ECON 5213: Advanced Econometrics

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University of Oklahoma

Department of Economics

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1 Remark

This syllabus is *only* tentative and subject to change. I will update it according to the progress of this course. **It is your responsibility to check Canvas and Github page constantly for updates.** There may be major changes regarding the course such as grading policy, exams and empirical project if deemed necessary, but they will be explicitly announced in class at least one month ahead.

Email is the fastest way to contact me.

2 Course Description

This is a graduate level introduction to econometrics offered primarily to first-year Ph.D. economics students. The course is designed to provide a **foundation** for and a **general introduction** to econometric technique, theory, and application to prepare students for future study of 1) frontier topics in econometrics or 2) empirical applications of these techniques in topical areas. Knowledge of multivariate calculus, some probability and mathematical statistics is assumed. As well, you should be comfortable with basic matrix algebra. A prior course in undergraduate econometrics would be helpful, but not required.

The course has four basic objectives. The first is to provide some background knowledge in probability theory and mathematical statistics necessary for econometrics. The second is to review, extend, modify, and otherwise build on the **econometric techniques** already covered in undergraduate econometrics classes (i.e., the classic linear regression model, non-spherical disturbances, instrumental variables, et cetera). The third objective is to present sufficient **econometric theory** (i.e., large sample/asymptotic theory) so that students will 1) have deeper understanding of the techniques they are using, and as well, will recognize the circumstances under which they might be appropriately used; 2) gain experience of formal proofs and rigorous

derivations of econometric theory. It is important to know that "To understand a mathematical proof, it is not sufficient to simply read the proof, you need to follow it, and re-create it for yourself." (Bruce Hansen, 2019)

Finally, while this is a more theory oriented course, we should also emphasize the "application" aspect of this course, which entails becoming familiar with statistical software (Stata will be used in the course). Students will eventually develop and prove competency in Stata in order to apply the techniques learned and to evaluate the theories.

I would like to emphasize that this is an *econometrics* course. And we will try to distinguish ourselves from statisticians or other quantitative researchers by emphasizing the economic motivations and interpretations behind these methods whenever we can. This course will introduce concepts in probability and mathematical statistics in a way that would eventually prepare you to study *econometrics*, instead of treating these topics as stand-alone ones.

3 Online Learning

My goal for this course is to replicate in-person classes as much as I can in a virtual environment. Our lectures will be live and won't be recorded. Recordings are also not allowed. Just as with in-person classes, missing one lecture will entail some cost, but the impact is minimum. It won't be detrimental to your learning, and one can easily catch up by going through the assigned material, including slides, and the notes that you can borrow from your classes.

No matter what we do, however, online learning will surely be different from in-person learning. Throughout the semester, we may encounter many challenges pertaining to online learning. One of such challenges is that when in a virtual environment where interactions may not be the same as in-person classes, it may take a different approach to stay engaged. So, I would ask you try your best to avoid distractions and stay engaged.

1. Try to give the Zoom meeting your full attention. Turn off email, text, and other instant notifications to avoid distraction.

2. If you are moving around the room, wrestling with your cat, or need to step away for a second, turn off your video to avoid distracting others.

3. Avoid multi-tasking. You'll retain the discussion better if you refrain from replying to emails or text messages during the meeting and wait to work on that PowerPoint presentation until after the meeting ends.

Throughout, the most important thing is again **communication**. Show understanding and patience to each other, and collectively come up creative solutions to address any challenges that may get in the way of our learning. Hopefully, by addressing them, we may be able to fully exploit some of the advantages of online learning.

4 REQUIRED READINGS

[BH] Bruce Hansen of Wisconsin provides two free textbooks that cover the core material typically taught in a one-year Ph.D. course in econometrics. The first one is available here

at `https://www.ssc.wisc.edu/~bhansen/probability/Probability.pdf`. The second one is available here at `https://www.ssc.wisc.edu/~bhansen/econometrics/Econometrics.pdf`

"Probability, Statistics, and Econometrics" by Oliver Linton is also closely related to the structure that I use in this course. This book used to be freely available through our library website, but this service was unfortunately disconnected, effective in July 2019.

