

## Econometrics I - Fundamentals

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**Scheduled Class Time and Organization:** Class will meet twice a week *Monday*s and *Wednesday*s from 10:30-12:00 for lectures in Room 101, PCPSE. The teaching assistant will conduct a one hour discussion and review session once a week. Details will be announced.

**Course Description:** This is the first econometrics course in the first-year Econ Ph.D. sequence at Penn. The course covers selected topics in mathematical statistics, least squares estimation, large sample analysis of least squares and related estimators, endogeneity, generalized methods of moments (GMM), maximum likelihood estimation of linear and nonlinear models, analysis of panel data models, as well as re-sampling techniques.

**Prerequisites:** Calculus, Linear Algebra, Probability and Statistics

**Courseware:** Course documents and information are available via Canvas:  
<https://canvas.upenn.edu>

**Statistical Software:** We will use the statistical package *R* via a front-end called RStudio throughout the course. Both programs are free and open source. See the

last page of this document for instructions on how to configure your computer to run *R* and RStudio.

**Course Requirements:**

- **Problem Sets:** There will be 8 problem sets, assigned during the semester. The problem sets are designed to give the students the opportunity to review and enhance the material learned in class. Students are encouraged to form small study groups, however, each student has to submit his or her own write-up of the solution. These solutions must be submitted on the specified due dates. [20%]
- **Midterm Exam:** Monday, Oct 15. [40%]
- **Final Exam:** Monday, Dec 10. [40%]

**Course Texts:**

Hayashi, Fumio (2000): “*Econometrics*,” Princeton University Press, ISBN 0-691-01018-8, HB139.H39 2000. (highly recommended)

Casella, George and Roger Berger (2001): “*Statistical Inference*,” Duxbury Press, ISBN: 9780534243128 (highly recommended)

Whitney Newey and Daniel McFadden (1994): “*Large Sample Estimation and Hypothesis Testing*, ” Handbook of Econometrics, volume IV (reference)

**Econometrics Software:** The problem sets will involve computer-based exercises in which the econometric techniques introduced in the lectures will be applied. The recommended software for this course is *R*. It is available free of charge at: <http://www.r-project.org/>.

## Econometrics I – Course Outline

### Probability

- Definition and basic properties
- Random Variables, Distribution and Density Functions, Transformations, Expectations
- Common Families of Distributions
- Multiple Random Variables

### Statistical Inference

- Point Estimation
- Hypothesis Testing
- Coverage Sets

### Linear Regression

- Least Squares and Projections
- Small Sample Inference for Linear Regressions
- Asymptotics: Modes of Convergence
- Asymptotics: Large Sample Analysis of Linear Regression Model
- Asymptotics: Likelihood Function, Wald, LR, and LM Tests
- Bayesian inference
- Regressor selection

### Endogeneity

- Endogeneity and Instrumental Variables
- Estimation of Linear Models with Endogeneity
- Identification-robust inference

### Extremum Estimation

- Generalized Method of Moments
- Extremum Estimator and Asymptotic Theory
- Maximum Likelihood Estimation of Nonlinear Models

### Panel Data Models

### Computational Approaches

- Bootstrap
- Posterior samplers for Bayesian inference

## *R* Resources

**Installing R and RStudio:** First, download and install *R* from

<http://cran.r-project.org/>.

Second, download and install RStudio by visiting

<http://rstudio.org/download/desktop>

and clicking the link listed under “Recommended for Your System.”

**References:** While not required, these references may be useful if you need some extra help learning *R*, or want to go beyond the material covered in the course.

- Contributed Documentation by Comprehensive R Archive Network (CRAN)  
<http://cran.r-project.org/other-docs.html> Comprehensive list of freely available reference material for *R*.
- *R Twotutorials* by Anthony Damico <http://www.twotutorials.com/>  
Ninety energetic, two-minute video tutorials on statistical programming with *R*.
- Google Developers R Programming Video Lectures  
<http://www.r-bloggers.com/google-developers-r-programming-video-lectures/>  
R Programming video tutorials from beginning to advanced.
- *Econometrics in R* by Grant Farnsworth  
<http://cran.r-project.org/doc/contrib/Farnsworth-EconometricsInR.pdf>
- *Resources to help you learn R* by UCLA Academic Technology Services  
<http://www.ats.ucla.edu/stat/R/> A wealth of information about *R*, conveniently arranged in one place. The *R* Starter Kit is particularly helpful.
- *R in a Nutshell* by Joseph Adler  
<http://proquestcombo.safaribooksonline.com/book/programming/r/9781449377502>  
Electronic version of the book of the same name published by O’Reilly (Accessible on the UPenn Network). Provides a comprehensive reference guide to *R*.

- R-bloggers <http://www.r-bloggers.com> A blog aggregator for R news and tutorials, with lots of applications.