QUESTROM SCHOOL OF BUSINESS, BOSTON UNIVERSITY

MF 840: DATA ANALYSIS AND FINANCIAL ECONOMETRICS
SPRING 2021

Pr. Eric Jacquier **Office:** SMG 548B **Email:** jacquier@bu.edu

Overview

MF840 is the second course of the econometrics sequence in the Math. Finance MSc program. It expands on MF793. After a quick review of regression analysis, the course moves to 1) more advanced econometric techniques and 2) econometric models of special interest to quantitative finance.

The course starts with a review of OLS, and moves on to GLS and Seemingly Unrelated Regressions (**SUR**). It then covers Maximum Likelihood Estimation (**MLE**) and its practical applications for estimation, concentrating on the normal model. After that, the core of the course concentrates on Bayesian Inference, now an unavoidable mainstay of Financial Econometrics. After learning the basic principles of Bayesian Inference, we study their implementation for central and recent models in finance, especially related to portfolio construction and volatility forecasting. A major impediment to the Bayesian framework has long been that only the most trivial cases had an analytical solution. Over the last twenty years, radical advances in simulation methods, and the vast increase in computer power have changed this. The absence of analytical solutions for estimation and forecasting is not a problem anymore since one can design convenient simulation methods. Therefore, after studying basic, aka Direct, Monte Carlo simulation methods, we will study the more advanced simulation methods of Markov Chain Monte Carlo (**MCMC**).

The course also covers the major issues in financial econometric modeling, such as the two pass method to estimate asset pricing models, estimating possibly large covariance matrices, factor and principal component analysis, assessing the predictability of financial returns, time varying volatility by GARCH or stochastic volatility (SV) models.

Schedule

The class meets weekly: Th 8:00 – 10:45 am, D1 Online
Th 12:30 – 3:15 pm, D2 Online and in HAR 224

- Every week, in-person students registered in the D2 section declare their intent to come to class via the new LfA app.

Teaching Assistants, Office Hours

		Office Hour
Ketong Lin	ktlin at bu dot edu	Tuesday 6:00pm – 7:00pm
Zeyu Zhu	zz918 at bu dot edu	Friday 6:00pm – 7:00pm

My office hours: Wed 6:00pm – 7:00pm

- Office hours may change. Always follow the latest announcement on Questrom Tools. Changes in the schedules will be posted on the course site.
- You are welcome to go to any TA's office hour. Both Ketong and Zeyu are greatly experienced with the course material

Course Requirements and Grading

The course requirements involve several (possibly computer intensive) assignments, and two partial exams. The following weighting scheme will determine the course grade:

33%	Assignments	
34%	Exam 1	Thursday March 5th morning period online
34%	Exam 2	Wednesday May 6th, 3:00 – 5:00.

Up to 6 extra participation points can be earned

Participation

- Participation is made of attendance, attention to the lecture and ... participation in the class!
- Attendance is necessary but not sufficient: lack of attendance will hurt your participation points, simply attending will not give you participation points.
- Saying that you studied a lot will not give you participation points
- Not attending the whole lecture regularly, not having your video on, are sure ways to get no extra points.
- To get participation points, you will need to participate by asking or answering questions during the lecture
- If you have questions, you need to ask them during class, not during the break

Exam

- Absence from the exam leads to a zero grade unless officially excused before the exam for documented medical and family emergencies.
- You can not miss an exam for interviews or **any** professional reason. Responsible interviewers do not infringe on your academic calendar and you need to tell them when you have exams.
- Exams will be online in a style similar to MF793, that is, similar in style to the assignments, lecture notes, and class exercises and discussions.
- Exams will be managed through GradeScope as for MF793

Assignments

- There will be at least 4 assignments, to be done and handed in in groups of one or two at most, no exception. You can a make groups across D1/D2.
- Assignments are graded on a check minus, check, check plus scale.
- Assignments are turned in on GradeScope as we did in MF793 in the end. Late Assignments will not be graded.
- All algebra and any non-computer non-R based work **must be hand-written and then scanned**. Do not use Word or Latex to write homework algebra, it's a waste of your precious time.
- Every member of a group is supposed to have done everything on the assignment. In the past, students who did not fully participate in their group got their assignment points revoked. Feel free to fire your assignment partner if he/she does not work enough.