My lecture slides would be the main material for the course. But the following resources will prove to be useful as well. Later I will provide a course schedule noting how our material is corresponding to some of these recommended books and notes.

4.1 MATH PREREQUISITES

You should be very familiar with the material in Appendix A in BH's notes. You should come in familiar with material covered in Cal I and Cal II, including integration techniques (a review is available here, `https://tutorial.math.lamar.edu/Classes/CalcI/CalcI.aspx`, `https://tutorial.math.lamar.edu/Classes/CalcII/CalcII.aspx`).
You may also find the following website for symbolic calculation useful. `https://www.symbolab.com/solver/integral-calculator`

4.2 PROBABILITY THEORY AND MATHEMATICAL STATISTICS

The first part of the semester will be focused on probability theory and mathematical statistics so that everyone is on the same page for more advanced econometrics. Pick any mathematical statistics book, Review Appendices in Greene, Google any material that you think would be helpful. Below is a link to Penn State website that would be helpful for those of you who need some reviews at the undergrad level.

`https://onlinecourses.science.psu.edu/stat414/node/3`

Below are some recommended (NOT required) readings:

[CB] George Casella, Roger L. Berger, 2001, *Statistical Inference*, 2nd edition.

Vadim Marmer's lecture notes: `http://faculty.arts.ubc.ca/vmarmer/econ327/index.html`

Robert V. Hogg , Allen Craig , Joseph W. McKean, *Introduction to Mathematical Statistics* or any versions no later than 5th edition.

Herman J. Bierens, *Introduction to the Mathematical and Statistical Foundations of Econometrics*

4.3 ECONOMETRICS

The second part of the sememster will be focused on econometrics. While I emphasize the separation of these two parts for the organization purpose, it does not mean that these two parts are distinct and unrelated. Instead the second part is built on and transitioned from the first part. Hopefully by presenting these two parts altogether, we can see the connections between the two, and probably understand them better as well.

William Greene, *Econometric Analysis*. The 8th edition is the most recent. Corrections and other information for the text can be found at `http://pages.stern.nyu.edu/~wgreene/Text/econometricanalysis.htm`. Certain chapters and material in the older editions can be used as a substitute.

It is also recommended that you have access to the following:

Jeffrey M. Wooldridge, *Econometric Analysis of Cross Section and Panel Data*, Cambridge, MA: MIT Press, 2010 (Second Edition).

Note that Greene's book is not necessarily "best" for any topic, but it is likely, at a minimum, second best for just about every topic.

5 (SOME) MORE RECOMMENDED READINGS

1. Symposium on Econometric Tools, Journal of Economic Perspectives, Vol. 15, No. 4, Fall 2001

2. A Guide to Econometrics, 6th Edition, Kennedy, Peter, The MIT Press: Cambridge, MA.

3. Introduction to Econometrics, Fourth Edition, Maddala and Lahiri, Wiley: 2009, ISBN: 9780470015124

4. Introductory Econometrics, Fourth Edition: Wooldridge, South-Western: 2009, ISBN: 9780324660545

6 (SOME) RECOMMENDED RESOURCES FOR STATA

1. Undergrad Econometrics Using Stata at Rochester `https://www.youtube.com/channel/UCbeLdyQFjWuP39wuVfl4Xlw`

7 ASSIGNMENT, TESTING, AND GRADING

7.1 Tests

There will be one midterm exam (**tentative date: 10/21/2020**) and one final exam. The format of these exams will be announced later. **No make-up exams will be given.** If a student misses a midterm examination for **any reason**, the weight of that examination will

be added to that of the final exam. I'd like to have the flexibility to speed up or slow down depending on how I think the class understands the material. So, the midterm date may be subject to change according to the progress but will be announced one week in advance.

7.2 Homework Assignment

There will be homework assignments following each topic. Students are usually given a week to complete these assignments, but this could vary depending on the length of the homework. **Homework assignments will be due at the beginning of class and late homework assignments will not be graded for credit.** It is important to know that the homework assignments are very important in that the basic ideas covered by them invariably show up on the mid-term and the final. If you know you are going to be missing a class on the day a homework exercise is due, hand in your homework **in advance** to receive full credit for your work.

- You should try to type all the homework. This is also courteous to your TA who would be grading the homework.

