Economics 208D   Fall 2019
Department of Economics
Duke University

ECONOMETRICS
Intuition, Theory and Applications

Instructor: Duncan Thomas
Office: 314 Social Sciences
Email: dthomas@econ.duke.edu
Lectures: Monday and Wednesday 8.30-9.45am, Old Chemistry 116
Office hours: Monday 1:00-2:45 pm or by appointment
Class web site: http://ipl.econ.duke.edu/dthomas/ec208d (or log on through sakai)

Graduate teaching assistants

Name	Email
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Sections	Day/time	Place
01	Wednesday 6:15-7:05 pm	Social Sciences 111
02	Thursday 6:15-7:05 pm	Social Sciences 111

Attendance at lectures is required. Attendance at sections is very strongly recommended. Sections are led by outstanding PhD students who have considerable expertise in applying econometric methods to data and also have experience teaching the material in this course. In addition to sections, the TAs will hold office hours on Thursdays and Fridays from 1.15-3.15 pm in Social Sciences 03.

Undergraduate teaching assistants

The class is also supported by two excellent undergraduate teaching assistants, Amir Perk (amir.perk@duke.edu) and Tim Rickert (timothy.rickert@duke.edu) who are available to assist you with material from the course and problem sets. They will hold office hours from 12.30-2:00 pm on Sundays in Social Sciences 111.

Examinations

There will be two examinations: a midterm and a final. Both examinations are required.

> *Midterm*:   *Monday September 30, 8:30-9:45am* (Old Chem 116 and Social Sci 113)
> The in-class mid-term will be open book. You may bring any materials you need to the exam. You may not communicate with anyone inside or outside the room during the examination.

> *Final*:   *Thursday December 12, 7:00pm-10:00pm*
> The final will be closed book. You may bring *one two-sided 8.5"*11" page of formulae and notes* that you construct and that you think will be of use to you during the exam. The sheet must be handed in with your exam. The exam will not include questions that require the use of STATA. Please bring a calculator to the exam.

If you have substantive questions about the course material you want to ask me, please see me after class or during my office hours. Emailed questions about the material are very hard for me to answer effectively. It has been my experience that I typically need to know more about the problems you are encountering than you tell me in your email. In addition, I have no way to assess whether my e-mail response has cleared up the problem for you. I will, therefore, not attempt to answer substantive questions sent to me by email. If you cannot attend my office hours, we can make an appointment to meet at a time that is convenient for you.

Course Objectives

The goal of this course is to provide an introduction to both *the theory and application* of modern econometric methods to address questions in economics and the behavioral sciences. Mastery of the material is intended to provide you with sufficient knowledge of statistical and econometric methods to enable you to think critically when you evaluate the quality of evidence in support of a claim about how individuals behave, markets work, firms make money or societies operate. You will develop the skills to be an effective consumer and producer of empirical research in economics. Throughout the class, emphasis is placed on *intuitive understanding* of underlying concepts with more rigorous arguments serving to strengthen the foundation of your knowledge. Central concepts are illustrated with *applications*.

Course Requirements

You are required to have passed Probability and Statistical Inference (Stat 111). This class builds on the foundation laid in that class. Ideally you will have taken Stat 111in the semester immediately preceding this class or at least within the twelve months preceding enrolling in this class. It will be assumed that you have a good understanding of the material covered in Stat 111. With my permission, you may substitute Stat 130, 203, 250 Math 230 or 342 for Stat 111. In my experience, those classes cover somewhat different material; since Stat 111 is the pre-requisite, it is incumbent upon you to be sure you have all of the material in that course under your belt. In addition, it is assumed that you have a good grasp of calculus.

Building on the foundation laid in the pre-requisite classes, this class will begin with an introduction to the linear regression model. Core statistical concepts that you have covered in your statistics preparation will be applied to the regression model to provide a fuller understanding of the value of these tools to better understand economic phenomena and the world around us. This class will evaluate extensions to the linear regression model that are designed to address real world problems that arise in the study of economic behavior and provide rigorous tests of hypotheses in the economics and related literatures. In addition to understanding the theoretical concepts that underlie modern regression analysis, you should develop the practical skills necessary for good data analysis as well as learn how to interpret the results of your analyses. You will be required to do econometric analysis with real data from actual applications. You may use whatever computer hardware and software you like. Instruction will be provided for using STATA which you are strongly encouraged to learn. The product will serve you well in this class and other classes, research at Duke and beyond Duke. We will use STATA in this class. You may download a copy of STATA/SE for your own Mac, Windows or Linux computers. Instructions are on the class web site, http://ipl.econ.duke.edu/dthomas/ec208d/statalinks.html.

In addition, help using STATA is available in the Data and GIS lab in Perkins and at SSRI West. There are many good on-line resources, some of which are linked from the class web page.

