Queen's University
Department of Economics

ECONOMICS 351* -- Winter Term 2009

INTRODUCTORY ECONOMETRICS

Winter Term 2009 M.G. Abbott

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Purpose and Organization

The purpose of this course is to introduce students to the theory and application of econometric methods. It covers the **basic tools of estimation and inference** in the context of the **single-equation linear regression model**, and deals primarily with **least squares methods of estimation**. The course emphasizes the intuitive understanding and practical application of these basic tools of regression analysis, as distinct from their formal theoretical development. Course material is presented predominantly in scalar terms; use of matrix algebra is confined to summarizing major results and to interpreting output listings of computer software programs.

The organization of the course is set out in the accompanying course outline. The first part of the course introduces least squares estimation and inference in the context of the simple (two-variable) linear regression model. The second part extends the principles of least squares estimation and inference to the multiple linear regression model. The third part of the course considers some important uses of linear regression analysis, including linear coefficient restrictions and covariance analysis. Finally, the fourth part of the course deals with various problems that commonly arise in applying the linear regression model to cross-section data, including multicollinearity, specification errors and heteroskedasticity.

Course Format

The course is based on two 80-minute lectures per week. In addition, hands-on tutorials are scheduled weekly during the term at times to be arranged. The tutorials are designed to familiarize students with those features of the statistical software program *Stata* they will require to complete the assignments in the course.

Course Work

Three assignments will be assigned periodically during the term. These will require students to perform various econometric exercises using the econometric software program *Stata*. Students with their own PCs may wish to acquire a PC version of *Stata* suitable to their hardware. Other students will have to become familiar with how to use *Stata* on the Queen's PCs located in the Economics Department Computer Classroom in Dunning 350. ***Students are permitted to submit assignments in groups of no more than two persons.***

A **mid-term test** will be given during a regular class period in the seventh or eighth week of the term. A three-hour **final examination** will be given in December during the Fall Term examination period, and will cover the entire term's work.

The final course grade will be computed using the following weights:

Assignments …….	**20%**
Mid-term Test ……..…	**25%**
Final Examination ……..	**55%**

Reading Materials: Required and Recommended

Required Textbook

The required textbook for the course is the fourth (2009) edition of the introductory econometrics textbook by Jeffrey Wooldridge:

Jeffrey M. Wooldridge, *Introductory Econometrics: A Modern Approach*, Fourth Edition. South-Western Cengage Learning, 2009. ISBN13: 978-0-324-58162-1. ISBN10: 0-324-58162-9.

This book provides excellent modern treatments of all topics included in the course. It also contains plenty of real applications of econometric methods. Copies of Wooldridge (2009) can be purchased in the Campus Bookstore. Note that the third (2006) edition of this textbook (ISBN 0-324-28978-2) is also completely adequate for purposes of this course.

Recommended Textbook

The recommended textbook for the course is the fourth edition of Gujarati's standard introductory text:

Damodar N. Gujarati, *Basic Econometrics*, Fourth Edition. New York: McGraw-Hill, 2003. ISBN 0-07-233542-4.

The Gujarati textbook is a widely used introductory econometrics textbook that provides an excellent alternative treatment of many topics to that given in Wooldridge (2009). A copy of Gujarati (2003) is on reserve in Stauffer Library Reserve Room.

Computer Software

The required econometric software package for the course is *Stata*. The current release of *Stata for Windows* is Release 10 (*Stata 10*), but both Release 9 (*Stata 9*) and Release 8 (*Stata 8*) are perfectly adequate for purposes of this course.

The ***Stata* web site** is at: www.stata.com.

Stata Tutorials

A set of ***Stata 10* Tutorials** has been prepared by the instructor to give students a hands-on introduction to those features of ***Stata for Windows*** that relate specifically to the topics covered in the course. These ***Stata 10* Tutorials** will be distributed during the term on the course web site. In addition, **scheduled computing labs** in the Department of Economics Computer Classroom (Dunning Hall 350) will give students the opportunity to obtain individual computing assistance with both the Stata tutorials and the assignments.

Stata 10 for Windows will run under Windows Vista, Windows XP and Windows 2000. Students with their own PCs may wish to acquire a PC version of *Stata* suitable to their hardware.

