

Economics 508: Econometrics

Spring 2013
MW 5:30 – 7:00
SAR 102

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Course Description: The course involves the economic applications of the statistical techniques of simple and multiple regression analysis. These techniques are dependent on certain assumptions which may be violated. So, part of the course involves what techniques to use if these violations occur. The course is evenly divided between the theoretical and the applied approaches to econometric analysis. The course assumes a basic knowledge of statistical analysis, e.g., hypothesis testing and interval estimation., and builds upon this knowledge.

Textbooks:

Introductory Econometrics: A Modern Approach, Jefferey M. Wooldridge, 4th edition (required)

A Guide to Econometrics, Peter Kennedy, (recommended, especially if you anticipate being a professional econometrician or going for a Ph.D. in economics)

Grading: Homework (30%)
Project (20%)
Midterm (25%)
Final (25%) (not comprehensive)

Grade Scale: 10 point grading scale (after curving)

Proposed Topics and Problems Assigned:

Chapter 1: Nature of Econometrics

Chapter 2: Simple Regression Model: 2.2, 2.3, 2.5, 2.7 – 2.10; C2.2, C2.4, C2.6

Chapter 3: Multiple Regression Analysis: Estimation: 3.2, 3.4, 3.5, 3.9, 3.11, 3.13; C3.2, C3.6, C3.8

Chapter 4: Multiple Regression Analysis: Inference: 4.2, 4.4, 4.6 – 4.9; C4.6, C4.9

Chapter 5: Multiple Regression Analysis: OLS Asymptotics (Skim Over)

Chapter 6: Multiple Regression Analysis: Further Issues (Skim Over)
6.3, 6.4, 6.6, 6.7; C6.3, C6.5, C6.9

Chapter 7: Multiple Regression Analysis: Binary Variables (Skim Over)

7.1, 7.4, 7.7, 7.9; C7.3, C7.5, C7.10

Chapter 8: Heteroskedasticity (Skim Over)
8.2, 8.5 – 8.7; C8.2, C8.3, C8.6

Appendix D: Summary of Matrix Algebra
D.3 – D.8

Appendix E: Linear Regression Model in Matrix Form
E.1 – E.5

Chapter 10: Basic Regression Analysis with Time Series Data
10.3 – 10.6; C10.1, C10.3, C10.9, C10.10

Chapter 11: Further Issues in Time Series OLS
11.1 – 11.7; C11.1, C11.2, C11.4, C11.6 – C11.9

Chapter 12: Serial Correlation and Heteroskedasticity in Time Series Regression
12.6, C12.1, C12.2, C12.10

Project: Choice of One

- 1) A time series analysis updating the Mishkin study (circa 1980) of does money really matter. It evaluates the question of does anticipated or unanticipated monetary policy changes influence real GDP or the unemployment rate. It was one of the basic studies in determining the authenticity of Keynesian versus Classical economics. You will need to go on the internet, download the appropriate data, perform the necessary regressions and analyze the results comparing the results to the original study. From the BEA and FRB web sites gather quarterly real GDP and some money measure (M1, M2, MB, MZM). The money measure will have to be deflated. In addition you will need additional economic data that could be used to predict money growth. Reproduce the Mishkin analysis using data since 1982 (including lags) to the present. A paper of the problem, analysis and results is to be handed in on the day of the final. It would be useful to have Microsoft Word with Microsoft Equation.
- 2) A regression analysis updating the study by Barro and Sala – I – Martin of income convergence across states. Their study concluded that state's income per capita were converging to constant value and will at some time in the future be equal across all states. One shortcoming of their analysis was that they considered only nominal income per capita, not adjusted for inflation, and they did not consider cost of living differences across states. You will need to download the appropriate data, perform the appropriate regression, and analyze the results comparing the results to the original study. Gather state personal income and population data from the BEA web site (annual probably OK). Also, download an economic series to deflate real income. It would be helpful to locate economic time series that measures the relative cost of living differences between states. It may be OK to use state real GSP instead. This study also divided Classical and Keynesians. A paper of the problem, analysis and results is to be handed in on the day of the final. It would be useful to have Microsoft Word with Microsoft Equation.

