise covered in the course.

If you feel that an error has occurred in the grading of any test or assignment, you may request a regrade of that assignment within one week of receiving your grade. In any request, I ask that you carefully explain why you think the assignment should be re-graded. Be aware that it is possible that the re-evaluation process will result in a lower grade.

STATEMENT ON ACADEMIC CONDUCT AND SUPPORT SYSTEMS

Academic Conduct:
Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, "Behavior Violating University Standards" policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. For additional information in SCampus and university policies on scientific misconduct, see http://policy.usc.edu/scientific-misconduct.

Students with Disabilities:
USC is committed to making reasonable accommodations to assist individuals with disabilities in reaching their academic potential. If you have a disability that may impact your performance, attendance, or grades in this course and require accommodations, you must first register with the Office of Disability Services and Programs (www.usc.edu/disability). DSP provides certification for students with disabilities and helps arrange the relevant accommodations. Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to your TA) as early in the semester as possible. DSP is located in GFS (Grace Ford Salvatori Hall) 120 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776. Email: ability@usc.edu.

Support Systems:
Counseling and Mental Health - (213) 740-9355 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.
https://studenthealth.usc.edu/counseling

National Suicide Prevention Lifeline - 1-800-273-8255
Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. http://www.suicidepreventionlifeline.org

Relationship & Sexual Violence Prevention Services (RSVP) - (213) 740-4900 - 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender-based harm. http://studenthealth.usc.edu/sexual-assault

Office of Equity and Diversity (OED) – (213) 740-5086 / Title IX compliance – (213) 740-5086
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. https://equity.usc.edu https://titlex.usc.edu

Bias Assessment Response and Support – (213) 740-5086 or (213) 821-8298
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity |Title IX for appropriate investigation, supportive measures, and response. https://usc-advocate.symplicity.com/care_report

Student Support & Advocacy – (213) 821-4710
Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. https://studentaffairs.usc.edu/ssa/

Diversity at USC – (213) 740-2101
Tabs for Events, Programs and Training, Task Force (including representatives for each school), Chronology, Participate, Resources for Students. https://diversity.usc.edu/

USC Emergency Information – UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible. https://emergency.usc.edu

USC Department of Public Safety – UPC: (213) 740-4321, HSC: (323) 442-1000 – 24-hour emergency or to report a crime.
Non-emergency assistance or information. https://dps.usc.edu

Office of the Ombuds - (213) 821-9556 (UPC), (323)-442-0382 (HSC)
A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.
https://ombuds.usc.edu

TENTATIVE COURSE OUTLINE AND ASSIGNMENTS

Lecture	Lecture topics	Readings	Videos
1	Introduction to the course		Jupyter Notebooks, Introduction to Dataframes
2	Taxonomy of quantitative investing		Extracting Columns from Dataframes
3	Python/Pandas basics		Introduction to Indexes, Extracting Rows from Dataframes
4-5	Trading and market structure	"Crypto Trading 101: How to Read an Exchange Order Book" teaching notes on the limit order book	Trading, Working with Indexes
6	Portfolio performance evaluation	teaching notes on performance evaluation	Common Dataframe Methods
7	Introduction to backtesting	teaching notes on backtesting	The Rolling Method, OLS Regression
8-9	Volatility prediction	teaching notes on volatility modeling Li, Zhang, and Zhang, "The information content of Chinese volatility index for volatility forecasting," Applied Economics Letters, 2020	For Loops and Vectorization, Asset Allocation Parts 1 and 2
10-11	Market return prediction	teaching notes on optimal asset allocation Hull and Qiao, "A practitioner's defense of return predictability," Journal of Portfolio Management, 2017	Asset Allocation Parts 3 and 4
12	Technical analysis	Neely, Rapach, Tu, and Zhou, "Forecasting the Equity Risk Premium: The Role of Technical Indicators," Management Science, 2014	If Statements
13	Review session		
14	Midterm		
15-16	Return reversal	de Groot, Huij, and Zhou, "Another look at trading costs and short-term reversal profits," Journal of Banking and Finance, 2012	Multi-Indexes, The Groupby Method
17	Fama-Macbeth regression	teaching notes on Fama-Macbeth	

18-19	Momentum	Asness, Frazzini, Israel, and Moskowitz, "Fact, Fiction, and Momentum Investing," Journal of Portfolio Management, 2014	
20	CRSP and Compustat	teaching notes on WRDS databases	
21-22	Value investing	teaching note on valuation ratios Gray, "The Quantitative value investing philosophy," alphaarchitect.com, 2014	
23	Profitability, quality, and growth	Walkshäusl, "Piotroski's F-Score: international evidence," Journal of Asset Management, 2020	
24-25	Volatility and beta anomalies	van Vliet and Blitz, "The conservative formula: Quantitative investing made easy," working paper, 2018	
26	Applications of machine learning in quant investing		
27	Intro to algo trading		
28-29	Student presentations		
30	Review session		

Appendix II

PEER EVALUATION FORM

Please identify your team and team members for the ____ Project(s) that you worked on. Then rate all your team members, *including yourself,* based on the **contributions** of each team member for the selected assignment according to the criteria listed below. On a scale of 0 to 2, with 0 indicating does not meet expectations, 1 meets expectations and 2 exceeds expectations, rate each person on each of the five criteria. Lastly, add up the points for each person with the maximum number of points for each person being 10. In the box below, describe the exact contributions of each team member, including yourself.

Team Members/ Assessment Criteria of Team Contributions	Team Member 1	Team Member 2	Team Member 3	Yourself
1. Conceptualization of the project (coming up with the idea, the scope, and/or the application)				
2. Managing the assignment (making a work plan, keeping the group on track)				
3. Execution (locating and cleaning data, coding)				
4. Written exposition (writing, preparing figures)				
5. Presentation prep (creating presentation slides, prepping group members for questions)				
Total				

Contribution details: