AUTUMN TERM

Aims
Much of the economics you have seen so far and which you will continue to study this year consists of theoretical models. Economics, however, is more than that. Many economists analyse data to learn how the world works and to test which economic models best describe the facts. The first half of the course is intended to provide you with a solid understanding and practical experience of the essentials of empirical research techniques (i.e., econometrics) used by applied economists.

Learning Outcomes
By the end of this term, students should:

- use, understand and distinguish between standard econometric techniques
- be able to carry out formal statistical tests of economic hypotheses
- manipulate and analyse data sets and conduct your own econometric investigations, both written and using computer software.

Course Delivery
There will be a two-hour lecture and a one-hour class each week.

The lectures will combine discussion of econometric theory along with demonstrative use of the econometrics package Stata to enable students to understand the practical art of econometrics as well as the underlying theories and assumptions.

There will be a set of lecture slides for each lecture, which will be made available on Moodle a day in advance. Students are expected to make notes on these slides during lectures and after (by consulting the relevant pages in the course texts).

The course is very much an 'applied hands-on' econometrics full of real world data and practical examples. Students who do not attend lectures or classes and who do not attempt problem sets will find this course very difficult.

Problem Sets
One problem set will be given out and discussed each week which will involve both written questions and computer-based exercises. To have any hope of doing well in the end of year examination and the dissertation all these problem sets should be attempted. Students should bring written answers to the class to be discussed by the class teacher. Students will be allowed to
retain their work so that they can add comments and rectify errors during the discussion. There will not be time to discuss all the answers to every question in the problems sets. Students will be expected to work through the answers to those questions not covered in classes in their own time.

To facilitate this, answers to the problems sets – along with lecture handouts and data sets - will be posted (with a lag) on the course Moodle page
http://moodle.rhul.ac.uk/
and on the course website
http://personal.rhul.ac.uk/uhte/006/ec2203/index2.html

Computer Exercises
To really understand econometrics and empirical work, you need to have experience of doing it yourself. Most of the problem sets assigned during term will include questions requiring use of real world data sets and use of the Stata regression package. Detailed instructions for using the package will be included in a separate handout and in the problem sets. The seminars will take place in the computer labs. So you will have plenty of opportunity for practice.

Reading
The course text, which you should probably buy (though there are several copies in the library) is

The lecture will not follow the text page by page, but the book is a useful companion to the lecture notes you will be provided with.

Other useful texts are
(Library Code: 330.01 GUJ)

J. Wooldridge, Introductory Econometrics: EMEA Edition
(Library code: 330.01 WOO)

(Library code: 330.01 STO)

(the last two are probably pitched just above the overall level of this course, but are more comprehensive and contain lots of useful intuition and worked examples).

The lectures and associated classes will not cover basic statistical issues like expected values, covariances, the normal distribution, hypothesis testing or confidence intervals. It is assumed that you have a good knowledge of these topics from last year. If you need to revise them,


is a good source.

Time permitting, the course will go over the following areas.

Weeks 1-2. Simple Regression Analysis
Simple regression model; derivation of linear regression equation; goodness of fit.

Aims: know the formulae for the regression coefficients and understand the principle underlying how they are derived; know the definition of $R^2$ and how it is related to the residual sum of squares.

Weeks 3-4: Properties of Regression coefficients
Gauss-Markov conditions and unbiasedness of the regression coefficients; precision of the regression coefficients; Gauss-Markov theorem; t test of a hypothesis relating to a regression coefficient; Type I error and Type II error; confidence intervals; F test of goodness of fit.

Aims: How to interpret a regression coefficient; how to investigate whether or not estimators are biased.

Week 5. Multiple Regression Analysis
Regression with 2 explanatory variables; properties of multiple regression; Hypothesis testing.

Aims: To be able to perform F tests, Chow tests, and give economic interpretation of estimated coefficients.

Week 6. Specification of Regression Equations
Functional form; F tests in multiple regression model; transformation of variables elasticities; dummy variables; omitted variable bias.

Aims: To be able to choose appropriate functional form for given datasets and interpret coefficients of the chosen model accordingly.

Week 7. Endogeneity
Definition and consequences of endogeneity; simultaneous equation systems; measurement error; tests for endogeneity; instrumental variable estimation as a solution to problem.

Aims: Demonstrate consistency of IV estimation and perform relevant tests.

Week 8. Autocorrelation
Definition and consequences; tests for AR(1) autocorrelation; autocorrelation with lagged dependent variable.

Aims: To be able to perform tests and be aware of possible solutions to autocorrelation.

Week 9. Models using Time Series Data and Non-Stationary Processes
Dynamic models; short and long-run coefficients; stationary and non-stationary processes; cointegration.

Aims: To be able to analyse short and long-run implications of dynamic models; determine whether a time series is stationary; understand the principles behind the unit root test.

Week 10 Heteroskedasticity
Meaning and consequences of heteroskedasticity. Tests for heteroscedasticity.

Aims: To know how to undertake tests for heteroskedasticity.
**Week 10. Panel Data**

The idea of panel data. Fixed Effects and Random effects.

*Aims*: To have a simple appreciation of panel models.