Other Important Topics

- 1) It is recommended that you read both the first section and the business section of one of the local newspapers every day (Mondays are pretty good) and the Wall Street Journal on a regular basis. Current affairs may be discussed at your initiative.
- 2) If you have to bring your child with you in order to attend class, please do so.
- 3) Exams can only be made up in the case of family, medical, or work emergencies.
- 4) Late homework will only be accepted for the three circumstances discussed in #3. Otherwise for each class day late a reduction of 25% of the grade will occur.
- 5) It is highly recommended that you show up for each class.
 - There may be extra credit questions on all exams based on extra material covered during the class.
 - There are helpful hints concerning the exams.....sometimes.
- 6) If you choose the pass/no pass grading option, you must attain a C- or better to obtain the pass.
- 7) Econometrics is an analytical field of study. Each day's material is part of a building block. Regular attendance is crucial. For example, some believe they can pass the course just by showing up for the tests and the final. This is so not true.
- 8) Do not hesitate to e-mail me or call me at work to answer questions or to notify me of an absence on the day of the exam.
- 9) University policy calls for severe sanctions for cheating or any other form of academic dishonesty. This policy will be enforced for all tests and quizzes in the course. Working together on homework assignments is encouraged.
- 10) Students with disabilities will be accommodated. Please see me if you need specific resources for this class.
- 11) Actively participate. Being engaged with the learning process will make your experience more pleasant and will result in better grades. Try to control the "entertainment" wants that we all have. Sometimes the birth of an economic concept can be slow so exercise patience with the process. If you do have trouble focusing, please refrain from engaging your fellow students in conversation. This is most unfair to those who are focused and are trying to learn. If you are believed to be causing a disruption to the class, then you will be subject to an after-class conversation and may not be given the benefit of the doubt is your grade is "borderline".

EC508: Econometrics
Boston University
Department of Economics
Spring 2013

Instructor

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Teaching Assistant

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Discussion section: F 2:00-3:00pm, KCB 106

Objectives

The aim of this course is to familiarize the students with fundamental concepts in econometrics and build their skills to perform regression analyses. This course will cover linear regression with multiple regressors, instrumental variables, nonlinear regression, regression with limited dependent variables, and an introduction to time series analysis. The emphasis of this course will be on understanding of the econometric theory and how to apply the theory to real economic data. After completing this course, the students are expected to be equipped with the knowledge of basic econometric theory and be ready for conducting regression analyses on various types of economic data.

Course website:

-Blackboard Learn Site ID: 13sprgcassec508_c1.

Announcements will be made through the course website. Please check it periodically.

Prerequisites

No prior preparation in econometrics is required, but familiarity with basic linear algebra and calculus is assumed. Background in statistics at EC507 level is also assumed.

Textbook & references

Textbook: James Stock and Mark Watson "Introduction to Econometrics (3rd edition)," Addison-Wesley. This book is available at Barnes & Noble at Boston University.

Reference: Fumio Hayashi "Econometrics," Princeton University Press.

This book is an advanced graduate level textbook, which provides theoretical foundations of the topics covered in this course.

Grading and Exam policies

The final grade will be determined based on problem sets (20% of final grade), two midterm exams (40% of final grade) and a final exam (40% of final grade).

-Problem sets:

Problem set due dates will be announced in class. You are encouraged to work in groups on problem sets, but you must turn in your own copy. Late problem sets will not be accepted as the answer key will be posted on the course website immediately. There will be some questions that require a statistical software, Stata. Stata can be accessed in the computer labs on the 5th floor of the Economics department. Our TA will give a brief review on how to use Stata in a discussion section. When you report graphs or tables created by Stata, you must make sure that they have meaningful titles and labels.

-Exams:

The two midterms will be held in class. The first one will take place on **Tuesday, February 19**. The second one will be on **Thursday, March 28**. The final will be cumulative. The date of the final will be announced. You should periodically check the exam schedule on the Student Link: http://www.bu.edu/link/bin/uiscgi_studentlink.pl for any variations and location changes.

