Ec509: Topics in Econometrics with Applications

Dr. Ani Dasgupta
Economics Department,
Boston University
and
International Maritime Business Department,
Mass. Maritime Academy

Office: Econ Department, Room 414
Office Hours: T, Th 8.15 – 9.45 pm or by appointments
Email: AniruddhaDG@aol.com

Course Overview

Ec509 is an elective course for the MA program in the Economics Department at BU. It could be viewed as an optional addendum to the two-part sequence of Statistics (Ec507) and Econometrics (Ec508) that is part of the core curriculum of the MA program.

The course introduces students to a) standard time series techniques and time permitting, b) a few advanced cross-sectional techniques while emphasizing their applications in Social Sciences (e.g. Economics and Politics) and Business (e.g. Finance and Marketing). Several topics in these two areas are described in an outline that follows; however, the list contains lot more topics than can be covered in one semester. The ones actually covered in the course will depend on student and instructor interest as well as time constraints. The time series topics include univariate Box-Jenkins modeling, unit roots and trends, vector autoregression, cointegration, nonlinear models and issues in forecasting. The advanced cross-sectional topics include Bayesian methods, bootstrap and other simulation based methods.

The course is not a cookbook course – we do rigorously prove many fundamental theoretical results – but our eventual interest is mainly in applying econometric tools to applied settings, and consequently quite a few theoretical results will be assumed. Besides textbook material, the course requires students to study several articles. However, as the field of time series and modern cross-sectional econometrics can be technically very demanding, and our emphasis is not on theoretical econometrics, we study papers confined to three categories: classic path-breaking papers, survey articles and application papers. Not all the papers mentioned in the accompanying reading list will be discussed in detail; however, we will attempt to thoroughly understand the core contributions made by several of them.

It is very much hoped that learning the techniques discussed in this course will encourage students to write an original research paper; however this is not required.

1 The reason for inclusion of standard time-series techniques and advanced cross-sectional techniques is that time series techniques are hardly addressed in Ec508, while standard cross-sectional techniques are covered in quite a bit of detail.
Prerequisites

There are four pre-requisites. Students need to have

- a graduate level background in mathematical statistics (fulfilled by Ec507 or something similar)
- a graduate level background in econometrics (fulfilled by Ec508 or something similar)
- a high level of comfort with matrix algebra
- a high level of familiarity with a statistical/ econometrics /mathematical modeling package including programming ability and the ability to run simulations in that package (In particular, the ability to perform maximum likelihood estimation will be very helpful).

If you are interested in the course, but do not have one or more of these pre-requisites, please consult the instructor before registering. If you have done coursework in graduate level macroeconomics and finance, you will enjoy the applications more, but this is not a prerequisite.

Grading

Students will be graded on a midterm, a final, a team research project or a presentation and finally, a class performance / subjective component. The weights on the various criteria are as follows:

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<th>Criteria</th>
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<tr>
<td>Midterm</td>
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<td>Final</td>
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<td>Class Performance</td>
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<td>Project/Presentation</td>
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Both projects and presentations are normally to be done in two-person teams. It is ok to go solo (both on presentations and projects), but please see me before deciding on this option. If you go for the project option I will be available throughout the semester to advice you on modeling strategies; however you must come up with the problem itself and the responsibility for data collection is yours as well. As for the project area is concerned, students are free to choose any area (it need not have anything to do with economics!) as long as some technique discussed in the course is used to address the problem. A project report will be due on the last day of class along with a cd containing datasets and programs. If you choose to present a paper, you can choose from several that are listed later. Note that in this case, you will be expected to understand not just `your paper’, but several related ones as well.
Meeting Times and Important Dates

The course will meet twice a week for 75 minutes for lecture sessions. In addition, some weeks, on Fridays there will be a lab session at 4 pm lasting between 60-75 minutes. Attendance is not compulsory for the lab sessions; however students are strongly encouraged to attend. These lab sessions will be used to go over problem sets and/or provide software guidance. The midterm will be held on Thursday, 25th October. If your group plans to write a paper, a proposal is due by Thursday, 1st of November. The paper itself will be due on Tuesday, 11th December, the last day of class. If on the other hand, you plan to make a presentation, you should let me know which paper you wish to present by Tuesday, 13th of November. Depending on how many opt to do presentations, they will be held on the week(s) of 3rd and 10th December. The final exam will be held during the slot allocated to us by the registrar’s office.

Textbook and Reading Lists

Most people learning a subject for the first time rely on good books rather than journal articles. To this end, I provide an extensive reading list to go with the main texts for the course.