Grading and Organization

Each week there will be two lectures. You are *required* to attend every lecture. Please turn off all phones, tablets, laptops etc. before class starts and do not turn them back on until the class has ended; they may not be used during class. Lectures will be supplemented by a weekly section led by an experienced Ph.D. students. Sections will cover statistical material not covered in this class that was covered in the pre-requisite class. You will be responsible for that material. Sections will also review lecture material, problem sets and provide computer instruction. Each week, one TA will be responsible for all sections and the same material will be covered in every section that week. You may attend the section that is more convenient for you. You are expected to understand and uphold the Honor Code, http://studentaffairs.duke.edu/conduct/about-us/duke-community-standard.

Problem sets

There will be a problem set every second week. The problem are designed to help you understand important ideas in the theory and application of econometric methods and contribute to your developing a sophisticated understanding of how to interpret empirical evidence in a practical, real-world setting. To underscore the importance of taking the problem sets seriously, they will account for 20% of the final course grade. Completed problem sets must be submitted in person at the beginning of the lecture on the due date. Late problem sets will not be accepted. If you cannot hand in your problem set at the beginning of the lecture, with my prior consent, you can hand it in earlier. Problem sets must be handed in on paper, preferably typewritten. Emailed problem sets will not be accepted.

You may work with other students in this class on problem sets. By collaborating with your peers, my expectation is that you will better learn the material. Explaining an idea, concept, method or result to a peer is one of the best ways to reinforce your own understanding. However, to be sure that you do understand the work, *you must write up your own answers and submit your own work.* Please indicate on your problem set answers with whom you collaborated. You may only refer to the answer keys provided for this year's problem sets which are posted on the class web page after the problem set is due. Prior year answer keys may not be used in any way or under any circumstances. A grade of zero will be assigned to all problem sets for the course for any student who violates this policy for any problem set.

For each problem set, the grades will be: 3 if you do an absolutely stellar job and your answers are at least as good as the answer key; 2 if, roughly speaking, you get at least $2/3^{rd}$s of the problem set correct; 1 if you get between $1/3^{rd}$ and $2/3^{rd}$ s correct; and 0 otherwise. Answers to questions that call for intuition or interpretation are given more weight than calculations. A grade of 1 is a signal to you that you need help. A grade of 0 indicates a very serious problem and you should seek help from the TAs or me immediately. Problem sets handed in late will get a grade of 0. The final problem set grade will be based on the total score over all problem sets. I cannot overstate the value to you of making a good faith attempt to complete every problem set and submit it on time. Each problem set will be graded by one TA. If you have any questions, that TA will be the best person to review your answers after you have submitted your problem set. All questions about grades should be taken up with the TA who graded that problem set.

Answer keys for each problem set will be posted on the class webpage soon after the submission deadline has passed. Each problem set will be reviewed in section. The section will not only go over the answers but also provide insights into how to think about the problems and thereby strengthen your understanding of the material covered in class. Please carefully review the posted answer keys. There are three reasons this will be a good use of your time. First, it is not possible to provide detailed written individual-specific feedback tor each student on his/her answer. Second, it is very difficult for us to identify every instance in which you do not understand something; it is your

responsibility to make sure you understand all the material covered in each problem as laid out in the answer key. Third, the answer key is designed to provide a succinct, clear answer to each question; following the model used in the answer key will stand you in good stead in this class and beyond.

In-class quizzes

In-class quizzes will be administered to those attending lectures at randomly assigned times during the term. The quizzes are intended to assess your understanding of concepts covered in lectures up to that point and to provide feedback to you regarding your grasp of the material covered in the class. The in-class quizzes will account for 15% of the final grade. If you are absent from class, no matter what the reason, your grade for that in-class quiz will be zero.

Weekly discussion section

Each weekly discussion section will be led by a TA who is a PhD student. The TAs are experienced teachers who have expertise in econometrics. Sections will provide instruction in STATA, including classes on good programming and data management practices that will be helpful for other classes. Sections will review problem sets and extend ideas covered in the problem sets and review and reinforce material covered in this class or Stats 111. The sections in any week are designed to be identical; you are welcome to attend the section that fits your schedule best in any week.

Mid-term exam

There will be one mid-term which will account for 15% of your course grade. The mid-term will be an open book examination. You may bring any books or materials you want to the class. You may not communicate with anyone inside or outside the classroom during the exam; this includes texting, emailing or any other form of communication. There will be no make-up midterm. If you are unable to take the midterm, you must provide me with a written explanation *before* the mid-term. If the written explanation provides a reason that is clearly beyond your control, and I judge that it is appropriate to do so, then I will substitute your final grade for your midterm grade. In any other instances, your midterm grade will be zero.

Final exam

The final exam will be closed book and will cover all the material in the course. You do not need to memorize formulae for this class. You may bring one 8½*11 page of formulae with you for reference during the final exam; you may use both sides of the page. No other reference material is allowed. You may not communicate with anyone inside or outside the classroom during the exam; this includes texting, emailing or any other form of electronic communication. The final exam score will contribute 50% of the final grade for the course. If you miss the final exam for a reason that is outside of your control, with the approval of the Dean and if I judge that it is appropriate, you may be able to take the final exam the next time it is offered. In that case, I will substitute your grade in that exam for the final exam grade for this class after adjusting the grade so that the mean grade in both exams is the same. The date and time of the final exam is determined by the Registrar and it cannot be rescheduled.