Two basic versions of *Stata 10* are available:

Small Stata – *Stata 10* for small computers

- Datasets are restricted to a maximum of 99 variables and approximately 1000 observations.
- Matrices may be up to 40 x 40.
- String variables up to 80 characters.
- Computer should have at least 512 MB of RAM and 80 MB of disk space.

Stata/IC -- the standard professional version of *Stata 10*

- A maximum of 2,047 variables; the only limit on observations is the amount of RAM on your computer.
- Very fast.
- Matrices may be up to 800 x 800.
- 64-bit version available.
- Maximum number of right-hand variables = 798
- String variables up to 80 characters.
- Computer should have at least 512 MB of RAM and 80 MB of disk space.

Although either **Small Stata** or **Stata/IC** is adequate for purposes of this course, **Stata/IC** is the recommended version of *Stata 10*. Note that ***Intercooled Stata for Windows Release 9 (Intercooled Stata 9)*** is also perfectly adequate for this course.

Documentation for Stata 10

Core hard copy documentation for ***Stata 10 for Windows*** consists of five manuals (approximate prices in US dollars):

- ***Getting Started with Stata for Windows*** ($25.00);
- ***User's Guide*** ($45.00);
- ***Base Reference Manual*** (3 volumes, $150.00);
- ***Graphics Reference Manual*** ($65.00);
- ***Data Management Reference Manual*** ($50.00).

The first two manuals are particularly useful for relatively new *Stata* users.

Complete information on *Stata 10* documentation is available from the Stata web site at http://www.stata.com/bookstore/documentation.html.

Purchasing your own copy of the Stata 10 statistical software

The course instructor has set up a plan – called a *Stata* course GradPlan – whereby students can purchase their own copies of the *Stata 10* statistical software and documentation at special student discount prices. Students who wish to take advantage of this GradPlan should send an e-mail message to the instructor, who will send them instructions on how to proceed.

Background Preparation

It is assumed that students have successfully completed an introductory statistics course such as ECON 250*, and an introductory university-level calculus course such as MATH 126 or MATH 121. However, a selective review of basic concepts in statistics is often advisable.

For *a brief review of random variables and probability distributions*, see Wooldridge (2009), Appendix B, pp. 714-745; Wooldridge (2006), Appendix B, pp. 728-762; or Gujarati (2003), Appendix A, Secs. A.1-A.6, pp. 869-895.

For *a review of hypothesis testing*, see Wooldridge (2009), Appendix C, Secs. C.5-C.7, pp. 762-782; Wooldridge (2006), Appendix C, Secs. C.5-C.7, pp. 780-802; or Gujarati (2003), Appendix A, Sec. A.8, pp. 905-912.

For *a review of estimators and estimation*, see Wooldridge (2009), Appendix C, Secs. C.1-C.4, pp. 747-762; Wooldridge (2006), Appendix C, Secs. C.1-C.4, pp. 763-779; or Gujarati (2003), Appendix A, Sec. A.7, pp. 895-905.

Faculty of Arts and Science Statement on Academic Integrity

Academic integrity is constituted by the five core fundamental values of honesty, trust, fairness, respect and responsibility (see www.academicintegrity.org). These values are central to the building, nurturing and sustaining of an academic community in which all members of the community will thrive. Adherence to the values expressed through academic integrity forms a foundation for the "freedom of inquiry and exchange of ideas" essential to the intellectual life of the University (see the Senate Report on Principles and Priorities)

Students are responsible for familiarizing themselves with the regulations concerning academic integrity and for ensuring that their assignments conform to the principles of academic integrity. Information on academic integrity is available in the Arts and Science Calendar (see Academic Regulation 1), on the Arts and Science website (see http://www.queensu.ca/calendars/artsci/pg532.html), and from the instructor of this course.

Departures from academic integrity include plagiarism, use of unauthorized materials, facilitation, forgery and falsification, and are antithetical to the development of an academic community at Queen's. Given the seriousness of these matters, actions which contravene the regulation on academic integrity carry sanctions that can range from a warning or the loss of grades on an assignment to the failure of a course to a requirement to withdraw from the university.

COURSE OUTLINE AND READINGS

NOTE: All lecture notes posted on the course web site and all readings in Wooldridge (2009) or Wooldridge (2006) are required. **All required readings are underlined** in the reading list below. The other indicated readings are purely optional and should be consulted selectively as necessary, particularly if you encounter difficulties with a given topic.

