Economics 6213

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Instructor Dr. Lee C. Adkins

Phone 744-5196

Office 461 BUS

Hours Tuesday 10:00-12:30 and by appointment

E-mail lee.adkins@okstate.edu

WWW `http://www.LearnEconometrics.com`

1 Purpose

The objective of this course is to provide a survey of the main estimation principles used in modern econometrics. Topics include the estimation and specification of linear and nonlinear regression models, hypothesis testing, confidence intervals, and introductions to generalized least squares, maximum likelihood, instrumental variables and the generalized method of moments.

In order to become functionally literate in applied econometrics, you need to learn some of the fundamental principles of econometric theory. Trust me when I say that no matter how well you master current econometric practices, your econometric knowledge will depreciate very quickly. The basic tools of econometric theory will help to slow the rate of depreciation of your hard-earned, specific econometric human capital. It is well worth your time to learn these tools now, especially if you intend to do any empirical work in the future.

Econometrics II, the sequel to this class, is focused on application of the principles you learn in here. This course will prepare you for Econometrics II in either the Economics or Agricultural Economics departments.

1.1 Economics Program Learning Objectives

Goal 3 Econometrics Knowledge and Competency:

- Demonstrate an in-depth competency in the theory and application of the core areas of econometrics.
- Demonstrate the ability to construct, estimate, and interpret econometric models.

2 Textbooks

Required

> Russell Davidson and James MacKinnon, *Econometric Theory and Methods*, Oxford, 2004.

Most of our lectures and class assignments will come from Davidson and MacKinnon's book. The major shortcoming of this book is that it doesn't contain empirical examples. Also, the mathematics can be dense at times and you may find it useful to supplement your reading in ETM with other material. In particular, you may consider Wooldridge's *Introductory Econometrics: A Modern Approach*, Stock and Watson's *Introduction to Econometrics*, or Hill et al. (2011) all of which are nice upper level undergraduate books.

Recommended

Lee C. Adkins, *Using gretl for Principles of Econometrics*, e-book. 2012. Available from `http://learneconometrics.com/gretl/using_gretl_for_POE4.pdf`.

Wooldridge (2016), *Introductory Econometrics: a Modern Approach*, This undergraduate book contains much wisdom and great examples. Highly recommended.

Kennedy (2008), *A Guide to Econometrics*, This is the most useful econometrics book I've ever owned.

Baum (2006), *Introduction to Modern Econometrics using Stata*, has written an introduction to econometrics using Stata.

Verbeek (2012), *A Guide to Modern Econometrics*, is written by a finance guy, complements ETM fairly well (similar notation and approach), but is much more application oriented.

Cameron and Trivedi (2010), *Microeconometrics Using Stata*, is more advanced than Baum's book, but very good.

Other Sources

Stock and Watson (2011), *Introduction to Econometrics*. In particular, see the last two chapters for the good stuff.

Fomby et al. (1984), *Advanced Econometric Methods*. Old but good treatment of microeconometrics.

Judge et al. (1985), *The Theory and Practice of Econometrics*, (a.k.a., "Big Judge"). Encyclopedic coverage of the state of econometric knowledge in 1985. Much has changed since then, though. Greene's book, though less thorough, provides a more modern survey.

Judge et al. (1988), *Introduction to the Theory and Practice of Econometrics*, (a.k.a., "Baby Judge"). This contains very systematic coverage of the basic models. Even though it is old, it is still the best textbook treatment of introductory econometrics available. It is not a cookbook (see Greene for that).

Schmidt (1976), *Econometrics*. Theorem/Proof! Essential if taking Econometrics prelims or if you are a stat major, not so useful otherwise.

Greene (2012), *Econometric Analysis*. This is book is widely used for this course. It is a great resource to have if you already know introductory econometrics. As a way of learning econometrics it is not so good–which is why I don't use it this way. In my experience the book is not systematic enough in its development of each topic. Its major strength (completeness of coverage) is what makes it a poor choice for learning econometrics. To thoroughly cover a topic, it has to draw on material covered elsewhere; usually stuff that students haven't learned yet. That said, it is essential to own a copy of this book if you intend to apply econometrics. The coverage is unusually broad, containing many esoteric models, and the examples are great. Watch out for errors, though (there tend to be quite a few–though the author is especially quick to try to fix them).