Sharing class materials

All the material you need for this course will be available on the class web page. The material is copyrighted which means you may not re-distribute any material such as hand outs, slides, problem sets, exams or answer keys that we have created. Re-distributing includes posting material on a website, server, shared drive, file host or similar service or providing material to someone who is not enrolled in the class this term. *Please* do not distribute any materials from this class. Since I change the class each year, I strongly discourage you from attempting to use material from prior classes; in my experience, that results in confusion and disappointment.

Reading

The recommended text for this class is

> Wooldridge, Jeffrey M. (2020) *Introductory Econometrics: A Modern Approach, 7th Edition,* Cengage (ISBN: 978-1337558860)

Access to this book is encouraged. You may borrow the book from the library for 3 hours at a time (see https://library.duke.edu/course-support/course-reserves/textbooks). If youpurchase or rent the book, you may buy the paper or electronic version; you do not need access to the on-line resources and an earlier edition of the book will work well. If you find you do not like the presentation in Wooldridge's book, I encourage you to look at one or more of the following:

> Angrist J. and S. Pischke. (2014) *Mastering Metrics: The Path from Cause to Effect.* Princeton University Press.
> Goldberger, A. (1998). *Introductory Econometrics*, Harvard University Press.
> Gujarati, D. (2003), *Basic Econometrics*, Irwin-McGraw-Hill.
> Hill, C., W. Griffiths, and G. Lim (2011). *Principles of Econometrics*, Wiley.
> Stock, J and M. Watson (2011) *Introduction to Econometrics*, Pearson.
> Studenmund, A. H. (2013) *Using Econometrics: A Practical Guide*. Pearson.

None of these books covers statistical theory in a comprehensive manner. If during the course you feel you need a statistical reference, use the text from your statistics course or look at:

> Hogg, R. V. and E. Tanis and D. Zimmerman. (2015). *Probability and Statistical Inference*, 9th ed, MacMillan.

I will provide handouts throughout the course to supplement the lectures and textbook. There is no shortage of alternative text books and there is a large amount of material on-line that will supplement this course. The class web-site has links to some of the on-line material.

Course Outline and Required Reading

Readings from Wooldridge are intended to complement the lectures and I encourage you to read the appropriate chapters <u>before</u> class.

		Wooldridge
1.	*Introduction to econometrics*	Chapters 1 and 19
2.	*Simple linear regression model*	Chapter 2, 9.5, 9.6
3.	*Fundamentals of multiple regression*	Chapter 3, 9.2 9.3, 9.4
4.	*Theory of estimation and inference*	Appendices B and C
5.	*Linear regression model: Inference*	Chapter 4, 5
6.	*Linear regression model: Interpretation*	Chapter 6
7.	*Indicator variables*	Chapter 7
8.	*Non-spherical errors: Heteroskedasticity and correlated errors*	Chapter 8
9.	*Limited dependent variable models*	Chapter 17
10.	*Omitted variables and sample selectivity*	Chapter 9
11.	*Instrumental variable estimation and two stage least squares*	Chapters 15 and 16
12.	*Panel data methods*	Chapters 13 and 14

If, after class, you have difficulty with the lecture notes and Wooldridge's presentation, you should consult one of the alternative texts. They are listed, with chapter references, below. Alternative readings are identified only to assist you and are not required.

Alternative readings

Sections 1, 2 and 3: Introduction to regression model
Angrist and Pischke	Chapters 1 and 2
Goldberger	Chapters 1 and 2
Gujarati	Chapters 1, 5 and 6
Hill, Griffiths and Lim	Chapters 1, 2 and 4
Stock and Watson	Chapter 1

Section 4 : Theory of estimation and inference
Goldberger	Chapters 2-4
Gujarati	Chapters 2, 3
Hill, Griffiths and Lim	Chapters 1P, 3
Stock and Watson	Chapters 2-3

Section 5, 6 and 7: Classical multiple regression model
Angrist and Pischke	Chapter 2
Goldberger	Chapters 6 -12
Gujarati	Chapters 7-9
Hill, Griffiths and Lim	Chapters 5-7
Stock and Watson	Chapters 4 -7

Sections 8, 9 and 10: Relaxing assumptions of the regression model
Goldberger	Chapters 13-17
Gujarati	Chapters 10-14
Hill, Griffiths and Lim	Chapter 8
Stock and Watson	Chapters 8, 9 and 11

Sections 11: Unobserved heterogeneity and instrumental variable methods
Angrist and Pischke	Chapter 3
Goldberger	Chapters 18 and 20
Gujarati	Chapter 15
Hill, Griffiths and Lim	Chapters 10-11
Stock and Watson	Chapter 12

Section 12: Panel data methods
Angrist and Pischke	Chapter 5
Gujarati	Chapters 10, 11 and 12
Hill, Griffiths and Lim	Chapter 15
Stock and Watson	Chapter 10