PRIMARY COURSE TEXTS

The required time series text for this course comprising core material that the student must know by the end of the course is


This text has been written with economists in mind, does not require an advanced background beyond basic calculus, linear algebra and linear regression methodology, and covers most of the topics relevant to this course. However, the author’s treatment falls quite a bit short of the level of rigor and technical details that we will aspire for. Consequently, supplementary material will be drawn from other sources and lecture notes prepared by the instructor will be uploaded on Blackboard regularly.

Also, a good, not too technical an overview of the time series field can be gleaned by going through the following online text:


The text recommended for cross-sectional techniques is

- *Microeconometrics: Methods and Applications – A. Colin Cameron and Pravin K. Trivedi (Cambridge)*
Hereafter, this is referred to as CT. We will, in all likelihood, cover only a tiny fraction of CT, which is why I am not making this a required purchase, but the book is an excellent investment as no other graduate level textbook in the market is as modern as it is, plus, it also offers a very modern and up-to-date overview of techniques that were covered in Ec508.

For the papers we read, copies will be posted on Blackboard.

OTHER PRIMARY TEXTS

A few other texts, which the student with Ec507 and Ec508 background should have no difficulty reading, are stated next.

A basic time series text written in a similar vein as the Enders book is


This book will be referred to as KW hereafter.

Two other times series textbooks, with strong focus on financial applications, are:


Tsay’s text, while not being overtly technical, has good material on some modern topics such as the econometrics of option pricing, extreme value modeling and value-at-risk and an entire (very readable) chapter on Markov Chain Monte Carlo methods.

A very recent text on cross-sectional techniques is

- *Micro-Econometrics: Methods of Moments and Limited Dependent Variables* - Myoung-jae Lee (Springer)

It is a little denser than CT, but has a fuller treatment of nonparametrics, and in its first few chapters, it too covers a good deal of Ec508 material.

I now provide a list of secondary texts, which are more of a reference nature. I will make good use of almost all of these in compiling my lecture notes.

SECONDARY TEXTS: TIME SERIES

The first are two standard, venerable PhD level textbooks, the first one usually used in Economics departments and the second in Statistics departments:
• *Time Series Analysis* – James Hamilton (Princeton)
• *Time Series: Theory and Methods* – Peter Brockwell and Richard Davis (Springer)

Hamilton’s book is (mostly) in theorem-proof format, and so, is very suitable for anyone understanding the theory well. Although, it was published in 1994, and requires an updating urgently, if you wish to acquire one advanced textbook, this should be it (I will be referring to this book a lot).

Brockwell-Davis is hard reading if you do not have an advanced background in analysis, probability and statistics but it has coverage on topics hard to find elsewhere, such as a formal proof of Wold’s Theorem and functional analytic approach to Time Series.

Two very good introductions to traditional Time Series topics including Box-Jenkins methodology, transfer function modeling, Kalman filtering and spectral analysis are

• *Time Series Analysis* – William Wei (Pearson, 2nd edition)
• *Time Series Analysis with Applications in R* – Jonathan Cryer and King-Sik Chan (Springer, 2nd edition)

The last book serves as a good reference for using R for solving time series problems.

On volatility in Time-Series a good textbook treatment is offered by

• *ARCH Models and Financial Applications* – Christian Gourieroux (Springer)

A good collection of original and classic papers can be found in

• *ARCH: Selected Readings* – (ed) R. F. Engle (Oxford)

including Engle’s original paper introducing the methodology with application to UK inflation. Several new books have recently surfaced on volatility models with financial applications; a relatively simple treatment with attention to practice is offered by


On unit roots and cointegration, a good textbook treatment, although somewhat dated is

• *Unit Roots, Cointegration and Structural Change* – G.S. Maddala and In-Moo Kim (Cambridge)

while a very good collection of original articles edited by two Nobel laureates (including a few simple and delightful introductions to the topic by the editors and by the Stock-Watson team) can be found in
• *Long-Run Economic Relationships* – R. F. Engle and C. W. J. Granger (Oxford)

A recent text in the field of cointegration is

• *The Cointegrated VAR Model* – K. Juselius (Oxford)

It carries a lot of nice applications (particularly in the area of labor markets) but probably is too detailed for someone casually interested in the topic.

