Econ 7818: Mathematical statistics for economists

Edward Morey

Fall 2010 (working draft: July 30, 2010)

Econ 7818 is the first course in the statistics/econometrics sequence for Ph.D. students in Economics . Statistics is the foundation of econometrics.

Most of you are destined to become econometricans of one sort or another: different variations on the theme "applied econometrican".

1   What is statistics?

This will be the topic of our first lecture. Put simply: A course in statistics studies *statistics*. Every function of random variables is a statistic. (What's a random variable?) Econometricans develop statistics, then use these statistics, along with data, to estimate things about the world of interest to economists.

Some quotes:

> To understand God's thoughts we must study statistics, for these are the measure of His purpose. (Florence Nightingale, famous dead nurse

> Statistics are like a bikini. What they reveal is suggestive, but what they conceal is vital. (Aaron Levenstein)

> The first lesson that you must learn is, when I call for statistics about the rate of infant mortality, what I want is proof that fewer babies died when I was Prime Minister than when anyone else was Prime Minister. That is a political statistic. (Winston Churchill)

> There are three kinds of lies: lies, damned lies, and statistics. (Benjamin Disraeli, but sometimes attributed to Mark Twain)

2 What is econometics?

Quoting from *A Guide to Econometrics* by Peter Kennedy (The exchange originally appeared, with *statistican* rather than *econometrican* in the front of *The Advanced Theory of Statistics*, Vol. 2, by M.G. Kendall and A. Stuart. They attributed it to the fictitious K.A.C. Manderville, *The Undoing of Lamia Gurdleneck.*),

> "You haven't told me yet," said Lady Nuttal, "what it is your fiancé does for a living."
>
> "He's an econometrician." replied Lamia, with an annoying sense of being on the defensive.
>
> Lady Nuttal was obviously taken aback. It had not occurred to her that econometricians entered into normal social relationships. The species, she would have surmised, was perpetuated in some collateral manner, like mules.
>
> "But Aunt Sara, it's a very interesting profession," said Lamia warmly.
>
> "I don't doubt it," said her aunt, who obviously doubted it very much. "To express anything important in mere figures is so plainly impossible that there must be endless scope for well-paid advice on how to do it. But don"t you think that life with an econometrician would be rather, shall we say, humdrum?"
>
> Lamia was silent. She felt reluctant to discuss the surprising depth of emotional possibility which she had discovered below Edgar's numerical veneer.
>
> "It's not the figures themselves," she said finally, "it's what you do with them that matter."

Some other quotes from *A Guide to Econometrics*:

Econometrics is what econometricians do.

Econometrics is the study of the application of statistical methods to the analysis of economic phenomena.

What distinguishes an econometrician from a statistician is the former's preoccupation with problems caused by violations of statistician's standard assumptions; owing to the nature of economic relationships and the lack of controlled experimentation, these assumptions are seldom met.

Econometricians are often accused of using sledgehammers to crack open peanuts while turning a blind eye to data deficiencies and the many questionable assumptions required for the successful application of these many techniques.

Econometric theory is like an exquisitely balanced French recipe, spelling out precisely with how many turns to mix the sauce, how many carats of spice to add, and for how many milliseconds to bake the mixture at exactly 474 degrees of temperature. But when the statistical cook turns to raw materials, he finds that hearts of cactus fruit are unavailable, so he substitutes chunks of cantaloupe; where the recipe calls for vermicelli he used shredded wheat; and he substitutes green garment die for curry, ping-pong balls for turtle's eggs, and for Chalifougnac vintage 1883, a can of turpentine. (Valavanis)

It is the preparation skill of the econometric chef that catches the professional eye, not the quality of the raw materials in the meal, or the effort that went into procuring them (Griliches)

The art of the econometrician consists in finding the set of assumptions which are both sufficiently specific and sufficiently realistic to allow him to take the best possible advantage of the data available to him (Malinvaud)

The applied econometrician: The applied econometrician, unlike the theoretical econometrician, needs to worry as much about her data as about the theory. The forecasts and predictions generated by the econometric model are only as good as the data that produced them.

