Mathematical Statistics for Applied Econometrics: Lecture I

Charles B. Moss

August 21, 2026

Denali

Bear in Denali

1. Course Overview
   - Course Objectives
   - Instructor Information
   - Textbooks
   - Grading
   - Course Outline
2. Introduction to Statistics, Probability, and Econometrics
   - What are we going to be doing for 15 weeks?
   - Use of Math Stat in Food and Resource Economics
   - Example of the Dichotomy
   - What is Probability?
   - What is a Statistic?
3. Random Variables
   - Random Variables - Overview
   - Another Definiton of Statistics
4. Reading for Monday and Wednesday

Course Objectives

This course develops statistical foundations that will be used in microeconomic theory, econometrics, production economics, and financial economics. The development focuses primarily on the mathematical formulation of statistics

Instructor Information

- Charles B. Moss
- 1175 McCarty Hall
- 352-294-7630
- cbmoss@ufl.edu

Textbooks

- Amemiya, Takeshi. 1994. *Introduction to Statistics and Econometrics*. Cambridge Massachusetts, Harvard University Press.
- Popper, Karl. 2002. *The Logic of Scientific Discovery*, 2nd Edition. New York, Routledge Classics.
- Salsburg, David. 2002. *The Lady Tasting Tea: How Statistics Revolutionized Science in the Twentieth Century* Holt Paperbacks.
- Moss, Charles B. 2014. *Mathematical Statistics for Applied Econometrics* Boca Raton, Florida: CRC Press.
- Other material including lecture notes are online at http://www.charlesbmoss.com:8080/econometrics.mathstat/

Grades

Table 1. Grade Assigned to Activities	
Activity	Percent of Final Grade
Homework	20 %
Two Midterm Examinations	50 %
Final Examination	30 %

Grade Scale

Table 2. Scale Used to Assign a Final Grade

Range	Letter Grade	Numeric GPA
96.0 - 100.0	A	4.00
92.0 - 95.9	A-	3.67
88.0 - 91.9	B+	3.33
84.0 - 87.9	B	3.00
80.0 - 83.9	B-	2.67
76.0 - 79.9	C+	2.33
72.0 - 75.9	C	2.00
68.0 - 71.9	C-	1.67
64.0 - 67.9	D+	1.33
60.0 - 63.9	D	1.00
56.0 - 59.9	D-	0.67
0 - 55.9	E	0.00

Outline

- Section I
  - Introduction to Statistics, Probability, and Econometrics (*2 Lectures*).
  - Random Variables and Probability Distributions (*3 Lectures*).
  - Moments and Moment Generating Functions (*3 Lectures*).
  - Binomial and Normal Random Variables (*3 Lectures*).
- **Test I**
- Section II
  - Large Sample and Asymptotic Theory
  - Point Estimation
  - Interval Estimation
  - Testing Hypothesis
- **Test II**

Outline - Continued

- Section III
  - Elements of Matrix Analysis
  - Bivariate and Multivariate Regression
  - Instrumental Variable Estimation
  - Generalized Method of Moments
- **Final Examination**

Introduction to Statistics, Probability, and Econometrics

- What are we going to study over the next fifteen weeks and how does it fit into my graduate studies in Food and Resource Economics?
- The simplest (and most accurate) answer to the first question is that we are going to develop statistical reasoning using mathematical reasoning and techniques.

Use of Mathematical Statistics in Food and Resource Economics

- From a general statistical perspective, mathematical statistics allow for the formalization of statistical inference.
  - How do we formulate a test for quality (light bulb life)?
  - How do we develop a test for the significance of an income effect in a demand equation?
- Related to the general problem of statistical inference is the study of Econometrics.
  - "Econometrics is concerned with the systematic study of economic phenomena using observed data." Spanos p. 3.
  - "Econometrics is concerned with the empirical determination of economic laws." Theil p.1.
  - Econometrics is the systematic study of economic phenomena using observed data and economic theory.