On **VAR and VARMA models**, a solid, 750+ page-length treatment of can be found in

• *New Introduction to Multiple Time Series* - Helmut Lutkepohl (Springer)

Lutkepohl’s book, despite its size, is actually extremely readable and the technicalities are not overbearing. Moreover, the book covers topics that are hard to find elsewhere in the econometrics literature (such as practicalities of estimating VARMA models). However, if you would rather read a synopsis, read chapter 3 of

• *Applied Time Series* – H. Lutkepohl and M. Kratzig (Cambridge)

On the area of **non-linear modeling**, a useful primer is

• *Non-linear Time Series Models in Empirical Finance* – P. Franses and D. van Dijk (Cambridge)

On **forecasting**, an undergraduate level text is

• *Elements of Forecasting* – Francis X. Diebold (Southwestern, 4th edition)

while a superb collection of scholarly surveys can be found in the following two collections

• *A Companion to Economic Forecasting* – (ed.) Michael Clements and David Hendry (Blackwell)
• *Handbook of Economic Forecasting, volume 1* – (ed) G. Elliott, C.W.J. Granger and A. Timmermann (North Holland)

Lastly, a good collection of articles on **time series as applied to finance** can be found in


SECONDARY TEXTS: CROSS SECTION

For bootstrap methods, a delightful starting point is the monograph coauthored by the ‘father’ of the technique…
Two more comprehensive references with a good collection of applications are:

- **Bootstrap Methods and Their Application** – A. C. Davidson and D. Hinkley (Cambridge Series in Statistical and Probabilistic Mathematics, No 1)
- **The Jackknife and the Bootstrap** – J. Shao and D. Tu (Springer)

For computation-intensive methods see

- **Handbook of Computational Statistics** – J. Gentle et. al. (ed) (Springer)
- **Discrete Choice Methods with Simulation** – K. Train (Cambridge University Press, 2nd edition)

Two books I recommend for Bayesian methods are

- **Introduction to Applied Bayesian Statistics and Estimation for Social Scientists** – S. Lynch (Springer)
- **Bayesian Statistics and Marketing** – P. Rossi, G. Allenby and R. McCulloch (Wiley)

Both books give a good overview of Markov Chain Monte Carlo, Gibbs Sampler, the Metropolis algorithm and all that.

For nonparametrics and semiparametrics, there are several very good books in the market. I list four in the order of the publication dates of the most recent edition (most recent last):

- **Nonparametric Econometrics** – Adrian Pagan and Aman Ullah (Cambridge)
- **Semiparametric Regression for the Applied Econometrician** – Adonis Yatchew (Cambridge)
- **Nonparametric and Semiparametric Models** – W. Härdle, M. Müller, S. Sperlich, A. Werwatz (Springer)
- **Semiparametric and Nonparametric Methods in Econometrics** – Joel Horowitz (Springer)

Of these, Yatchew’s book is probably most application oriented; many cases (based on author’s own publications) are discussed in this approximately 200-page book, and the datasets for these applications are downloadable from his University of Toronto website.

Finally, the 6-volume **Handbook of Econometrics** is a rich reference for almost everything that will be covered in the course; I refer several relevant chapters under the appropriate topics.
Software

In Ec508, you were introduced to STATA. In this course, we will go further with STATA; in addition, you will be introduced to R. To download this open-source program go to http://cran.r-project.org/. Some of the plus points of R is a) it is open source and free, and b) its graphic capabilities are a lot better than those of STATA. It used to be the case that it was more difficult to obtain help with R than in STATA, but that is changing as R’s user base is growing and many wonderful statistics/econometrics books are being written with R in mind (Springer has a whole series of books called “Use R!” that qualifies). That said, STATA is also very good and very capable in certain tasks and often, and I will make use of programs I have written in STATA.

Outline of Topics

The outline below is really a wish list, for there is no way all the topics listed here can be covered in one semester. I will reserve the right to decide on coverage based on student interest, and time constraints as these reveal themselves. The first part of the course is to be mostly devoted to covering time series topics more or less in the order presented in Enders. After we are done with this, we will choose a (small) subset of remaining topics. The papers listed below are suggested readings; of those that are underlined are likely to be covered in some depth.

PART I (Standard TS Topics)

Topic I (Difference Equations)

Primary Source:
- Hamilton, Chapters 1-2
- Enders, Chapter 1

Secondary Source:
- Brockwell-Davis, Pp 105-110
- Gandolfo2, Part I
- Kelley-Peterson, Chapter 33

Issues:
- Why difference equations
- General Theory of LDEs
- Stability

Topic II (Software: STATA and R)

Primary Source:
* STATA: My handouts from Ec508
* R: Fransworth

Secondary Source:
* STATA: Baum
* STATA: Various User’s Guides
* STATA: Gould, Pitblado and Sribney
* R: Various books in the Springer “Use R” Series

Issues:
* Review of STATA from Ec508
* More STATA Programming
* Introduction to R

