ECON 147 - Computational Finance and Data Analysis for Financial Engineering

(Spring, 2018)

UCLA, Department of Economics

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Time and Location: Monday and Wednesday, 12:30pm-1:45pm, HUMANTS A65

E-Mails: Please make sure that your full name with proper capitalization and Economics 147 appear in the "Sender" and in the "Subject" lines; I routinely delete suspicious e-mails without opening them. It is also advised to send emails from your ucla.edu account since emails from other accounts might be automatically classified as spam.

Office Hour: Wednesday 1:45 pm – 3:00 pm. My office is at 8379 Bunche Hall.

Description: This course is an introduction to econometric modelling in empirical/computational finance. The focus is to study econometric models and methods to understand financial market dynamics. We first begin by reviewing the essential concepts in probability/statistics and time series econometrics. Then some popular financial econometric models and estimation methods will be investigated. Finally, we review selected topics in finance, and learn how to apply the econometric methods to analyze and understand the empirical properties of financial market data. Both analytical problem sets, and data exercises will be assigned as homework to enhance our theoretical understandings and practical skills. We will use the software *R* for empirical analysis in class and data exercises in homework. I will arrange several lab sessions (**optional and not required**) during the quarter to get you familiar with *R*.

Required Textbook:

An Introduction to Computational Finance and Financial Econometrics, by Eric Zivot, manuscript in preparation. Pdf files will be provided through course webpage.

Supplemental Textbooks (Optional):

A Beginner's Guide to R, by Alain Zuur, Elena Ieno and Erik Meesters, Springer-Verlag.

Statistics and Data Analysis for Financial Engineering (2nd edition), by David Ruppert, Springer-Verlag.

The Elements of Financial Econometrics, by Jianqing Fan and Qiwei Yao, Cambridge University Press.

Course Outline:

Week 1. Course Introduction, Understanding Financial Returns

- Course introduction
- Stylized facts of financial data
- Computing asset returns

Week 2. Review of Concepts in Probability

- Characteristics of distributions
- The normal distribution
- Quantiles of a distribution
- Value-at-Risk
- Bivariate distributions
- Covariance, correlation, autocorrelation
- Linear function of random variables

Week 3. Review of Concepts in Statistics

- Descriptive statistics: histograms, sample means, variances, covariances
- The constant expected return model
- Standard errors of estimates
- Confidence intervals
- Hypothesis testing

Week 4&5. Time Series Econometrics

- Strictly stationarity and covariance stationarity,
- ARMA process
- Estimation and Inference of ARMA
- Time series forecasting
- Information set and conditional expectation
- Martingale and martingale difference
- Nonstationary time series
- Testing random walk

Week 6&7. Conditional Volatility Models

- Volatility clustering of asset returns
- ARCH(1) model
- GARCH(1,1) model
- Stochastic volatility model (tentative)
- Estimation and inference of GARCH model
- Mid-term Exam

Week 8&9. Portfolio Theory

- Financial risk of portfolio
- Portfolio frontier and efficient portfolios
- Two fund separation theorem
- Statistical analysis of efficient portfolios
- Matrix review
- Portfolio theory with matrix algebra

Week 10. Factor Pricing Model (Tentative)

- Market portfolio
- Mean, variance and covariance of the asset returns
- Estimation and inference of the factor model
- Multi-factor asset pricing models
- CAPM (tentative)

Homework: Homework problems will be posted bi-weekly on the course web site:

https://moodle2.sscnet.ucla.edu/course/view/18S-ECON147-1

and will be due by next week (before class). Please use our course webpage for your questions. In this way we can openly discuss what are difficult and how to overcome. You can discuss problem sets with classmates, but have to submit your own answers. Problems sets are mainly to encourage you to "practice", and doing them by yourself will be the most important task in this class. Around **60%** of midterm and final questions will be based on the homework problems. Numbers will be changed, so you should really understand how to solve these problems.

