

Queen's University – Department of Economics

**ECONOMICS 452\* -- Fall Term 2013**

**APPLIED ECONOMETRICS**

Fall Term 2013

M.G. Abbott

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**Web Site:** <http://www.econ.queensu.ca/pub/faculty/abbott/econ452/>

**Lecture Times (Slot 45):** Tuesdays, 1:00 p.m. – 2:20 p.m.  
Thursdays, 11:30 a.m. – 12:50 p.m.

**Office Hours -- Fall Term 2013 (Tentative):**

- ◆ Tuesdays 3:00 p.m. – 4:30 p.m.
- ◆ Thursdays 2:00 p.m. – 3:30 p.m.

**Secretary:** Jill Hodgson  
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## ECONOMICS 452\* -- Fall Term 2013

### APPLIED ECONOMETRICS

#### Purpose and Organization

The purpose of the course is to help students **learn to use econometric methods in empirical economic research**. The course focuses exclusively on econometric models and methods designed for analysis of *cross-sectional data*. It emphasizes problems that arise in actually conducting applied econometric research on cross-sectional data, and modern methods and practices for dealing with these problems. Empirical examples – many drawn from recent literature in applied economics – are presented to illustrate the application of all econometric methods covered in the course.

Course material is presented in both *scalar and matrix terms*. Extensive use is made of **matrix algebra** in the presentation of econometric methods and results.

#### Learning Objectives

Upon successful completion of the course, students should have acquired the methodological, operational and expositional skills required **to design and conduct a small-scale econometric investigation and to write an accurate, complete and coherent report** of its methods and findings. They should also have developed the **capacity to comprehend and critically assess applied econometric studies** based on cross-sectional data.

## Course Format

The course is based on *two 80-minute lectures per week*. In addition, *hands-on tutorials* are scheduled in the Department of Economics Computer Classroom (Dunning Hall 350) at times to be arranged. The tutorials are designed to familiarize students with those features of the statistical software program *Stata* they will need for the assignments in the course.

## Course Work and Assessment

### □ **Assignments: Two Research Projects**

**Two assignments** will be given during the term. These assignments will require students to perform small econometric research projects that apply the various econometric methods and practices covered in the course.

The assignments will be *goal-specific* rather than *task-specific* in nature. That is, they will specify broad research objectives, a general empirical or econometric framework, and a dataset for each project, but will not specify in detail how the objectives are to be achieved or how the empirical framework is to be implemented. Students will therefore be responsible **for formulating a specific research design** for achieving the research objectives of each project, **for executing or carrying out that research plan, for deciding what specific empirical results are reported and how they are presented and interpreted, and for writing an *accurate, complete, coherent* and *well-documented* project report.** The **required format** for each project report is that of a short economics journal article.

Students are not only permitted, but strongly encouraged, to work in pairs in researching, writing and submitting the two assignments. **NOTE: Should the final course enrolment exceed 24 students, all students will be *required* to work in pairs on the assignments; single-authored assignments will not be accepted.**

### □ **Mid-Term and Final Exam:** There will be **NO mid-term or final exam** in the course.

## □ **Final Course Grade**

Each student's **final course grade** will be computed using the following weights for the two course components:

|                     |             |
|---------------------|-------------|
| <b>Assignment 1</b> | <b>50 %</b> |
| <b>Assignment 2</b> | <b>50 %</b> |

## □ **Course Work Schedule**

### ▪ **Assignment 1 (Fall Term 2013)**

DISTRIBUTION DATE: Thursday September 19, 2013

**DUE DATE: THURSDAY OCTOBER 31, 2013**

Assignments submitted **AFTER** the penalty-free due date will be penalized *10 percentage points per day*.

### ▪ **Assignment 2 (Fall Term 2013)**

DISTRIBUTION DATE: Tuesday November 5, 2013

**DUE DATE: THURSDAY DECEMBER 5, 2013**

Assignments submitted **AFTER** the penalty-free due date will be penalized *10 percentage points per day*.

## Major Steps in an Econometric Research Project

**Step 1:** Formulate a methodologically sound *research design*, or *research plan*, that effectively utilizes the available sample data to provide ***credible and complete empirical evidence*** on the empirical question(s) you are investigating.