The exams will be closed-book. You may use a calculator during exams. A simple one is enough. If you have questions on grading (both problem sets and exams), you must contact the TA within a week after you receive your homework or exams. There will be no regrading of exams written in pencil. Makeup exams will only be given if absence is due to medical reasons (Doctors certificate required).

Academic conduct

Students should know and understand the CAS Academic Conduct Code. Copies of the CAS Academic Conduct Code are available in room CAS 105 and on the website <http://www.bu.edu/cas/academics/programs/conductcode.html>. Any suspected academic misconduct will be reported to the Deans Office.

Office hours

You are encouraged to come to our office hours if you have any questions on the course material. If you are unable to come to our regular office hours, please make an appointment by sending us an email. If you have questions that need brief answers, you can also ask me or Luis by sending an email, but please be aware that we may not be able to answer questions that need lengthy explanations. If you have such questions, please come to our office hours.

Course outline

The following is a tentative schedule of the topics we will cover. Corresponding sections in the textbook (SW) are listed below. Please note that there might be slight variations as we progress.

- Linear regression, SW 4-7, 9, 12, 17, 18
 - Review of matrix algebra
 - Regression with single regressor, SW 4.1-4.3, 5.1-5.4
 - Regression with multiple regressors, SW 6.1-6.5, 6.7
 - Asymptotic theory, SW 17.1-17.3, 18.1-18.3
 - Inference in regression models, SW 6.6, 7.1-7.5
 - Instrumental variables, SW 12.1-12.5
- Nonlinear regression and limited dependent variables, SW 8, 11
 - Nonlinear least squares, SW 8.1-8.4
 - Generalized method of moments (optional)
 - Probit and Logit, SW 11.1-11.3
- Time series analysis, SW 14
 - Forecasting, SW 14.1
 - Time series regression, SW 14.2-14.4
 - Nonstationarity, SW 14.6-14.7

Ec508: Econometrics
Syllabus and General Information
Professor Ani Dasgupta

Spring 2013
Boston University

Instructor: Dr. Ani Dasgupta
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Course Website: <http://blackboard.bu.edu> (Navigate to Spring 2013 -> Ec508 Section A1 site and enter BU userid and password when prompted)

INTRODUCTION: Ec508 is an entry-level *graduate* econometrics course, focusing mainly on cross-sectional techniques. It is entry-level in the sense that you are not presumed to have any prior acquaintance with econometrics, although you are assumed to have the required statistical and computing background at Ec507 level, and coursework in linear algebra and calculus including some optimization. You are also supposed to have basic familiarity with some statistical software such as STATA or R or SAS. Though entry level, this is very much a graduate course, which among other things, means that *rigor and understanding of the techniques are very much emphasized as opposed to learning cookbook methods*. It attempts to serve two types of audiences. For those who wish to pursue applied data analysis in the real world, it presents a wide array of problem instances and tools appropriate for those instances. I will expose you to a tool, show you why it works (at least in most cases) and ask you to apply the tool to solve similar problems with new datasets. The course also serves as a stepping stone for those interested in knowing the field more intimately and perhaps going on to do a Ph.D. in Economics, which it does by introducing them to a fair amount of theory and by giving them a tour of a small selection of classic and contemporary papers written in Econometrics.

REQUIREMENTS, GRADING, DATES AND GROUND RULES: For most courses, you learn only a small fraction of the material by just listening to the lectures. For econometrics, that fraction could be really small. You are expected to read the lecture material and suggested sections of the text immediately after every lecture, working through

the derivations yourself (yes, we do care about derivations). Most of the time, you will be expected to read preparatory material before a lecture, and you will need to come prepared to the lecture having read that material. When problem sets are distributed, you are expected to try out each and every problem.