Exams: There will be an in-class **mid-term exam** on **Monday, May 7, 2018**, and a final exam. The date of the final exam is decided by the university, and it is your responsibility to find the final exam schedule and location. (Last time I checked the registrar's web page, it is administered on **Monday, June 11, 2018, 3:00pm-6:00pm.**) Here are some important policies about the exams.

1. The midterm will cover everything discussed during the **April 2, 2018 – May 2, 2018** window. The final exam will cover everything discussed this quarter, including the material covered in the midterm exam.
2. In all exams, you are required to bring a calculator. The only acceptable calculator is Canon LS-100TS. It can be bought from ASUCLA book stores.
3. No cheat sheet is allowed in all exams.
4. Cell phones, PDAs or any other electronics are not allowed during the exams.
5. In both exams, you should write down your name and UID in both the answer sheet and the exam paper. The exam paper should be turned in together with the answer sheet for the full consideration of your grade.

Evaluation: Your final letter grade will be based on the weighted average of the assignments, the midterm exam and the final exam. No other factor will be considered when your letter grades are determined. The weights given to the assignments, the midterm and final examinations will be 20%, 30% and 50%, respectively. Roughly speaking, I will assign 30% students some A's, 40% students some B's, and 20% students some C's. In order to eliminate any ambiguity arising from ties, I will use the precise mathematical algorithm described below:

- Your score of the assignments will be divided by the maximum possible score, and then multiplied by 100. Call it H. Your midterm score will be divided by the maximum possible midterm score, and then multiplied by 100. Call it *M*. Likewise, your final score will be divided by the maximum possible final score, and then multiplied by 100. Call it *U*. Your weighted average *W* is calculated by the formula $W = H \times 0.2 + M \times 0.3 + U \times 0.5$.
- **Algorithm 1.** If $95 \le W$, you will get A+. If $85 \le W < 95$, you will get A. If $80 \le W < 85$, you will get A-. If $75 \le W < 80$, you will get B+. If $70 \le W < 75$, you will get B. If $65 \le W < 70$, you will get B-. If $60 \le W < 65$, you will get C+. If $55 \le W < 60$, you will get C. If $50 \le W < 55$, you will get C-. If $W < 50$, you will get F.
- **Algorithm 2.** Your *W* will be compared with every other *W*. Define your *r* to denote the number of students in class whose *W*'s are strictly higher than your own *W*.
    - Let $W_1, \ldots, W_n$ denote the weighted averages of all the students in class, where *n* denotes the number of enrolled students. Let *W* denote your weighted average. Let $Z_i = 1$ if $W_i > W$, and let $Z_i = 0$ otherwise. Your *r* is defined to be $\sum_{i=1}^{n} Z_i$.
    - Define your rank *R* by the formula $R = r + 1$.
    - Let n1, n2, n3, n4, n5, n6, n7, n8 and n9 denote the smallest integers larger than or equal to 0.05×n, 0.20×n, 0.30×n, 0.40×n, 0.60×n, 0.70×n, 0.80×n, 0.85×n and 0.90×n respectively.
    - If $R \le$ n1, you will get A+. If n1 $< R \le$ n2, you will get A. If n2 $< R \le$ n3, you will get A-.
    - If n3 $< R \le$ n4, you will get B+. If n4 $< R \le$ n5, you will get B. If n5 $< R \le$ n6, you will get B-.
    - If n6 $< R \le$ n7, you will get C+. If n7 $< R \le$ n8, you will get C. If n8 $< R \le$ n9, you will get C-.

    - If n9<*R*, you will get F.
- Your **final grade** will be the **maximum** of the two grades determined in algorithms 1 and 2 above.
- Just to be clear, the symbols < and ≤ have completely different mathematical meanings. Moreover, we have A+ > A > A- > B+ > B > B- > C+ > C > C- > F.

Other Rules: Consult the Common Syllabus, which can be found at:
http://www.econ.ucla.edu/undergraduate/?p=commonsyllabus.
Rules governing missed exams, e.g., can be found there.