Course Material

Lecture notes and readings will be posted ahead of class on the course web site.

Not one book covers this syllabus and any book includes topics not covered in this course. However, the following books will be very extremely useful for the course and after if you work in the field. To supplement the lectures, I will recommend readings from:

- General Econometrics:

  Econometric Analysis, Greene

- Bayesian Econometrics:

  Bayesian Econometrics, Gary Koop, Wiley, 2003.

- Time Series Analysis book:

  Time Series Analysis, J.D. Hamilton **The** classic textbook in Time Series analysis

  The Analysis of Financial Time Series, Ruay Tsay. Ruay is a renowned econometrician from Chicago with interests in Finance

Also recommended:

- *The Theory that would not die: How Bayes' Rule Cracked the Enigma Code*, Sharon Bertsch McGrayne, Yale University Press. Also available as an e-book
  A fun easy reading book on some famous applications of Bayes Theorem

- *The Econometrics of Financial Markets*, Campbell, Lo, McKinlay, Princeton University Press.
  Especially chapters 1, 2, 5. A classic but not updated in a long time. Still quite interesting if you work in the quantitative analysis of financial markets.

- An introduction to the Analysis of Financial Data with R, Ruey Tsay

  Companion to the original book, lots of examples of code, very useful

- *Introducing Monte Carlo Methods with R*. By Christian Robert. Available as an e-book and as a paper back on Amazon.

  Robert is one of the foremost Bayesian specialists of MCMC simulation techniques. He is not in Finance.

- Also useful but with some overlaps: Jim Albert, *Bayesian computation with R*, Springer

Two intense Bayesian Econometrics textbooks by two luminaries:

- John Geweke, *Contemporary Bayesian Econometrics and Statistics*, Wiley, 2005.
  Recent, dense, a lot on computations as well as theory.
  Geweke is one of the very top Bayesian statisticians.

- Arnold Zellner, In*troduction to Bayesian inference in Econometrics*, Wiley Classics, 1971
  The classic, a bit old, no simulation technique but all the concepts.
  Zellner is one of the founders of Bayesian Econometrics

Course Topics

We start with a brief review of MF793 topics and then move on to Bayesian and Simulation estimators. We will cover the following topics *not necessarily in the following order*.

1 Review of OLS and GLS:
  GLS
  Important for Finance: Seemingly Unrelated Regressions (SUR)

2 Maximum Likelihood Estimation (MLE)
  The Delta Method
  The Multivariate Normal Density, estimating mean vector and covariance matrix

3 Some Finance topics
  Estimating Long Term Returns
  Estimating CAPM parameters and Factor prices, the two-pass method of Fama-McBeth

4 Testing, significance level and power
  Hotelling T^2, Wald, Likelihood Ratio, Lagrange Multiplier test.
  Effect of data mining (data snooping) on the significance level
  Bonferroni and Hotelling significance levels

5 Bayesian inference:
  Priors and posteriors,
  Decision theory and estimation, risk of an estimator, loss function,
  Prediction
  Model comparison: odds ratios vs. classical testing, Model averaging
  Savage Density Ratio

7 Direct Monte Carlo simulation and integration
  Numerical Accuracy

8 Markov Chain Monte Carlo methods
- Accept Reject sampling
- Gibbs Sampling
- Metropolis algorithms (independence and random walk)
- Odds ratios within MCMC

9 Modeling large Covariance matrices:
- Principal Components and Asymptotic Principal Components
- MLE and Bayes factor analysis,

10 Time Series Models: ARMA models

11 Time Varying volatility
- GARCH models
- Covariance matrices: Engle's Dynamic Conditional Correlations (DCC) model
- Stochastic Volatility (SV) models

12 Kalman filter: the Filter, the Update, the Smoother