INTRODUCTION TO ECONOMETRICS (EC212)

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

Summer School Programme Area: Economics

LSE Teaching Department: Department of Economics

Lead Faculty (session two): Professor Taisuke Otsu and Dr Marcia Schafgans (Dept. of Economics)

Lead Faculty (session three): Professor Taisuke Otsu and Dr Tatiana Komarova (Dept. of Economics)

Pre-requisites: At least one semester of mathematical statistics with a serious analytical treatment of estimation and inference, and at least one semester of multivariate calculus, both passed at a respectable standard.

Course Objective:

The objective of this course is to provide the basic knowledge of econometrics that is essential equipment for any serious economist or social scientist, to a level where the participant would be competent to continue with the study of the subject in a graduate programme. While the course is ambitious in terms of its coverage of technical topics, equal importance is attached to the development of an intuitive understanding of the material that will allow these skills to be utilised effectively and creatively, and to give participants the foundation for understanding specialized applications through self-study with confidence when needed.

Content:

In the first week the course introduces the statistical tool known as regression analysis applied to cross-sectional data. We start with the classical linear regression model, introduce the ordinary least squares estimator, its properties, and use in statistical inference. From the second week onwards we discuss how various technical problems inherent in economic analysis (heteroskedasticity, autocorrelation and endogeneity) should be handled. Alternative estimators, such as weighted least squares and instrumental variables estimation, are introduced, and asymptotic properties of our estimators are discussed. Special attention is given to application of the regression model to time series data (both stationary and nonstationary). As an example of a setting where the linear regression model may be ill-advised, we discuss the maximum likelihood estimator in the popular binary choice model setting.

Although the course does not make use of matrix algebra, it is technically rigorous, giving emphasis to the analysis of the finite sample and asymptotic properties of least squares and instrumental variables estimators under different assumptions concerning the data generation process and to the accompanying implications for statistical inference. Participants are expected to be able to provide proofs of the unbiasedness or biasedness, and consistency or inconsistency of least squares and instrumental variables estimators in simple models where appropriate. Examples of applications in economics are used throughout.
In addition to the formal theory sessions, participants take part in daily workshops where they will get hands on experience implementing the various estimators and testing procedures in Stata to a wide range of questions of economic interest.

**Formative Assessment:** Homework to be submitted to the class teacher on Friday of week one, this will be marked over the weekend and then feedback given out on Monday of week two to aid with exam preparation. A second piece of homework to be submitted on Friday of week two, with feedback given early in week three to aid final exam preparation.

**Summative Assessment:** You will be examined on the basis of 2 closed book exams and one computer based exercise. The mid-course exam (2hr), which covers the material from week 1 only, has a 40% weight, the computer based exercise (in class) has a 10% weight and the final exam (2hr) has a 50% weight and covers the whole syllabus. The precise time and location of the exams will be circulated during the programme.

**Course Text:**

The course text will be the sixth edition of J.M. Wooldridge, *Introductory Econometrics: A Modern Approach*, International Edition (or, alternatively, the Emea 1st Edition + its online content)

**Topics Week 1**

1. **Simple Regression Analysis**
   It will be shown how a hypothetical linear relationship may be quantified using appropriate data. The principle of least squares analysis will be explained and expressions for coefficients derived. Conditions for the unbiasedness of the regression coefficients and factors governing their variance will be discussed. We discuss an optimality property of OLS: Gauss-Markov theorem.

2. **Multiple Regression Analysis: Estimation**
   The regression analysis is generalized to cover the case where there are several or many explanatory variables in the regression model, rather than just one. The problem of multicollinearity and the use of restrictions will also be discussed. This discussion also covers: the consequences of including in the regression a variable which should not be there; the consequences of leaving out a variable that should be included; and methods for testing whether a restriction is valid.

3. **Multiple Regression Analysis: Inference**
   Based on the properties of the estimated regression coefficients, hypothesis testing and the construction of confidence intervals of the regression model will be discussed. Various inference methods including single and multiple hypotheses testing will be covered.
4. Multiple Regression Analysis: Further Topics

Additional topics related to goodness-of-fit and functional form will be covered. Many economic processes are best modelled by nonlinear relationships: demand functions and production functions, for example. Linear regression analysis will be extended to cover nonlinear models. It frequently happens that some of the factors which should be taken account of in a regression model are qualitative in nature and therefore not measurable in quantitative terms. It will be explained how such factors can be handled with dummy variables.

Topics Week 2 and 3

1. Asymptotic properties of OLS

To deal with the situation where economic data follow non-normal distributions, some asymptotic properties of the OLS estimator for the regression coefficients will be discussed.

2. Heteroskedasticity

The course now turns to a common problem encountered in regression analysis, discussing its detection and consequences, and means to alleviate it. We discuss the WLS estimator.

3. Time Series data Modelling Dynamic Processes

Many economic processes require time to work themselves out and accordingly there is a need to introduce a time dimension into econometric modelling. The autoregressive distributed lag (ADL) model, an important method of modelling dynamics, is discussed and the asymptotic and finite-sample properties of estimators are investigated. Important concepts introduced are stationarity and weak dependence.

4. Autocorrelation

In time series models it is common for the errors to exhibit autocorrelation. We will discuss its detection, consequences, and means to alleviate it. We discuss the Cochrane-Orcutt procedure.

5. Endogeneity – omitted variables, measurement error and simultaneity

One further complication of the regression model discussed is that of correlatedness between the errors and regressors. We discuss various examples where this occurs: omitting relevant variables, measurement errors, lagged endogenous variables in the presence of autocorrelation, and simultaneity. We discuss the undesirability of using OLS in these settings and discuss a simple test for endogeneity.
6. Instrumental variable estimation and two stage least squares

The IV estimator (and the two stage least squares estimator) is an estimator that provides consistent estimates in the presence of endogeneity. In the presence of more instruments then we need (over-identification), the two stage least squares estimator is introduced as the optimal IV estimator in the presence of homoskedasticity.

7. Logit and Probit Models for Binary Response

Many economic variables we would like to explain are limited in some way. For instance we may want to explain whether an individual works (1=yes) or not (0=no), Using a linear probability model (OLS) for binary choice models has a drawback. To overcome these problems we discuss the maximum likelihood estimator (MLE) that models the probability of working explicitly.

8. Non Stationary Time Series

Many economic processes exhibit trending behaviour, such as GDP and consumption, that render them non-stationary. We will consider two types of non-stationary processes: trend stationary processes and difference stationary processes. While the former allows us to use standard regression analysis (weak dependence), the latter gives rise to persistence (strong dependence) that renders standard regression analysis invalid. As shocks have very different consequences in these settings, it is important to distinguish these processes and we will consider the DF and ADF test (tests for unit roots) for this purpose.

Conducting regression analysis with variables that exhibit a unit root can give rise to a spurious, or meaningless, relationship. We need to distinguish this from a cointegrating relationship, where our regression analysis is reflective of a long run relationship between the variables. We will show how to test for the presence of a spurious relationship.

Computer Exercises

Participants will be given homework assignments every day and some of these will involve the use of the computing facilities at LSE. The course will use the Stata regression application. No prior knowledge of this application is required. Assistance with the practical work will be provided.
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 or four 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