

Econometric Methods (PhD Econometrics – I)
(Tuesday 2:35 – 5:15 PM)

This class is the first one in the two-semester PhD Econometrics sequence. In this class we will discuss and study the fundamentals of mathematical statistics, the statistical foundations of estimation and inference in general, and the estimation and inference of a single-linear-equation/regression.

The primary objective of this class is to provide the background for understanding both (i) the theory and (ii) to develop the necessary mathematical, theoretical and empirical tools for practicing basic statistical and econometric theory. To achieve this goal we will concentrate on understanding the theory, its underlying assumptions (and mathematics) and its foundations. We will also discuss economic applications and implications. In the second part of the semester we will analyze real and artificial data as well as solve practical problems in the computer lab.

Tentative Outline of Class (we may change order and/or add topics throughout the semester):

Note: We will have at least One (Possibly Two) Computer lab Sessions

Lab dates:

Lab 1: Tuesday (2:35-5:15 p.m., Hurst 202) – 01/15/2013

Lab 3: Tuesday (2:35-5:15 p.m., Hurst 202) – 04/09/2013 (Tentative)

PART I: The Basics of Mathematical Statistics

NOTE: The exact sections of Freund's book will be updated within the first week of the semester.

Preliminary Reading: Freund, Chap. 1; Greene, Chap. 1, Appendix A and Appendix B;

Recommended: Chap E1 from MJM.

(Except for the preliminary readings, all required readings for PART I are taken from Freund's book. Additional complementary reading can be found in Greene's text.)

- I. Random Variables - 3-4 weeks** (Greene, Appendix B; Freund – see below).
- A. Probability density functions, distribution functions (discrete and continuous cases): Freund 2.1-2.5, 3.1-3.4.
 - B. Multivariate distributions (discrete and continuous cases): Freund 3.5.
 - C. Conditional probability: Freund 2.6-2.8.
 - D. Marginal and conditional distributions: Freund 3.6-3.7.
 - E. Mathematical expectations, moments: Freund 4.1-4.4, 4.6-4.8.
 - F. Moment generating functions: Freund 4.5.

G. Transformation of random variables – jacobian: Freund 7.1-7.5.

II. Selected Distributions, Best Linear Unbiased Estimation, Confidence Interval Estimation, Hypothesis Testing – 2-3 weeks

- A. Bernoulli and binomial distributions (multinomial distribution): Freund 5.3-5.4, 5.8.
- B. Poisson distribution: Freund 5.7.
- C. Hypergeometric distribution: Freund 5.6.
- D. Negative binomial distribution: Freund 5.5. [*Reading Only.*]
- E. Uniform distribution: Freund 6.1-6.2.
- F. Normal distribution (multivariate normal dist.): Freund 6.5-6.7.
- G. Gamma and chi-square distributions, inference about the variance: Freund 6.3, 8.4, 11.1, 11.6, 13.4.
- H. The t-distribution (multivariate t dist.), inference about means and equality of means: 8.1, 8.5, 11.2-11.3, 13.2-13.3.
- I. The F distribution, inference about equality of variances: Freund 8.6, 11.7.
- J. The exponential class of distributions and beta distribution: Freund 6.3-6.4. [*Reading Only.*]

III. The Central Limit Theorem – 1/2 week

- A. The law of large numbers, the central limit theorem: Freund 5.4, 8.2.
- B. Normal approximation to the binomial distribution and related inference: Freund 6.6.

IV. Further Topics in Point Estimation - 2 weeks

- A. Introduction: Freund 10.1.
- B. Unbiased estimation: Freund 10.2.
- C. Efficiency, the Rao-Cramer inequality: Freund 10.3.
- D. The Maximum Likelihood principle: Freund 10.8.
- E. Consistency: Freund 10.4.
- F. Sufficiency: Freund 10.5.
- G. Additional background: Freund 10.6-10.7, 10.9.
- H. Additional topics in hypothesis testing: Freund 12.1-12.2.
 - 1) Neyman-Pearson lemma: Freund 12.4.
 - 2) Power and power maximization: Freund 12.5.
 - 3) Likelihood ratio test: Freund 12.6.

V. Nonparametric Tests (Freund Chap. 16). [*Reading Only.*]

PART II: The Basics of Single-Equation Estimation (Linear Regression)

I. Self Review of Matrix Algebra (Greene, Appendix A)

II. Ordinary Least Squares: The Basic Linear Model (Greene, 2-3; 6.1-6.2; Also for background you may want to read Freund, Chap. 14) – 1-2 weeks.

III. Further Topics in Linear regression (Greene, 4-7) - 1 week.

IV. Generalized Least squares and Violations of the Ordinary Least Squares (Greene, 8) – 2 weeks.

VI. Review and Final Exam. (Final Exam: May 7)

Grades:

1. Problem Sets (approximately 6 or 7) will be given periodically (about every two weeks) and will involve (mostly) analytical problems and some computer work. This will amount to exactly 25% of final grade.
2. Midterm (25%) – Toward the end of Part I (March 19).
3. Final Exam (50%) – May 8 (02:35PM-05:05PM).

Important:

1. If the grade of the Final Exam exceeds the grade of the Midterm, only the Final will count toward the final grade. However, both Exams are mandatory.
2. Each exam will have at least one question from the problem sets.

Office Hours (Kreeger 121): Tuesday 12:00-2:00 and by appointment.

TA Office Hours:

Tuang: Monday 10:00AM – 12:00PM Kreeger G02 (Basement of Kreeger Hall)

Thursday 10:00AM – 12:00PM Kreeger G02 (Basement of Kreeger Hall)

Special Dates:

- Lab 1: Tuesday (2:35PM-5:15PM, Hurst 202) – January 15
- Spring Break: March 10 – 17 (No Class Tuesday March 12).
- Midterm: March 19
- Lab 2 (tentative): Tuesday April 9 (2:35PM-5:15PM, Hurst 202)
- Last Class: April 23
- Final: May 7

Text Books – Required

1. Miller and Miller, “**John E. Freund's Mathematical Statistics with Applications (8th Edition)**,” Pearson; December 31, 2012).
2. Greene, W. H., "Econometric Analysis" (Prentice Hall, 7th ed., 2011)

Other useful references

1. Davidson, R. and MacKinnon, J. G. *Econometric Theory and Methods* (Oxford, 2004).
2. Mittelhammer, R. C., G. Judge and D. Miller (MJM), *Econometric Foundations* (Cambridge, 2000).
3. Judge, et. al, "Introduction to the Theory and Practice of Econometrics" (Wiley, 2nd ed., 1988).
4. Chow, Gregory C., *Econometrics*, New York: McGraw-Hill, 1983.