3 Prerequisites

This course requires you to work with probability, statistics, calculus, matrix algebra, and to write computer programs (as well as learn econometrics). **The most important prerequisite, however, is an applied course in linear regression.** This is essential because I expect you to already know what a regression is, how to run one, and how to interpret the results.

This course is theoretical and if you do not have an understanding to what the theory is being applied, then you can quickly get lost. If you have any doubts about whether your experience is sufficient, please talk to me about it. At a minimum, I assume that you know the basics of differential calculus, matrix algebra, and the basics of linear regression and using some sort of econometric software (Stata, gretl, EViews, R, Matlab, etc.). If you have any doubts about whether your experience is sufficient, please talk to me about it.

4 Course Outline

1 Review of Regression Models, Chapter 1

- 1.1 Introduction
- 1.2 Distributions, Densities, and Moments
- 1.3 The Specification of Regression Models
- 1.4 Matrix Algebra
- 1.5 Method-of-Moments Estimation

2 The Geometry of Linear Regression, Chapter 2

- 2.1 The Geometry of Vector Spaces
- 2.2 The Geometry of OLS Estimation
- 2.3 The Frisch-Waugh-Lovell Theorem
- 2.4 Applications of the FWL Theorem
- 2.5 Influential Observations and Leverage

3 The Statistical Properties of Ordinary Least Squares, Chapter 3

- 3.1 Are OLS Parameter Estimators Unbiased?
- 3.2 Are OLS Parameter Estimators Consistent?
- 3.3 The Covariance Matrix of the OLS Parameter Estimates
- 3.4 Efficiency of the OLS Estimator
- 3.5 Residuals and Error Terms
- 3.6 Misspecification of Linear Regression Models
- 3.7 Measures of Goodness of Fit

4 Hypothesis Testing in Linear Regression Models, Chapter 4.1–4.5

- 4.1 Basic Ideas

4.2 Some Common Distributions

4.3 Exact Tests in the Classical Normal Linear Model

4.4 Large-Sample Tests in Linear Regression Models

5 Confidence Intervals, Chapter 5.1–5.2 and 5.5–5.6

5.1 Exact and Asymptotic Confidence Intervals

5.2 Confidence Regions

5.3 Heteroskedasticity-Consistent Covariance Matrices

5.4 The Delta Method

6 Nonlinear Regression, Chapter 6.1–6.7

6.1 Method-of-Moments Estimators for Nonlinear Models

6.2 Nonlinear Least Squares

6.3 Computing NLS Estimates

6.4 The Gauss-Newton Regression

6.5 Hypothesis Testing

7 Generalized Least Squares and Related Topics, Chapter 7.1–7.5

7.1 The GLS Estimator

7.2 Computing GLS Estimates

7.3 Feasible Generalized Least Squares

7.4 Heteroskedasticity

8 Maximum Likelihood, Chapter 10.1–10.6

9 IV Estimation, Chapter 8.1–8.7

10 Generalized Method of Moments, Chapter 9.1–9.4 (Time Permitting)

5 Computer Assignments and Homework

Homework operates on the honor system for the most part. I will assign homework and expect you to do it. **I will collect it in sets 2 or 3 times during the semester. I'll give you a few days notice before calling for it.** I will evaluate it based on it's degree of completeness, organization (how easy it is for me to figure out what you've done and whether it is correct), and originality (how similar is it to classmates and to previous year's

work). I may evaluate a sample for correctness. If you wish to have a copy, then make a duplicate before you turn it in. I will not return it to you. I'd rather see you try to do it and fail than to copy someone else's work and get it right. Remember that. Also, when you turn in an assignment that requires computing, turn in a copy of the computer code you used to get your results.

Some of the homework consists of algebraic puzzles, and for these I want to see how you do without my help (fairly common in statistics). This helps me to gauge your aptitude for further study in econometrics. Other assignments are purely empirical in nature and I am certainly willing to discuss these almost anytime, preferably in class so that I don't have to say the same thing 25 separate times.