Requires knowledge and understanding of both

- (1) the **principles of econometric model specification**, and
- (2) the **methods of estimation and inference** in econometric models.

**Step 2:** Execute the **research plan** in accordance with good econometric practice – i.e., conduct the econometric analysis required to assemble ***credible and complete empirical evidence*** on the empirical question(s) you were asked to investigate.

Requires a good working knowledge of both ***econometric methods*** and ***econometric software***.

**Step 3:** Write an accurate, complete, and logically coherent *research report* in which you fully and accurately explain *what you did*, *how you did it*, and *what you found*.

**Explaining *what you did* and *how you did it*** involves:

- Describing the sample data you used;
- Specifying the econometric models you estimated;
- Identifying the estimation methods you used;
- Specifying the hypothesis tests you performed on each model.

**Reporting *what you found*** involves:

- Tabulating the results of your econometric analysis, including the coefficient estimates of all reported models and the results of all hypothesis tests performed on these models;
- Interpreting and explaining the results of your econometric analysis;
- Assessing the strength of the evidence you obtained on the empirical questions you were asked to investigate;
- Identifying limitations of your analysis and suggestions for further research.

Requires **excellent organizational and technical writing skills**.

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## A Template of an Econometric Research Paper

Kalena E. Cortes, "Are Refugees Different from Economic Immigrants? Some Empirical Evidence on the Heterogeneity of Immigrant Groups in the United States." Berkeley, CA: Center for Labor Economics, University of California, Berkeley, Working Paper No. 41 (September 2001), 41 pp.

### **Body of Paper**

Title Page

1. Introduction
2. Literature Review
3. Conceptual Framework: A Model of Human Capital Investment
4. Empirical Methodology and Data Description
5. Characteristics of Refugees and Economic Immigrants
6. Empirical Results
  - 6.1 Model Specification and Regression Analysis
  - 6.2 Robustness Tests: Illusion or Reality
  - 6.3 The Effects of Improving English Fluency
7. Conclusion

## **Back Matter**

References

Figures

Tables

Appendix

## **Generic Outline of an Econometric Research Paper**

1. Introduction
2. Data Description
3. Econometric Models and Methods
4. Empirical Results
5. Summary and Conclusions
6. Back Matter – References, Figures, Tables, and Appendices

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**□ Cortes' Econometric Model: A Linear Regression Model**


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**Regression Model:**

$$\begin{aligned} \text{Ln}(\text{annearn})_{i,t} = & \alpha_0 + \alpha_1 D^{1990} + \alpha_2 D^{\text{Refugee}} + \alpha_3 D^{1990} D^{\text{Refugee}} + X_{i,t} \gamma + \beta_0 \text{Low\_Eng} \\ & + \beta_1 \text{Low\_Eng}^{1990} + \text{Educ}_{i,t} \theta + u_{it} \end{aligned} \quad (7)$$

**Variable Names and Definitions:**

$\text{Ln}(\text{annearn})_{i,t}$  = the natural log of annual wage and salary earnings for person i in year t;

$D^{1990}$  = a dummy variable indicating the 1990 census year;

$D^{\text{Refugee}}$  = a dummy variable indicating a refugee immigrant;

$D^{1990} D^{\text{Refugee}}$  = an interaction of refugee status and the 1990 census dummy;

$X_{i,t}$  = a vector of control variables (age, age<sup>2</sup>, age<sup>3</sup>, age<sup>4</sup>, region, marital status);

Low \_ Eng = a dummy variable indicating low English ability;

Low \_ Eng<sup>1990</sup> = a dummy variable indicating low English ability in 1990;

$\text{Educ}_{i,t}$  = a vector of educational attainment dummy variables (kindergarten, 1<sup>st</sup>-4<sup>th</sup> grade, 5<sup>th</sup>-8<sup>th</sup> grade, 9<sup>th</sup> grade, 10<sup>th</sup> grade, 11<sup>th</sup> grade, 12<sup>th</sup> grade, 1 to 3 years of college, 4 plus years of college);

$u_{it}$  = a random error term, which represents all the unknown, unobservable and unmeasured factors that determine the individual population values of the regressand  $\text{Ln}(\text{annearn})_{i,t}$ .