3

A well-known econometrican recently mentioned to me that he was hired by a group of wealthy gamblers to use his choice-modeling skills to predict the outcome of horse races. It might be important that he get it right.

3 Course Description:

Econ 7818 is an introductory course in statistics for Ph.D. students in economics.

Important components include probability theory, distribution theory, statistics, estimators and estimates, properties of estimators, sampling, inference, estimators such maximum likelihood and OLS, and hypothesis testing. Extensive use will be made of the mathematical and statistical software, *Mathematica*.

3.1 Web page:

My web site is located at http:www.colorado.edu/economics/morey/index.html . From it you can link to the web page for Econ 7818, or you can go directly to web page for the course at http:www.colorado.edu/economics/morey/7818/7818home.html .

All assignments, review questions, readings, lecture notes, etc. will, hopefully, be available there.

3.2 Text and readings:

The text for this course is Alexander Mood, Franklin Graybill, and Duane Boes, *Introduction to the Theory of Statistics*, McGraw Hill, 1974. ISBN 0-07-042864-6.

While you want to acquire your own copy of the book and cherish it forever, I have put the chapters of the book on the course web page. The book is no longer in print, but used copies are available from book sellers on the web.

The text for 7828 is ????? . When we find out what it is, I recommend you get it now rather than waiting.

3.2.1 Another text that I might have chosen for this course is

Takkeshi Amemiya, Introduction to statistics and econometrics, Harvard University Press, 1994, ISSBN 0-674-46225-4

3.2.2 For those who are considering additional books, I recommend:

Peter Kennedy, A Guide to Econometrics (4th edition), MIT Press, 1998. ISBN 0-262- 61140-6. This is an excellent book that provides, in words, the big picture. I recommend it highly. It will help with this course, and help even more in 7828.

Russell Davidson and James MacKinnon, *Estimation and Inference in Econometrics*, Oxford University Press, 1993. I recommend this book to those who want an advanced text in theoretical econometrics. It is well written. Russell and I went to graduate school together. This book is not for the faint of heart.

3.2.3 Additional reading and notes:

I might assign some additional readings for some topics. If I do, I will put them on the course web page.

3.3 Software:

The computer software *Mathematica* will be an important tool. You will use it in many assignments. For example, you will use it to investigate distributions such as the Normal, Chi-Squared, Student t and F distribution: distributions that play crucial roles in econometrics.

You will use it to draw random samples from these and other distributions.

You will use it to write your own code for different econometric estimators, to do simulations, and to do Monte Carlo studies.

For more details on *Mathematica*. including how to download the program to your Mac or PC, see the section of the 7818 web page
http://www.colorado.edu/economics/morey/7818/7818mathematica.html

3.4   Prerequisites:

A sufficient condition for being in this course is that you are a new Ph.D. student in economics here at C.U. But, it is not a necessary condition: graduate students in business often take this course, sometimes other people who simply have too much free time.

You need to get by and do well whether your preparation for 7818 is "not enough", "just right" or "too much."

I won't use matrix algebra in this course, but I am sure it will be used in your upcoming econometrics courses, so you might want to sleep with a matrix-algebra book.

3.5   Class format:

Lecture/problem solving/discussion/computer/estimation

I very much believe that one learns statistics by doing statistics - this is true of most things. Listening to me drone on about this or that is not the most efficient way to learn about this or that, particularly given my lack of expertise in the subject. That said, I love to drone on and on.

Hands on experience will be stressed. Class format will include both individual and group problem solving. We will extensively use random sampling to investigate the properties of a statistic, and then relate what we find to statistical theory. After completing the course, you will be able to critically evaluate and apply econometric theory.

You will spend a considerable amount of class time interactively formulating and solving problems and building models. Small groups will often be utilized. Many of your assignments will be group assignments.

I am hoping that you will spend more time talking than I will spend talking - maybe not.

3.6   Details of grading:

There will be problem sets, short projects and quizzes. Some of these activities will be done using *Mathematica*. Some of these activities will be done in groups larger than one. Some of these activities will be take-home, some will be done in class.