- Economic theory, most particularly production economics, relies on the implicit randomness of economic variables to develop models of decision making under risk:
  - Expected Utility Theory
  - Capital Asset Pricing Models
  - Asymmetric Information

Example of the Dichotomy

- *An Example of Inference versus Decision Making* – Skipping ahead a little bit, the normal distribution function depicts the probability density for a given outcome x as a function of the mean and variance of the distribution:

$$f\left(x;\mu,\sigma^2\right) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{\left(x-\mu\right)^2}{2\sigma^2}\right) \tag{1}$$

Normal Distribution with $\mu = 0$ and $\sigma = 1$

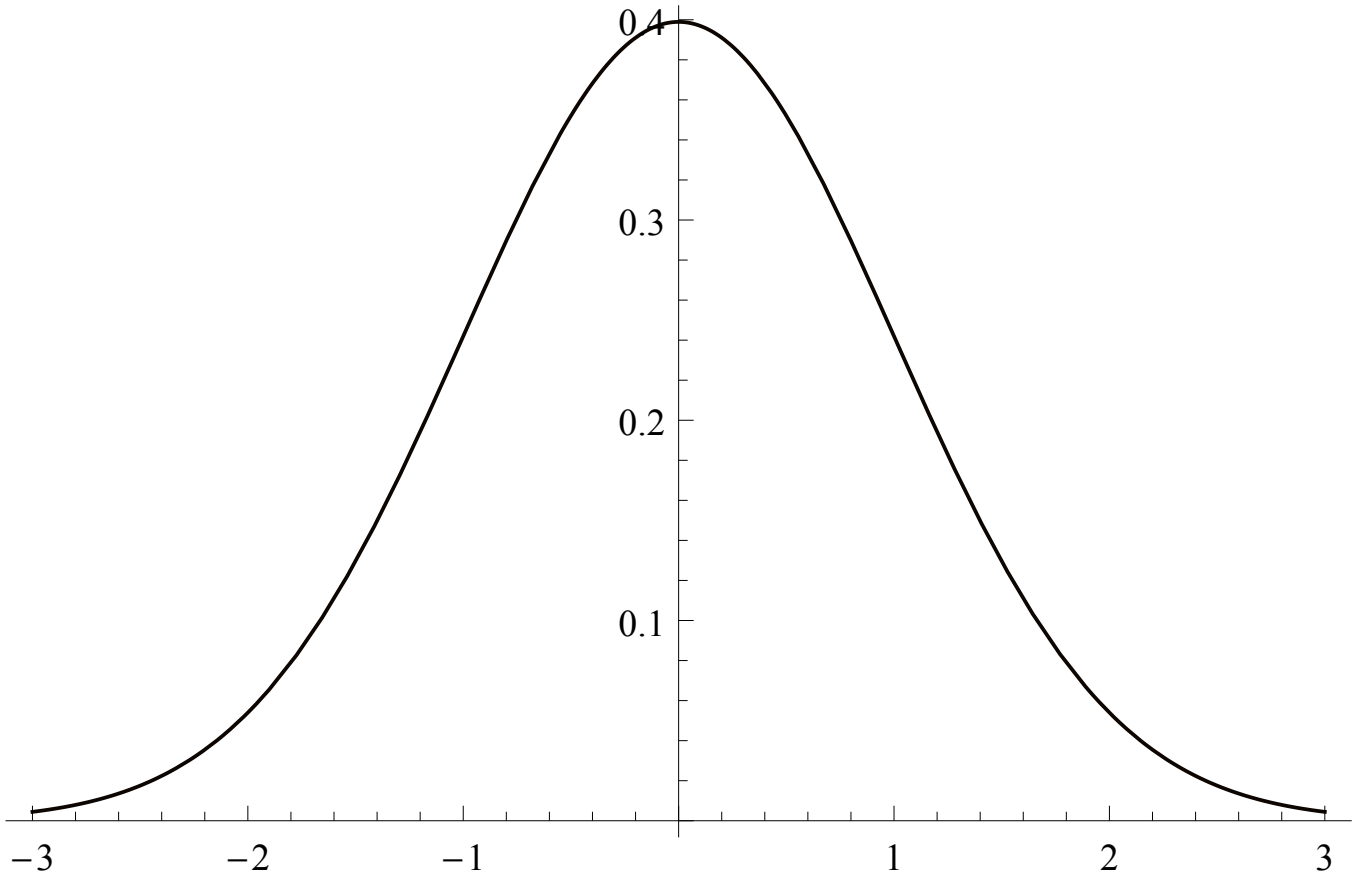
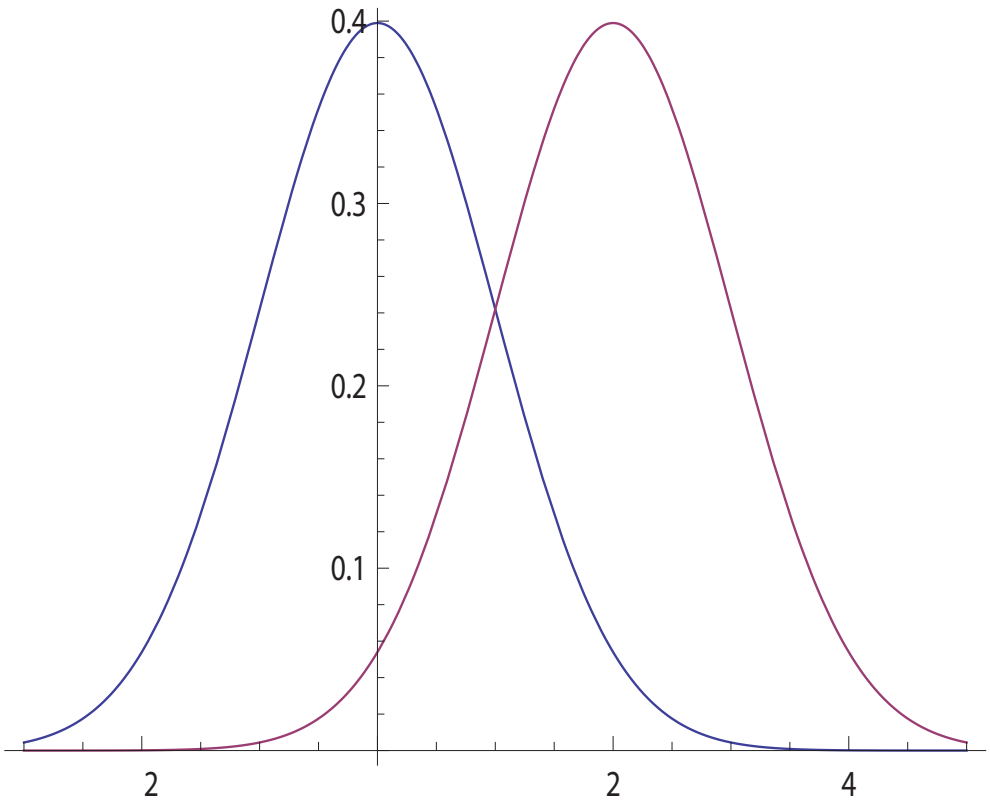