PART I. THE SIMPLE (TWO-VARIABLE) LINEAR REGRESSION MODEL

Section 1: Basic Concepts of Regression Analysis

Lecture 1: Econometrics: What's It All About, Alfie?
Lecture 2: Introduction to Linear Regression Analysis.
Gujarati (2003): Introduction, pp. 1-14; Chapter 1, pp. 15-32; Chapter 2, pp. 37-51.

Section 2: Specification – Assumptions of the Simple Linear Regression Model

NOTE 1: Specification – Assumptions of the Simple Classical Linear Regression Model (CLRM).
Wooldridge (2009): Chapter 2, Sec. 2.1, pp. 22-27.
Wooldridge (2006): Chapter 2, Sec. 2.1, pp. 24-29.
Gujarati (2003): Chapter 3, Sec. 3.2, pp. 65-76.

Section 3: Estimation – The Method of Ordinary Least Squares (OLS)

NOTE 2: Ordinary Least Squares (OLS) Estimation of the Simple CLRM.
NOTE 3: Desirable Statistical Properties of Estimators.
NOTE 4: Statistical Properties of the OLS Coefficient Estimators.
NOTE 5: Computational Properties and Goodness-of-Fit of the OLS Sample Regression Equation.
Wooldridge (2009): Chapter 2, Secs. 2.2-2.3, pp. 27-41 and Secs. 2.5-2.6, pp. 46-59.
Wooldridge (2006): Chapter 2, Secs. 2.2-2.3, pp. 29-44 and Secs. 2.5-2.6, pp. 50-64.
Gujarati (2003): Chapter 3, Sec. 3.1, pp. 58-65 and Secs. 3.3-3.9, pp. 76-93; Appendix 3A, pp. 100-106.

Section 4: The Normality Assumption

NOTE 6: The Fundamentals of Statistical Inference in the Simple Linear Regression Model.
Gujarati (2003): Chapter 4, Secs. 4.1-4.3, pp. 107-112.

Section 5: Inference – Interval Estimation and Hypothesis Testing

NOTE 7: Interval Estimation in the Classical Normal Linear Regression Model.
NOTE 8: Hypothesis Testing in the Classical Normal Linear Regression Model.
NOTE 9: F-Tests and Analysis of Variance in the Simple Linear Regression Model.
Gujarati (2003): Chapter 5, Secs. 5.1-5.9, pp. 119-142, and Secs. 5.11-5.13, pp. 145-151.

Section 6: Prediction in the Linear Regression Model

NOTE 10: Conditional Prediction in the Simple (Two-Variable) Linear Regression Model.
Gujarati (2003): Chapter 5, Sec. 5.10, pp. 142-145.

Section 7: Functional Form in the Variables

Wooldridge (2009): Chapter 2, Sec. 2.4, pp. 41-46.
Wooldridge (2006): Chapter 2, Sec. 2.4, pp. 44-50.
Gujarati (2003): Chapter 6, Secs. 6.1-6.2, pp. 164-173, Secs. 6.4-6.8, pp. 175-191.

PART II. THE MULTIPLE LINEAR REGRESSION MODEL

Section 8: Specification – The Classical Linear Regression Model (CLRM)

Introduction to NOTE 11: Example of a Multiple Linear Regression Model.
NOTE 11: The Multiple Classical Linear Regression Model (CLRM): Specification and Assumptions.
Wooldridge (2009): Chapter 3, Sec. 3.1, pp. 68-72.
Wooldridge (2006): Chapter 3, Sec. 3.1, pp. 73-78.
Gujarati (2003): Chapter 7, Secs. 7.1-7.3, pp. 202-207.

Section 9: Estimation – Ordinary Least Squares (OLS)

NOTE 12: OLS Estimators of the Multiple (Three-Variable) Linear Regression Model.
Wooldridge (2009): Chapter 3, Sec. 3.2, pp. 73-77 and Secs. 3.3-3.5, pp. 84-105.
Wooldridge (2006): Chapter 3, Sec. 3.2, pp. 78-85 and Secs. 3.3-3.5, pp. 89-111.
Gujarati (2003): Chapter 7, Sec. 7.4, pp. 207-211; Appendix 7A, pp. 243-245.