Your course grade will be based on 2 quizzes, a final, problem sets, and an optional term project and class performance. The weights for the two tracks (project and non-project) are displayed below:

Item	Weight (in %)	
	Project	Non-Project
Quizzes	20	30
Final	30	35
Problem Sets	20	25
Project	20	-
Class Performance	10	10

The first quiz is an in-class exam lasting the entire class period (about 1.5 hours). The second quiz is a take-home where you will be tested on your software skills. The final is a cumulative two-hour exam and it should prepare Econ MA students for their comprehensives. Doing well in these tests will require that you have mastered the problem sets of which there will be about ten in all.

In addition, if you choose the project track, you are required to turn in a group project at the end of the semester with each group having up to three members (if you will really like to go solo, you can – but talk to me about this first). The project can be of one of two types. You can either choose to read and report on a collection of papers written on a particular area. The second and the preferable option is to embark on an independent empirical analysis on a problem chosen by you. Of course, I will be available for consultation throughout the life of the project; however choice of the problem and collection of appropriate data will be your responsibilities. I will at some point during the semester circulate some project reports done by former students so that you can have an idea about what it entails. You will have until the middle of the semester to decide on whether to take the project option or not.

The final component of grading is a subjective class performance item, where I will take into account such intangibles as attitude and effort.

Here are some important dates. The first quiz will be held on **Thursday, February 28th**.

In case you choose the project option, I require a proposal that is due latest by **Thursday, March 21st** (however you are encouraged to come and talk to me about this earlier). I will need at least a three-page proposal where you have demonstrated having given serious thought to your ideas and perhaps having done some preliminary library/internet research as well. Please be forewarned that if you miss this deadline, two adverse things will happen. First, you will lose points on your project grade and second, you will have less access to me as a consultant compared to other groups which were on time. The second quiz, a take-home will be distributed on **Tuesday April 9th** and will be due on **Thursday April 11th**. The project report is due the last class day on **Thursday, May 2nd**.

The final exam has been scheduled by the registrar's office on **Tuesday, May 9th** (6 – 8 pm) and unless the entire class is agreeable with and keen on shifting the time, I will stick to it. Make-ups for quizzes and exams may be offered only in case of a serious medical emergency (you need to inform me before the exam about it and a doctor's certificate to the effect that you were unwell enough not to be able to make it to the exam is required). The format of the make-up(s) will be at the instructor's discretion. I take honesty and integrity issues very seriously. Any violation of the academic conduct code will be referred to the authorities, and if the individual concerned is found guilty, it will automatically result in an F for the course and perhaps other unpalatable actions.¹ If you wish to know more about what constitutes a violation and what the due process is, please refer to the CAS Academic conduct code.

MEETING TIMES: Please note that we will normally meet Tuesdays and Thursdays 6.30 pm to 8.00 pm (except on holidays and official class cancellations). On Fridays the TA or I will hold 'study sessions' from 4.00 pm to 5.00 pm. (We might change the times a bit later). These sessions will be used either to provide software tutorials, or to go over Problem Sets/Exams.

TEXTBOOKS AND STUDY MATERIAL: There is no textbook for the course. I have given up on finding a text suitable for the Masters level and rely on my posted/distributed notes entirely. In the past I have used the text **Econometric Methods with Applications in Business** by **Christian Heij et. al.** (Oxford University Press) for this course. This textbook is a nice introduction to econometrics and fairly modern in its coverage, although it is not quite as rigorous as I would have liked it to be. Its strength lies in the fact that it discusses numerous empirical exercises and provides useful datasets for you to try those exercises on your own.

Here are a few other texts and material that you may consider accessing. A popular and nice undergraduate text is **Jeffrey Wooldridge's Introductory Econometrics** (SouthWest College Publications). This book does not use matrix notation and does not delve much into theory, but it does a great job of providing intuition and economic context. It also has numerous empirical exercises. Similar in spirit and scope is **James Stock and Mark Watson's Introduction to Econometrics** (Addison Wesley). A wonderfully lucid, matrix-oriented book at this level (though mostly for classical topics) is **Econometric Methods** by **Jack Johnston and John DiNardo** (McGraw-Hill). If you can find it, I recommend the older third edition (written by Johnston alone) in addition to the current fourth (which is coauthored with John DiNardo).