Figure: Normal Distribution Function

Two Normal Distrubutions with $\mu = 0$ or 2 and $\sigma = 1$



- Inference versus Decision Making
  - Statistical inference involves testing a sample of observations drawn from this data set against an alternative assumption, for example $\mu = 2$.
  - Economic applications involve the choice between the two distribution functions.

What is Probability?

- Two defintions:
  - *Bayesian*: probability expresses the degree of belief a person has about an event or statement by a number between zero and one.
  - *Classical*: the relative number of time that an event will occur as the number of experiments becomes very large.

$$\lim_{N \to \infty} P[O] = \frac{r_O}{N} \tag{2}$$

What is a Statistic?

- Definition I: Statistics is the science of assigning a probability of an event on the basis of experiments.
- Definition II: Statistics is the science of observing data and making inferences about the characteristics of a random mechanism that has generated the data.

Random Variables

- By random mechanisms, we are most often concerned with random variables:
  - A *Discrete Random Variable* is some outcome that can only take on a fixed number of values.
    - The number of dots on a die is a classic example of a discrete random variable.
    - A more abstract random variable is the number of red rice grains in a given measure of rice.
  - A *Continuous Random Variable* represents an outcome that cannot be technically counted.
    - Amemiya uses the height of an individual as an example of a continuous random variable. This assumes an infinite precision of measurement.
    - The normally distributed random variable presented above is an example of a continuous random variable.

- The exact difference between the two types of random variables has an effect on notions of probability.
  - The standard notions of Bayesian or Classical probability fit the discrete case well. We would anticipate a probability of 1/6 for any face of the die.
  - In the continuous scenario, the probability of any outcome is zero. However, the *probability density function* yields a measure of relative probability.
  - The concepts of discrete and continuous random variables are then unified under the broader concept of a *probability density function*.

Another Definition of Statistics

- Definition III: Statistics is the science of estimating the probability distribution of a random variable on the basis of repeated observations drawn from the same random variable.

Reading for Monday and Wednesday

- Amemiya – Chapter 1
- Moss – Chapters 1 & 2
- Popper, K. 1959. *The Logic of Scientific Discovery* Routledge Classics. Chapter 1.
- Ambrosio,L., G. Da Prato, and A. Mennucci. 2011. *Introduction to Measure Theory and Integration* Springer. `https://link.springer.com/10.1007/978-88-7642-386-4`
- Bierens, H.J. 2005. *Introduction to the Mathematical and Statistical Foundations of Econometrics*. Cambridge University Press.