The other type of assignment may involve a small amount of applied regression analysis or a simulation based on simple regressions. For this you should use gretl. I will provide further instructions on how to get started with gretl and doing simulations with it later in the course. You are responsible for learning to use the software. To help, there are at least two excellent resources available (hint: see the reading list and look for my name). On the class website, I'll also supply links to other useful material.

Gretl

Gretl is an acronym for Gnu Regression, Econometrics and Time-series Library. It is a software package for doing econometrics that is easy to use and reasonably powerful. Gretl is distributed as free software that can be downloaded from `http://gretl.sourceforge.net` and installed on your personal computer. Unlike software sold by commercial vendors (SAS, Eviews, Shazam to name a few) you can redistribute and/or modify Gretl under the terms of the GNU General Public License (GPL) as published by the Free Software Foundation.

Gretl comes with many sample data files and a database of US macroeconomic time series. From the Gretl web site, you have access to more sample data sets from many of the leading textbooks in econometrics, including ours. Gretl can be used to compute least-squares, weighted least squares, nonlinear least squares, instrumental variables least squares, maximum likelihood, GMM and has special routines for specific models like logit, probit, tobit and a number of time series estimators. Gretl uses a separate Gnu program called *gnuplot* to generate graphs and is capable of generating output in LaTeX format. Gretl is under development so you can probably expect some bugs, but in my experience it is pretty stable to use with my Windows 7 systems.

So, why use Gretl? Well, its free, its fast, it will work on any platform, and it will do everything we are going to do in this class. Its programming language is very similar to commercial packages like Matlab, Gauss, IML, and so on so matrix code developed in gretl

translates quickly to these other environments.

Why not use Stata? Stata is a professional piece of software that has many more capabilities than Gretl. In the long-run, knowing how to use Stata could be beneficial. On the other hand, by the time you get around to using Stata, you may have forgotten it all and have to start from scratch anyway. As it turns out, knowing one package well (any package) is a pretty good introduction to other packages. For learning econometrics, though, gretl is very good. You'll have to do a little programming and gretl makes this as easy as possible. For doing sophisticated applied work using pre-programmed procedures, Stata is very good. But for learning how software works and how econometric theory translates into estimation results, gretl is much better.

Early in the course you will begin to use the computer to do portions of your homework. You will be responsible for learning to use the software of your choosing, though I can help you as needed.

6 Grades

Your grade in this class will be based on your performance on 3 exams and on homework assignments.

Grade Weights	
Midterm Exam I	30%
Midterm Exam 2	30%
Final Exam	30%
Homework	10%

Grades will be assigned according to the following scale:

Grades	
91%–100%	A
76%–90.9%	B
60%–75.9%	C
50%–59.9%	D
$< 50\%$	F

All exams must be taken at the designated time. No make up exams will be given. If you miss an exam you will receive a grade of zero.

Unless you are specifically told otherwise by me, all homework must be turned in at the beginning of the class period on the date that it is due. Homework will not be accepted if late.

7 Attendance

Regular attendance is expected. You are responsible for any material you miss because of absence. In general, I do not permit students to copy my notes. If you miss class and need a copy of the notes, please obtain them from one of your classmates.

Also, many of my notes are available on my website. As I develop new versions I add them so they are a bit disorganized at this point. Still, I usually base lectures on these so make use of them as you see fit.

8 Cheating Policy

Cheating will not be tolerated. You may not, under any circumstance, use material that comes from the solution manual to any of our textbooks. If you do (and I can usually tell since I know where the errors are) I will consider that an extremely bad case of cheating and I will begin procedures that will earn you an F! for the course.

Any violation of the University's academic integrity policy will be prosecuted according to University regulations. If you are not sure what this is about, then visit the link at the bottom of my website. Basically, you will receive a grade of 0 on any test or assignment you are caught cheating on. If the violation is especially egregious or it threatens my ability to evaluate work for others in the course, then you could earn an F! for the course and you may be suspended from the University. Remember, you are responsible for the security of your work (in other words, if someone copies your work, you will also receive a zero on the test or assignment).

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