A book that is not recommended as a stand-alone textbook but one that gives you an interesting perspective and overview of the classical topics in the field is **Peter Kennedy's A Guide to Econometrics** (MIT Press). For those of you with an applied bend, I strongly

¹ Please be aware of that getting unauthorized help for take-homes and problem sets (e.g. accessing and using solution sets distributed to previous years' course participants) constitute violation of academic conduct.

suggest that you take a look at **Ernst Berndt's The Practice of Econometrics: Classic and Contemporary** (Addison Wesley). For each chapter, the book chooses an area of interest to economists and illustrates empirical analysis in that area using a particular technique. I will use some applications from this book to illustrate the theoretical models.

Going into more advanced texts, **William Greene's Econometric Analysis** (currently in its 7th edition) is probably one of the best compendium of modern econometric techniques and if you want to keep one reference econometrics book in your library, Greene will probably be the best choice. Unfortunately, its explanations are quite terse and sometime unintuitive, reflecting, over time, the consequence of incorporating newer and newer material without making the book weigh like an iron chest (it already has 1000+ pages!). I will refer you to Greene from time to time though both for study material as well as exercises.

If you want to know classical econometric techniques well, an excellent choice is **Paul Ruud's An Introduction to Classical Econometric Theory** (Oxford), which provides most detailed step-by-step explanations for the classical technique. Its coverage of least squares theory, in particular, is exhaustive. Two other serious Ph.D. level texts in the market are **Jeff Wooldridge's Econometric Analysis of Cross Section and Panel Data** (MIT Press), and **Russell Davidson and James McKinnon's Econometric Theory and Methods** (Oxford). Both these texts make the reader think beyond the theorem-proof approach. Wooldridge, although mainly a theory text, makes you really think about how to apply the theory to data with many pertinent examples. Davidson-Mackinnon is very strong in theory, particularly in the geometrical underpinning behind algebraic equations. My personal favorite Ph.D. level text, which is more textbookish than Wooldridge and Davidson-Mackinnon and more modern in approach than Ruud while being amazingly thorough and readable with plenty of stimulating exercises, is **Fumio Hayashi's Econometrics** (Princeton University Press). It's a hard read, but if you aspire to get into a Ph.D. program someday, you will need to learn the content of this book (for instance it is the text used at Princeton). In my lectures, I will make use of material from all the above-mentioned texts.

These days, one can learn a lot in almost any field from surfing the web; econometrics is no exception. You can download great set of lecture notes written by noted econometricians and find out what is being taught at other prestigious graduate programs. Professor **Bruce Hansen** (U Wisconsin Madison) has a nice set of lecture notes at <http://www.ssc.wisc.edu/~bhansen/econometrics/> while Professor **Herman Bierens** of Penn State has another great set of notes on various topics at <http://econ.la.psu.edu/~hbierens/LECNOTES.HTM>

SOFTWARE: The course places heavy emphasis on using software to analyze data, so students need to get up to speed with this aspect of the course real soon. The official software for this course is **STATA**; however in the past I have also worked with **R**, **LIMDEP** and **SAS**. Any of these software should be adequate for this course, but if you wish to use something other than STATA, please be forewarned that if you are stuck with

something, you will be on your own. Also, the answers to the take-home must be done in STATA.

Students from Ec507 course should be already quite familiar with **STATA**, which has numerous canned packages plus a fair bit of programming capabilities. If you were not in Ec507 last semester or have not already purchased it then, note that as a BU student, you may buy a perpetual license for the standard version (the “Intercooled version”) at an academic price of \$179 (go to www.stata.com and look under ‘gradplan’ for details). They also have an annual license for a reduced price of \$98. Finally, you also have the option of buying a one-year license for the ‘small’ version of STATA at a price of \$32. If you have small STATA, you will be able to carry out most of the assignments (I would say about 90-95%), but there may be some involving long simulations and large datasets that you may not be able to carry out. The current version is STATA 12 but if you happen to have STATA 11 (or even STATA 10), you will be able to do everything you need to do in this course.