### **Mini-Assignment 1 on Cortes (2001) Paper**

In no more than two sentences, answer the following question:

***Question:*** What is the primary *empirical* question addressed in the Cortes (2001) paper?

***Due Date:*** Tuesday September 24, 2013 (not marked)

## **Textbooks: Recommended**

***Required Textbook: There is NO required textbook for this course.***

### ***Recommended Textbooks***

The ***recommended textbooks*** for the course are the fourth (2009) or third (2006) edition of the introductory textbook by Jeffrey Wooldridge, and the third (2011) edition of the introductory textbook by James Stock and Mark Watson:

**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.

**Jeffrey M. Wooldridge, *Introductory Econometrics: A Modern Approach*, Third Edition. South-Western College Publishing, 2006.** ISBN: 0-324-28978-2. Call number: HB139 .W665 2006.

**James H. Stock and Mark W. Watson, *Introduction to Econometrics*, Third Edition. Addison-Wesley, 2011.** ISBN-13: 978-0-13-612508-2. ISBN-10: 0-13-612508-5.

These books provide excellent modern treatments of all topics included in the course. They also contain plenty of real applications of econometric methods. One copy of Wooldridge (2006) is on reserve in Stauffer Library Reserve Room (call number: HB139 .W665 2006). Note that the third (2006) edition of the Wooldridge textbook (ISBN 0-324-28978-2) is completely adequate for purposes of this course.

### ***Other Recommended Textbooks***

The following two textbooks are recommended for supplementary reading.

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

A standard textbook in introductory econometrics, Gujarati (2003) provides clear expositions of many of the topics covered in the course.

**Ernst R. Berndt, *The Practice of Econometrics: Classic and Contemporary*. Don Mills, ON: Addison-Wesley Publishing Company, 1991.** ISBN 0-201-17628-9.

Berndt (1991) is an excellent "hands-on" textbook in applied econometrics; it emphasizes the implementation of econometric techniques in real empirical applications.

## Computer Software

The required econometric software package for the course is *Stata/IC*. The current release of *Stata* is Release 13 (*Stata 13*), but Release 12 (*Stata 12*) is perfectly adequate for purposes of this course.

The *Stata* web site is at: [www.stata.com](http://www.stata.com).

**Stata tutorials** distributed during the term on the course web site will give students hands-on instruction in those features of *Stata* required to implement the econometric methods covered in the course and to do the two research assignments. In addition, **scheduled computing labs** in the **Department of Economics Computer Classroom (Dunning Hall 350)** will give students the opportunity to obtain individual assistance with both the computer tutorials and the research assignments.

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*Stata 12 or Stata 13 for Windows* will run under Windows 8, Windows 7, 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 13* are available:

**Small Stata** – *Stata 13* for small computers

- Datasets are restricted to a maximum of 99 variables and 1,200 observations.
- Matrices may be up to 40 x 40.
- Maximum number of right-hand-side variables = 98
- String variables up to 244 characters.
- Computer should have at least 512 MB of RAM and 500 MB of disk space.

**Stata/IC** -- the standard professional version of *Stata 13*

- 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-side variables = 798
- String variables up to 244 characters.
- Computer should have at least 512 MB of RAM and 500 MB of disk space.

**Stata/IC** is the required version of *Stata 12* or *Stata 13* for this course. Small Stata's restrictions on dataset size would prove to be binding for the research assignments in the course. ***Stata/IC 13* is available for Windows, Mac and Unix platforms.**

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## ***Documentation for Stata 13***

Core documentation for ***Stata 13 for Windows*** or ***Stata 13 for Mac*** consists of *Getting Started with Stata, User's Guide*, and the *Base Reference Manual*. These and all other documentation for *Stata 13* can be downloaded in PDF format from the *Stata* web site at the following link: <http://www.stata.com/features/documentation/>