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**SPRING TERM**

*Aims*

The second term of QMII is devoted primarily to the mathematical theory of optimisation. Understanding optimisation theory will also require the study of linear algebra and calculus. In the second term, you will develop your econometric and statistical skills, and you will use those skills to analyse data sets. *This outline primarily concerns the first term.*

**Learning Outcomes**

Upon completion of the course you should:

- Have a thorough understanding of the main mathematical tools used in economics and of optimisation theory in particular, (Maths)
- Be able to use this knowledge to manipulate and solve problems and models, (Maths)
- Be familiar with the logic of proofs of mathematical theorems and be able to construct simple proofs yourself, (Maths)
- Understand the theory and practice of statistical inference and regression analysis in economics, (Econometrics)
- Be able to analyse data sets and to conduct formal tests of statistical hypotheses. (Econometrics)

**Course Delivery**

The course will be delivered through two hourly lectures every week, plus a one-hour seminar. Seminars will be based upon problems assigned in the previous week's lecture, some of which will come from the recommended text. Problem sets will be given weekly. Although these will not be part of the formal method of evaluation, you are advised that solving the problems will be of enormous help in examinations and tests.

Seminars will be compulsory and failure to attend can lead to students being issued with a formal warning.

You should prepare answers to the problems before the weekly seminars and expect to present them to the rest of the group. Skeleton problem solutions will be posted on the web, after the relevant seminars.

**Reading**

There is no set textbook for this half of the course, the most appropriate textbook is:


(Note that the previous edition authored solely by Chiang is also suitable, though chapter numbers are different). The lecture notes will be self-contained for those students who attend the lecture and numerous examples will be provided during the lecture.
We will also use the book as a source for problems. It is not the responsibility of the library to stock large copies of standard texts, so I strongly recommend that you buy a copy of this book should you struggle to keep up with lectures.

Dowling, Edward T., *Theory and Problems for Mathematics for Economists*, Schaum is a cheap supplement that contains many worked examples. If you work with a study partner you may wish to buy one copy of each text between you.

Course materials will be available on Moodle. I will hand out the notes in lecture, these will be blanked to encourage you to work on the problems during the lecture, but you should go to the website for additional copies and for problem solutions; which will be uploaded with about a two week lag.

### Weekly Timetable

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<th>Week</th>
<th>Title</th>
<th>Learning Outcomes</th>
<th>Reading</th>
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<tr>
<td>1</td>
<td>Introduction to optimisation theory.</td>
<td>By the end of this topic you should be familiar with the role of optimisation in economics and be reminded of the rules of differentiation and the first order conditions for unconstrained maximization.</td>
<td>Chiang and Wainwright, Chapter 7 parts 1-4 and Chapter 9 parts 1 and 2. Chapter 12 parts 1 and 2.</td>
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<td>2-3</td>
<td>Nonlinear programming</td>
<td>By the end of this topic, you should understand how Lagrange multipliers can be used to solve nonlinear constrained maximisation problems and able to apply the method to various economic problems.</td>
<td>Chiang and Wainwright, chapter 13, sections 1-3.</td>
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<td>4</td>
<td>Vectors</td>
<td>By the end of this topic you should understand the concept of a vector in $n$-dimensional space, be able to perform basic operations on vectors, and understand the concepts of linear combinations of vectors, linear independence, and the inner product of vectors.</td>
<td>Chiang and Wainwright, chapter 4, sections 1, 3</td>
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<tr>
<td>5-7</td>
<td>Matrices and solving systems of linear equations.</td>
<td>By the end of this topic, you should understand the concept of matrix, know the rules of matrix algebra, know what an inverse of a matrix is and how to calculate it, know what a determinant is, be able to define the rank of a matrix, know how to perform elementary row operations on a matrix, use matrix algebra to solve systems of linear equations,</td>
<td>Chiang and Wainwright, chapter 4, sections 1-2, 3-5, chapter 5, sections 1-4.</td>
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understand comparative statics analysis in linear models.

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<th>Further applications of programming and matrix algebra: Input-Output Analysis.</th>
<th>By the end of this topic, you should how matrix algebra can be used for input-output analysis, understand how to calculate input requirements given an output requirement and understand how to check for productiveness of in input output system.</th>
<th>Chiang, chapter 5, section 7.</th>
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<td>8</td>
<td>Second order conditions and Comparative Statics</td>
<td>By the end of this topic, you should know what concave and convex functions are, understand how to check second-order conditions for a maximum using matrix methods and be familiar with some basic methods of conducting comparative static analysis.</td>
<td>Chiang and Wainwright, chapter 11, chapter 12 section 3.</td>
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<td></td>
<td>Revision</td>
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<td>Final Week</td>
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Assessment

60% of the course grade will come from an examination taken during the summer term. The exam will test your knowledge of and understanding of the material covered in both parts of the course and your ability to manipulate and solve related problems.

Assessment comprises an Econometrics project (based on material covered in the Autumn term) to be handed in early in the Spring term. Students will have to devise their own econometric project, find data and present estimation results - to be completed by the beginning of the Spring term. More details about the project will also be given in a separate handout in the Autumn term.

The project carries a weight of 20%.

There will be a written 1 hour mid-term test in each term worth 5% each.

There will also be 2 assessed online tests in each term. Each online test carries a weight of 2.5%.

You will receive standardised feedback on your project and tests.

Test and project hand-in dates can be found in the student handbook and reminders will be provided in Moodle.