Since, most of you have been introduced to STATA via Ec507, I will not waste class time here re-introducing you to the package; however, in case you were not a student in that course, I will post my introductory material on STATA to get you started. There are also numerous (free) tutorials that are available both online with the package and on the net some of which will be posted on our website. In this course, we will take STATA programming to somewhat higher level, and in particular, spend considerable time doing ML estimation with STATA. At the beginning of the course, some dedicated sessions will be offered on STATA to help folks who are new to it or had trouble with it last semester.

There are several free alternatives to STATA that are downloadable from the net. I mention a few here:

1. **EALIMDEP**, written by Professor William Greene (NYU), the author of “Econometric Analysis” is the baby version of the full-blown package LIMDEP and is limited in the sense that you cannot estimate more than 15 parameters in a model and data sets have to be relatively small (but still large enough for us). Here is the url for a page that has some relevant information on downloading and manuals:
<http://www.iona.edu/faculty/rjantzen/eco310/eco310ealimdep.htm>
2. Another (totally) free software is **EASYREG** written by Professor Herman Bierens of Penn State University. This one does not have the programming flexibilities of EALIMDEP, but it has no limitations on model size (to be more accurate, it does but there is little chance that you will need to exceed those constraints). It has many canned packages that the former does not (particularly in Time Series analysis). Go to <http://econ.la.psu.edu/~hbierens/EASYREG.HTM> for downloading and additional information.
3. **R**, which is a clone of S/SPLUS, is also a terrific piece of software with great graphics and programming options. To download a free copy, go to: <http://cran.r-project.org/>. R like STATA, is very much a live software in the sense that people are all the time contributing their programs for free usage. Also, Springer has published a whole collection of books on R, some of which may be accessible online via BU library.

A fair question at this stage is if all these software are available for free why am I recommending that students purchase STATA? There are several reasons for that. First, not

all packages are written with all disciplines in mind (they cannot be). STATA has a definite econometrics audience in mind, and several canned packages specifically needed by econometricians are available in STATA (and nowhere else); in fact some of the folks in charge of maintaining the repository of STATA programs (like Prof. Kit Baum of BC) are econometricians. But at the same time, STATA allows you to write your own programs which, as far as I know, among the freely available packages, only R does. Finally, note that one problem with free software is that you do not get technical support if things go wrong. I have had reasonably good experience with STATA's technical support and I suspect that from time to time you might need it too.

TOPIC LIST: The following is a list of areas I wish to cover in this course (reference to reading material besides lecture notes being provided in parentheses²). This is indeed a wish list, for the list is long and hence, tentative; we will almost certainly skip some topics to concentrate on others. Topics 1-8 make up the core part of the course and hence, we will focus on them. Of the remaining topics, time constraints, class interests and relevance to ongoing student projects will determine which ones we will discuss. If you are very interested in a particular topic, please let me know.

Topic 0 (Introduction):

- Introduction to the course and the subject of econometrics

Topic 1 (Linear Algebra):

- Basic Linear algebra and matrices including a thorough treatment of eigenvalues and eigenvectors (G Appendix A, J Chapter 4)

Topic 2 (Statistics):

- Univariate statistics refresher (use your Ec507 text)
- Multivariate Statistics (T Chapter 1, G Appendices B and C, J Chapter 4)

Topic 3 (Classical Linear Model):

- The multiple regression model (T chapter 2 for background, H 3.1, G Chapter 2, H Chapter 1)
- Least squares geometry (T 3.1, G Chapter 3, DM Chapter 2, H Chapter 1, R Chapters 2, 3)
- Finite sample properties (T 3.2, G Chapter 4, DM Chapter 3, H Chapter 1, J Chapter 5, R Chapters 6-8)
- Inference (T 3.3-3.4, G Chapter 5, H Chapter 1, J Chapter 5, R Chapters 9-11)

² B refers to Berndt, CT refers to Cameron-Trivedi, DM to Davidson-McKinnon, H refers to Hayashi, G refers to Greene (6th ed), J refers to Johnston (3rd ed), JD refers to Johnston-Dinardo (4th ed), and R refers to Ruud, and T refers to the Heij et. al. text. You are only responsible for reading my lecture notes and any original paper I ask you to read.