- Group discussion is encouraged when working on the problem sets. Your answers should show individual understanding of the materials and be written in your own words. If you collaborate with other student(s), everyone in your group should be acknowledged at the beginning of the homework. Identical homework assignments would receive a zero for both students.

7.3 Grading

The weights in the final grade are assigned as follows:

Homework Assignments:	35
Midterm :	25
Final:	35
Participation:	5

The grading scale is:

90-100	A
70-90)	B
60-70)	C
55-60)	D
0-55)	F

A number with a parenthesis means any number less than it. For example 90) means any number less than 90, but not equal to 90. It could be 89.9999999. I reserve the right to change the grading scale. The required score for the final grade could be lower but not higher. For example, the current requirement for an A is 90-100, but later I may change the cut-off point to 85-100, but won't change it to 97-100.

8 University Policies

8.1 Accommodations for Students with Disabilities

If you are a student with a documented disability who will require accommodations in this course, please register with the Disability Resource Center (Goddard Health Center, Room 166, 325-3852). Students who are already registered with the Office of Disability Services and wish to receive accommodations in this course are strongly encouraged to share their Accommodation Letter with me in a timely manner so I can provide an appropriate contact to discuss accommodations necessary to ensure full participation and facilitate your educational opportunities. Students with disabilities must be registered with the Disability Resource Center before receiving academic adjustments.

8.2 Academic Honesty

Cheating is strictly prohibited at the University of Oklahoma, because it devalues the degree you are working hard to get. As a member of the OU community it is your responsibility to protect your educational investment by knowing and following the rules. For specific definitions on what constitutes cheating, review the Student's Guide to Academic Integrity at `http://integrity.ou.edu/students.html`.

8.3 Religious Observance

It is the policy of the University to excuse the absences of students that result from religious observances and to reschedule examinations and additional required classwork that may fall on religious holidays, without penalty.

8.4 Title IX Resources and Reporting Requirement

For any concerns regarding gender-based discrimination, sexual harassment, sexual assault, dating/domestic violence, or stalking, the University offers a variety of resources. To learn more or to report an incident, please contact the Sexual Misconduct Office at 405/325-2215 (8 to 5, M-F) or smo@ou.edu. Incidents can also be reported confidentially to OU Advocates at 405/615-0013 (phones are answered 24 hours a day, 7 days a week). Also, please be advised that a professor/GA/TA is required to report instances of sexual harassment, sexual assault, or discrimination to the Sexual Misconduct Office. Inquiries regarding non-discrimination policies may be directed to: Bobby J. Mason, University Equal Opportunity Officer and Title IX Coordinator at 405/325-3546 or bjm@ou.edu. For more information, visit `http://www.ou.edu/eoo.html`.

8.5 Adjustments for Pregnancy/Childbirth Related Issues

Should you need modifications or adjustments to your course requirements because of documented pregnancy-related or childbirth-related issues, please contact your professor or the Disability Resource Center at 405/325-3852 as soon as possible. Also, see `http://www.ou.edu/eoo/faqs/pregnancy-faqs.html` for answers to commonly asked questions.

9   Tentative Course Outline

Note that the schedule is subject to change depending on the pace of the course. Not all material would be covered, and extensions of the basic models not listed below may be added to deepen our understanding of these techniques. Moreover, the material will not be necessarily covered in the same order as below.

1. Intro to Probability Theory and Distribution

2. Mathematical Expectation

3. Alternative Ways to Characterize Distributions

4. Quantile Function

5. Monte Carlo Simulation and Parametric Distributions

6. Joint Distribution

7. Conditional Distribution

8. Conditional Expectation and Its Properties

9. Linear Regression: Basics

10. Linear Regression: Computational Tool

11. Linear Regression: Approximation Tool

12. Understanding OLS more: Holding Everything Else Constant

13. Understanding OLS more: Finite Sample Properties

14. Understanding OLS more: Asymptotic Properties

15. Hypothesis Testing

16. Violations I and II: Collinearity and Functional Form

17. Violation III: Endogeneity and IV

18. Violation IV: Endogeneity and Panel Data (time permitting)

19. Violation V: Heteroskedasticity (time permitting)