**Topic III (ARIMA Models and Box-Jenkins Methodology)**

Primary Source:
* Enders, Chapter 2
* KW, Chapter 2

Secondary Source:
* Hamilton, Chapters 2-4
* Wei, Chapters 2-8

Issues:
* Stochastic Processes and Notions of Stationarity and Ergodicity
* Wold’s Decomposition Theorem
* ARIMA models
* Estimation, Diagnostic Checking and Model Selection
* ARIMA forecasting
* Seasonal Models
* Transfer Function Modeling

Papers:

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4 Grant Fransworth, “Econometrics in R”, (online book available online at [http://cran.r-project.org/](http://cran.r-project.org/))
5 Christopher Baum, “An Introduction to STATA Programming”, STATA Press
Topic IV (Modeling Volatility)

Primary Source:
- Enders, Chapter 3
- Tsay, Chapters 3, 7, 9

Secondary Source:
- Gourieroux, Chapters 3, 4
- Handbook of Financial Time Series (ed. Anderson et. al.), Part I (Recent Developments in GARCH Modeling)

Issues:
- Why modeling volatility is important in economics and finance
- ARCH model
- GARCH model
- ARCH-M model
- Related Models: IGARCH, EGARCH, GARCH-M
- Testing for ARCH/GARCH effects
- Estimating GARCH models
- Stochastic Volatility Models

Papers:

Topic V (Trends and Unit Roots)

Primary Source:
- Enders, Chapter 4
- KW Chapter 5
Secondary Source:

- Hamilton, Chapter 17
- Maddala and Kim, Chapters 3, 4

Issues:

- Spurious Regressions
- TSP and DSP processes
- Unit Roots and Weiner Processes
- Unit Root Tests
- Panel Data Unit Root Tests
- Structural Change

Papers:


**Topic VI (Vector Time Series)**

Primary Source:

- Enders, Chapter 5
- KW, Chapter 4
Secondary Source:
- Lutkepohl, Chapters 2-5, 9-11

Issues:
- A Brief History of Macroeconometric Modeling
- Causality
- VAR processes, Properties, Estimation and Forecasting
- Order Selection and Checking for Model Adequacy
- VAR processes with Parameter Constraints
- VECMs
- SVARs
- VARMA models and their estimation
- State-space Models and Kalman Filter

Papers:

**Topic VII (Cointegration)**

Primary Source:
- Enders, Chapter 6
- KW, Chapter 6

Secondary Source:
- Juselius, Chapters 4-18
- Lutkepohl, Chapters 6-8

Issues:
- Motivation for Cointegration
- Testing for Cointegration
- Error Correction Models and Cointegration
- System Estimation Methods
Papers:

PART 2 (Optional TS and CS Topics)

Topic VIII (Bootstrap)

Primary Source:
• CT, Chapter 11

Secondary Source:
• Davison and Hinkley, Chapters 2 – 6

Issues:
• The Basic Idea
• Standard Errors, Hypothesis Testing, Confidence Intervals and Bias Correction
• Bootstrap theory and Asymptotic Refinements
• Related Issues: Subsampling, Jackknife, Cross-validation and Moving Blocks
• More Applications: Heteroskedasticity, GMM and Time Series

Papers:

**Topic IX (Simulation Based Methods)**

**Primary Source:**
- CT, Chapter 12

**Secondary Source:**
- Train, Chapters 6, 9, 10, 14

**Issues:**
- Drawing random variates
- Integration via Simulation
- Method of Simulated Moments
- Maximum Simulated Likelihood Estimation
- EM Algorithm

**Papers:**

**Topic X (Bayesian Methods)**

**Primary Source:**
• CT, Chapter 13

Secondary Source:
• Lynch, Chapters 3-6, 9
• Rossi et. al., Case Studies 1-7, Appendices A, B

Issues:
• The Bayesian Philosophy
• Linear Regression via Bayesian Approach
• MCMC and Gibbs Sampling
• Metropolis-Hastings Algorithm
• Hierarchical Models
• Bayesian Model Selection

Papers:
• Yang, S., Y. Chen and G. Allenby (2003): “Bayesian Analysis of Simultaneous Demand and Supply”, Quantitative Marketing and Economics, 1, 251-276 (also see comments by Bajari, Berry, Dube and Chintagunta).

**Topic XI (Topics in Forecasting)**

Primary Source:
• Lecture Notes

Secondary Source:
• Handbook of Economic Forecasting
• A Companion to Economic Forecasting

Issues:
• Forecast evaluation
• Comparison of Standard Forecasting Models
• Forecasting in Economics
• Forecasting in Marketing
Papers: