

## FURTHER STATISTICS FOR ECONOMICS AND ECONOMETRICS (EC113)

**Course duration:** 54 hours lecture and class time (Over three weeks)

**LSE Teaching Department:** Department of Economics

**Lead Faculty:** Dr James Abdey

**Pre-requisites:** No previous knowledge of statistics will be assumed, although familiarity with elementary statistics to the level of EC112 would be an advantage. Mathematics to A-level standard or equivalent is highly desirable, i.e. competency with basic calculus, integration and algebraic manipulation (although a refresher document will be provided).

### Course Structure:

Course content will be delivered by formal lectures supported by daily classes. All topics will be explained during lectures accompanied by examples demonstrating the material. A comprehensive course pack will be provided and daily exercise sets will be distributed to provide an opportunity to practise problems. Solutions to exercises will be discussed and distributed in the classes. Supplementary materials will be accessible via the course's virtual learning environment to facilitate additional self-study.

### Course Objectives:

The course provides a precise and accurate treatment of probability, distribution theory and statistical inference. As such, there will be a strong emphasis on mathematical statistics as important discrete and continuous probability distributions are covered. Properties of these distributions will be investigated followed by a thorough overview of parameter estimation techniques.

Application of this theory to the construction and performance of statistical tests follows, leading to multiple linear regression which is widely used in much economic and statistical modelling.

In summary, the main objectives of this course are:

1. To provide a solid understanding of distribution theory which can be drawn upon when developing appropriate statistical tests. Useful properties of some important distributions will be reviewed as well as parameter estimation techniques for various probability distributions.
2. To facilitate a comprehensive understanding of the main branches of statistical inference, and to develop the ability to formulate the hypothesis of interest, derive the necessary tools to test this hypothesis and interpret the results.
3. To introduce the fundamental concepts of statistical modelling, with an emphasis on linear regression models with multiple explanatory variables.

Collectively, these topics provide a solid training in statistical analysis. As such, this course would be of value to those intending to pursue further study in statistics, econometrics and/or empirical economics. Indeed, the quantitative skills developed by the course are readily applicable to all fields involving real data analysis.

### Reading List:

As a stand-alone course pack will be provided, there will be no need to rely on a particular text. Several good texts exist at the right level for this course which can be used in support of the provided course materials. A suggested text is:

- Larsen, R.J. and M.J. Marx (2011) *An Introduction to Mathematical Statistics and Its Applications*, Pearson Education, 5<sup>th</sup> edition.

### Course Content:

#### *Probability theory:*

Set theory: the basics  
Axiomatic definition of probability  
Classical probability and counting rules  
Conditional probability and Bayes' theorem

#### *Random variables:*

Discrete random variables  
Continuous random variables

#### *Common distributions:*

Common discrete distributions  
Common continuous distributions  
Moment generating function

#### *Multivariate random variables:*

Joint probability functions  
Conditional distributions  
Covariance and correlation  
Independent random variables  
Sums and products of random variables

*Sampling distributions of statistics:* Random samples

Statistics and their sampling distributions  
Sampling distribution of a statistic  
Sample mean from a normal population  
The central limit theorem  
Some common sampling distributions

*Point estimation:*

Estimation criteria: bias, variance and mean squared error  
Method of moments (MM) estimation  
Least squares (LS) estimation  
Maximum likelihood (ML) estimation

*Interval estimation:*

Interval estimation for means of normal distributions  
Use of the chi-squared distribution  
Interval estimation for variances of normal distributions

*Hypothesis testing:*

Introductory examples  
Setting  $p$ -value, significance level, test statistic  
 $t$  tests  
General approach to statistical tests  
Two types of error  
Tests for variances of normal distributions  
Summary: tests for  $\mu$  and  $\sigma^2$  in  $N(\mu, \sigma^2)$   
Comparing two normal means with paired observations  
Comparing two normal means  
Tests for correlation coefficients  
Tests for the ratio of two normal variances  
Summary: tests for two normal distributions

*Linear regression:*

Introductory examples  
Simple linear regression  
Inference for parameters in normal regression models  
Regression ANOVA  
Confidence intervals for  $E(y)$   
Prediction intervals for  $y$   
Multiple linear regression models  
Multiple regression using Minitab

*Nonparametric tests:*

Tests for binary distributions  
Tests for medians  
Sign test  
Wilcoxon signed-rank test

*Goodness-of-fit/independence tests:* Goodness-of-fit test for a finite distribution

Tests for independence of two discrete  
random variables

*Analysis of variance (ANOVA):*

Testing for equality of three population means  
One-way analysis of variance  
From one-way to two-way ANOVA

**Credit Transfer:** If you are hoping to earn credit by taking this course, please ensure that you confirm it is eligible for credit transfer well in advance of the start date. Please discuss this directly with your home institution or Study Abroad Advisor.

As a guide, our LSE Summer School courses are typically eligible for three credits within the US system and 7.5 ECTS in Europe. Different institutions and countries can, and will, vary. You will receive a digital transcript and a printed certificate following your successful completion of the course in order to make arrangements for transfer of credit.

If you have any queries, please direct them to [summer.school@lse.ac.uk](mailto:summer.school@lse.ac.uk)