Each will be graded on a 10 point scale. Your best $(N - 2)$ grades on these activities will constitute 50% of your course grade, the midterm 20%, the final 25%, and 5% will be set aside for participation (I will be the "decider" when it comes to how much you positively participated). The final will be cumulative and will likely have a take-home part and an inclass part.

Wrt the problem sets, short projects, and quizzes: I do **not** accept things late. Note that you could, in theory, blow off two of these assignments and still have a perfect grade on these assignments.

This will be a course where writing down a bunch of math will **not** suffice. Explaining, in words, what you are doing and what it means is more important. The emphasis will be on understanding, explaining, and applying, not on regurgitating a bunch of math and symbols. So, your ability to write is important. Some of you will have find explaining stuff in words the most difficult part of the course.

3.7   Questions:

There are review questions for each section of the course, even some answers. Knowledge of these review questions will be helpful when taking exams. Every year I update these questions, occasionally deleting a bad question, but most mostly by adding new questions. I will updateon a section by section basis. Keep in mind that are few questions to ask, but that there are many ways to ask the same question.

I strongly encourage you to write out answers to all the review questions and discuss them with you classmates. You will want to form study groups. Bouncing ideas off each other will help you to determine if your thinking is correct, and will make you a better explainer. You can discuss answers with Mr./Ms.X, your T.A.

In class I will ask many questions. I also expect you to ask questions. In addition to these question, I will sometimes give you the opportunity to earn, or lose, points by verbally answering specific questions. Participation in this latter activity is completely voluntary.

3.8 Advice for quizzes, assignments and exams:

As I said above, your answers to most questions should include a significant proportion of explanatory words, not just math. Some of you are likely more comfortable keeping your words to an absolute minimum and simply writing down a bunch of math. This is a bad idea. If the math is correct but there is no explanation, the answer is deficient.

Explaining what you are doing in words is critical, so is writing down the appropriate equations and showing enough of your math so that I do not have to do math to detemine if your answer is correct or incorrect. The issue is not just whether an answer is correct; just as important is how much effort it takes to figure out if it is correct.

There is always the issue of what a grader should assume you know when you don't state it. Forcing me to make these calls is generally a bad idea. If I can assume some calculation or process was obvious to everyone in the class at the beginning of this term (note that backgrounds vary significantly), I will not deduct points if you do not show the calculation or process. Otherwise, I am forced to assume you don't know it unless your show it.

When I grade your exams and quizzes, I ask whether the reader will know the answer and understand it after they have read your answer, assuming that he or she did not know the answer before reading your answer. Getting the correct answer is not sufficient.

Exclude stuff that you know to be incorrect – seeing how you were initially wrong and then figured things out makes for a very hard read. The object of an answer is not to describe the toturous path to it.

However, if you are forced to say something that you know to be incorrect, point out that you know it is incorrect, and tell me why you are telling me something that is incorrect.

Knowing the material is not sufficient. You all need to convey that knowledge to the reader. So writing skills and the ability to communicate on the page are as important knowing what calculations to do and doing them - I am getting repetitive.

3.9   Group Assignments:

Some of the assignments will be done in groups. I will tell you in advance if an assignment is a group endeavor. The first assignment is a group assignment.

The group will work together and turn in only one assignment. Everyone in the group will get the same grade for that assignment. Group activities are one of my ways of giving you an incentive to work and study together.

3.10 Office hours, contacting me outside of class, and answering questions outside of class

My office hours are posted on the course web page. If you can't make it to an office hour and want to see me, catch me before or after class to schedule a time.

My office is Econ 122. Please feel free to contact me by E-mail at Edward.Morey@Colorado.edu about setting up an appointment. Sometimes it will take a day or so for me to get back to you.

You can also E-mail me questions. I will try to answer them but will not always have the time or the knowledge to do so. If I do respond, I will typically send your question, with my response, to all members of the class. Information is a public good, so passing it along to everyone is, in general, efficiency increasing.

Keep in mind that if you have a question, you can E-mail your question to everyone in the class, including me. I encourage this. I suspect that some of your fellow students will have better answers than mine: they often have a better appreciation of what is and is not obvious. People can comment on and add to the answers of others.