Econometrics I  
G31.2100 (Part I)  
Fall 2004

Instructor:

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Time:

Tuesday and Thursday 12:30-2:30, Room 315 [Lecture]  
Friday 12:30-2:30, Room 315 [Lab]

Text (Required):


Supplementary material will be available in the C.V. Starr library.

Course Objectives:

We will begin by briefly reviewing probability and distribution theory. We will then consider estimation theory from both a general perspective and within the narrower context of linear models. Throughout the course our focus will almost exclusively be on parametric estimation problems. Starting with a behavioral model, we derive decision rules (or equilibrium conditions) that can be expressed in terms of functions $y = g(x, \varepsilon; \theta)$, where $y$ is an endogenous variable, $g$ is a function known up to some $k$ dimensional vector $\theta$, $x$ is a vector of observed “covariates” or “state variables,” and $\varepsilon$ is an unobservable disturbance term. Given the decision rule $g$, access to sample information on $y$ and $x$, and assumptions regarding the joint distribution of the $x$ and $\varepsilon$, our goal is to obtain “good” estimates of $\theta$. Estimation theory addresses both the question of what information is needed to obtain some estimate of $\theta$, and, given identification (within some class of estimators), how to construct an optimal estimator. Given an estimator, assumptions regarding the distribution of the disturbance terms, and the data, we then derive the sampling distributions of our estimators. Knowledge of these distributions is necessary for us to enter the somewhat metaphysical world of hypothesis testing.
This section of the course (prior to the midterm exam) is principally concerned with linear estimation theory and applications; that is, attention focuses on the model \( y = x\beta + \varepsilon \) and estimators of \( \beta \) that are linear functions of \( y \). After the exam, we will begin our introductory study of nonlinear estimation problems. In reality, most careful, applied economic analyses often do not lead to linear estimators, especially given the severe data constraints that applied economists face. For this reason, knowledge of nonlinear estimation theory and the computational techniques necessary to obtain estimates is an important part of any empirical economist’s repertoire.

The estimation method of choice in most nonlinear contexts is maximum likelihood, and we will spend a fair amount of time on the theory behind the optimality of the maximum likelihood estimator in large samples. We will also devote a lecture to the important problem of computing nonlinear estimators and their sampling distributions. We conclude our introduction to the theory of nonlinear estimation with the consideration of large sample testing methods.

The final two lectures treat topics which involve extensions of the basic linear estimation method covered in the first part of the course. In the first, we consider relaxation of the assumption \( \text{Var}(\varepsilon|x) = \sigma^2 \) in the linear model \( y = x\beta + \varepsilon \) [we will continue to assume that \( \text{E}(\varepsilon|x) = 0 \) for all \( x \)]. We discuss linear and nonlinear estimation of the model in which \( \text{Var}(\varepsilon|X) \) is not a constant. The last topic concerns estimation and inference when the dependent variable is binary. We will analyze the properties of linear and nonlinear estimators of \( \beta \) in the model \( y = x\beta + \varepsilon \) when \( y \) is a dummy variable, and will develop other econometric frameworks that may be more theoretically coherent in the estimation of dummy endogenous variable models.

We will distribute weekly problem sets, many of which will include computational exercises. For the most part these exercises will involve the use of real data sets, and students will be expected to program in GAUSS, a matrix programming language. Instruction in the use of GAUSS will be provided in some of the early lab sessions.
Course Requirements and Grading:

Students are expected to complete all of the weekly problem sets. These problem sets will be distributed at the end of each lecture and collected at the beginning of the lecture in the following week. Each problem set will be graded and discussed in the lab session of the same week in which the problem set was collected. The average homework grade will be a component of the student’s final grade. The average grade will be computed after dropping the two lowest homework scores received over the course of the (entire) semester. No late homework assignments will be accepted under any circumstances. Students will also take a midterm exam [during a class period] and a final [during finals week].

The final grade for the course (the Chen section and the Flinn section) will be determined using the following weights:

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\begin{align*}
\text{Homework Average} & \quad .20 \\
\text{Midterm (Flinn)} & \quad .40 \\
\text{Final (Chen)} & \quad .40 
\end{align*}
\]

Course Information:

I will be posting course information, including the syllabus, assignments, data sets, and old examinations, on my home page.
Lecture Schedule:

1. Introduction to Statistics and Econometrics; Review of Probability Theory
   (a) R Appendix D
   (b) S 1
   (c) MGB 1

2. Distribution Theory: Functions of Random Variables; Important Inequalities; Independence; Prediction; Conditional Moments
   (a) MGB 2,3,4,5

3. Estimation Theory: General Principles
   (a) S 2
   (b) MGB 7

4. Estimation Theory: Linear Regression Context
   (a) R 6,7.1-7.5,8
   (b) S 3

5. Estimation Theory: LR Model (continued); Sampling Distributions for the Linear Regression Context
   (a) R 9,10

6. Inference
   (a) R 11
   (b) S 5,6

7. Applications of the Regression Model
   (a) G 8,9

8. Maximum Likelihood Estimation
   (a) S 4
   (b) R 14
9. Asymptotic Distribution Theory
   (a) R 15
   (b) T 8

10. Computation of Nonlinear Estimators
    (a) R 16

11. Large Sample Inference
    (a) R 17
    (b) S 7

12. Heteroskedasticity and Errors in Variables
    (a) R 18

13. Dummy Endogenous Variables
    (a) R 27.1
    (b) DM 3.4

14. Examination

where:

- (S) Silvey, S.D. Statistical Inference. London: Chapman & Hall, 1975

In addition, some applied economics papers will be distributed and discussed throughout the course. The papers chosen will be examples of good econometric practice.