- Application: Returns to scale in electricity (Marc Nerlove's paper, H Chapter 1, B Chapter 3)
- Dummy variables (T 5.3, G Chapter 6, J Chapter 6)
- Parameter consistency and structural stability (T 5.3, G Chapter 6, J Chapter 6, 10)
- Application: Solow's 1957 study of technical change (G Chapter 6)

Topic 4 (Model Specification):

- Consequences of Under and Over Specification (T 5.2, G Chapter 7)
- Model Selection Criteria (CT 8.5)
- The pitfalls of data mining (Lovell Paper)

Topic 5 (Large Sample Theory):

- Convergence Concepts (T 4.1, G Appendix D; H Chapter 2; R Chapter 13, B. Hansen Lecture Notes)
- Classical regression model with large samples (T 4.1, H Chapter 2, G Chapter 5, R Chapter 13)
- Application: Semiparametric inferential techniques (excerpts from Adonis Yatchew's book on this topic)

Topic 6 (Instrumental Variables):

- Causes of Endogeneity (T 5.7, H 3.1, 3.2, G Chapter 12)
- IV and 2SLS Estimation (T 5.7, G Chapter 12)
- Tests with IVs (T 5.7, G Chapter 12, DM 8.5-8.7)
- Weak instruments and too many instruments (CT 4.9)
- Application: Returns to Schooling (Angrist and Krueger paper, Ashenfelter and Krueger paper)

Topic 7 (Nonlinear Models and More General Estimation Frameworks):

- Nonlinear models: NL regression, Maximum Likelihood Estimation and Generalized Method of Moments (T 4.2, H Chapters 4 and 7, DM Chapters 6, 9 and 10, G Chapters 11, 15 and 16, R Chapter 14)
- Testing via the trinity (T 4.3, G Chapter 16, R Chapters 17)
- Application of ML: stochastic frontier model; Aigner, Lovell and Schmidt's study of metal industry (G Chapter 17, original article)
- Application of ML: Who wrote "And Quiet Flows the Don"? (Claeskens and Hjort book on Model selection)
- Application of GMM: Consumption and Asset Pricing Models (Hall, Hansen and Hansen-Singleton Papers)

Topic 8 (Data Problems):

- Generalized least squares (T 5.4, G Chapter 8)
- Heteroskedasticity (T 5.4, G Chapter 8; R Chapter 18)
- Application: credit card expenditures (G Chapter 8)
- Autocorrelation (T 5.5, G Chapter 19; H Chapter 2, 6; R Chapter 19)
- Application: Fama's test of efficient market hypothesis (Original article; H Chapter 2)

Topic 9 (Multiple Equation Systems):

- System of equations and SUR (T 7.7, G Chapter 14, J Chapter 8)
- Application: estimation of interrelated factor demands (B Chapter 9)
- Identification in simultaneous equation modeling (T 7.7, G Chapter 15, J Chapter 11)
- Estimation in simultaneous equation systems (T 7.7, G Chapter 15, J Chapter 11)
- Application: Improving the efficiency of a queuing system; Study of Calcutta port (Dasgupta-Ghosh's original article)

Topic 10 (Discrete Choice and Limited Dependent Variable Models):

- Binary choice models (T 6.1, G Chapter 21)
- Multinomial choice models (T 6.2, G Chapter 21)
- Ordered data and count data (T 6.2, G Chapter 21)
- Censoring, truncation and tobit models (T 6.3, G Chapter 22)
- Sample Selection (T 6.3, G Chapter 22)
- Application: College Choice Decision (Bridgett Long's article)

Topic 11 (Panel Data Models):

- Fixed effects (T 7.7, G Chapter 9, H Chapter 5)
- Random effects (T 7.7, G Chapter 9, H Chapter 5)
- Dynamic panels (G Chapter 9)
- Application: Growth and convergence (Hayashi Chapter 5)