Section 10: Goodness-of-Fit

NOTE 13: Goodness-of-Fit in the Multiple Linear Regression Model.
Wooldridge (2009): Chapter 3, Sec. 3.2, pp. 77-83; Chapter 6, Sec. 6.3, pp. 199-205.
Wooldridge (2006): Chapter 3, Sec. 3.2, pp. 85-89; Chapter 6, Sec. 6.3, pp. 206-213.
Gujarati (2003): Chapter 7, Secs. 7.5-7.6, pp. 212-215, Secs. 7.8-7.10, pp. 217-229.

Section 11: Selected Aspects of Model Specification

NOTE 14: Functional Form in the Variables: Common Specifications.
NOTE 15: Marginal Effects of Explanatory Variables: Constant or Variable?
Wooldridge (2009): Chapter 6, Sec. 6.2, pp. 189-199.
Wooldridge (2006): Chapter 6, Sec. 6.2, pp. 197-206.

Section 12: Inference – Interval Estimation and Hypothesis Testing

NOTE 16: Tests of Exclusion Restrictions on Regression Coefficients: Formulation and Interpretation.
NOTE 17: F-Tests of Linear Coefficient Restrictions: A General Approach.
Wooldridge (2009): Chapter 4, Secs. 4.1-4.3, pp. 117-140 and Secs. 4.5-4.6, pp. 143-156.
Wooldridge (2006): Chapter 4, Secs. 4.1-4.3, pp. 123-147 and Secs. 4.5-4.6, pp. 150-167.
Gujarati (2003): Chapter 8, Secs. 8.1-8.5, pp. 248-264.

PART III. SOME USES OF LINEAR REGRESSION ANALYSIS

Section 13: Linear Coefficient Restrictions

NOTE 18: F-Tests of Exclusion Restrictions on Regression Coefficients: Numerical Examples 1.
NOTE 19: F-Tests of Exclusion Restrictions on Regression Coefficients: Numerical Examples 2.
NOTE 20: Tests of Single Linear Coefficient Restrictions: t-tests and F-tests.
Wooldridge (2009): Chapter 4, Sec. 4.4, pp. 140-143.
Wooldridge (2006): Chapter 4, Sec. 4.4, pp. 147-150.
Gujarati (2003): Chapter 8, Secs. 8.6-8.7, pp. 264-273.

Section 14: Dummy Variable Regressors and Covariance Analysis

Introduction to NOTE 21: Using Dummy Variables as Regressors in Linear Regression Models.
NOTE 21: Using Dummy Variables to Test for Coefficient Differences.
NOTE 22: Tests for Coefficient Differences: Examples 1.
NOTE 23: Tests for Coefficient Differences: Examples 2.
Wooldridge (2009): Chapter 7, Secs. 7.1-7.4, pp. 225-246 and Sec. 7.6, pp. 251-254.
Wooldridge (2006): Chapter 7, Secs. 7.1-7.4, pp. 230-252 and Sec. 7.6, pp. 258-261.
Gujarati (2003): Chapter 9, Secs. 9.1-9.6, pp. 297-312, Sec. 9.10, pp. 320-322.

PART IV. PROBLEMS IN REGRESSION ANALYSIS

Section 15: Specification Errors – The Selection of Regressors

NOTE 24: Specification Errors in the Selection of Regressors.

Wooldridge (2009): Chapter 3, Sec. 3.3, pp. 89-94 and Sec. 3.4, pp. 99-101.
Wooldridge (2006): Chapter 3, Sec. 3.3, pp. 94-99 and Sec. 3.4, pp. 105-106.
Gujarati (2003): Chapter 7, Sec. 7.7, pp. 215-217; Chapter 13, Secs. 13.1-13.4, pp. 506-524.

Section 16: Multicollinearity

Wooldridge (2009): Chapter 3, Sec. 3.4, pp. 94-99.
Wooldridge (2006): Chapter 3, Sec. 3.4, pp. 101-104.
Gujarati (2003): Chapter 10, pp. 341-375.

Section 17: Heteroskedasticity – Nonconstant Error Variances

NOTE 25: Statistical Inference in Linear Regression Models With Heteroskedastic Errors.
Wooldridge (2009): Chapter 8, Secs. 8.1-8.4, pp. 264-290.
Wooldridge (2006): Chapter 8, Secs. 8.1-8.4, pp. 271-295.
Gujarati (2003): Chapter 11, pp. 387-428.