- ***Getting Started with Stata for Windows***  
(Stata Press, 2013; ISBN-13: 978-1-59718-114-3; 139 pp.)  
<http://www.stata.com/bookstore/getting-started-windows/>
- ***Getting Started with Stata for Mac***  
(Stata Press, 2013; ISBN-13: 978-1-59718-112-9; 136 pp.)  
<http://www.stata.com/bookstore/getting-started-mac/>
- ***User's Guide***  
(Stata Press, 2013; ISBN-13: 978-1-59718-115-0; 409 pp.)  
<http://www.stata.com/bookstore/users-guide/>
- ***Base Reference Manual***  
(Stata Press, 2013; ISBN-13: 978-1-59718-116-7; 2,535 pp.)  
<http://www.stata.com/bookstore/base-reference-manual/>

Complete information on *Stata 13* documentation is available from the *Stata* web site at:  
<http://www.stata.com/support/documentation/>

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### ***Purchasing your own copy of the Stata/IC 13 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/IC 13* statistical software and documentation at **special student discount prices**.

Note that each installation of *Stata* includes **all documentation in PDF format**, which consists of 20 manuals with over 11,000 pages.

Students who wish to take advantage of this course GradPlan should **send an e-mail message to the instructor with their full name and student number**, who will send them instructions on how to proceed.

The following are the US dollar prices (excluding shipping costs) for the 6-month, annual, and perpetual licenses of *Stata/IC 13*:

- *Stata/IC 13* software with PDF documentation      US\$ 69.00 / 6 months
- *Stata/IC 13* software with PDF documentation      US\$ 98.00 / annual      (regular price is US\$ 295)
- *Stata/IC 13* software with PDF documentation      US\$ 189.00 / perpetual      (regular price is US\$ 595)

The **Stata/IC 13 software is available for delivery via electronic software download or DVD**. For orders with delivery via download, students will receive download instructions and then their License and Activation Key after their order has been processed, typically within one day.

## Background Preparation for ECON 452\*

It is assumed that students have successfully completed an introductory undergraduate econometrics course such as ECON 351\*, and an introductory university-level calculus course such as MATH 126 or MATH 121.

Since **extensive use is made of matrix algebra**, a selective review of basic concepts in matrix algebra may be advisable. For *a brief review of matrix algebra*, see either Wooldridge (2009), Appendix D, pp. 788-797 or Wooldridge (2006), Appendix D, pp. 808-818.

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## COURSE OUTLINE AND READINGS

**NOTE:** All lecture notes posted on the course web site are required reading. The readings in Wooldridge (2009, 2006) and Stock and Watson (2011) are optional, but recommended.

### 1. SPECIFICATION ISSUES IN LINEAR REGRESSION MODELS

#### *A. Theoretical Specification of the Classical Linear Regression Model*

NOTE 1: Formulation and Specification of the Multiple Linear Regression Model in Vector-Matrix Notation.  
Wooldridge (2009). Ch. 3, Sec. 3.3, pp. 84-88; Appendix D, pp. 788-798; Appendix E, Sec. E.2, pp. 801-805.  
Wooldridge (2006). Ch. 3, Sec. 3.3, pp. 89-94; Appendix D, pp. 808-818; Appendix E, Sec. E.2, pp. 822-825.  
Stock and Watson (2011). Ch. 4, Secs. 4.4-4.5, pp. 122-130; Ch. 6, Secs. 6.5-6.7, pp. 196-203; Ch. 18, Sec. 18.1, pp. 698-702.

#### *B. Selection of Regressors*

NOTE 2: Specification Errors in the Selection of Regressors.  
Wooldridge (2009). Ch. 3, Sec. 3.3, pp. 89-94.  
Wooldridge (2006). Ch. 3, Sec. 3.3, pp. 94-99.  
Stock and Watson (2011). Ch. 6, Sec. 6.1, pp. 179-186; Ch. 7, Sec. 7.5, pp. 229-235.

1. Exclusion of Relevant Regressors: Omitted Variables Bias
2. Inclusion of Irrelevant Regressors

### ***C. Functional Form of the Regression Function***

Wooldridge (2009). Ch. 2, Sec. 2.4, pp. 41-46; Ch. 6, Sec. 6.2, pp. 189-199; Ch. 9, Sec. 9.1, pp. 300-306.  
Wooldridge (2006). Ch. 2, Sec. 2.4, pp. 44-50; Ch. 6, Sec. 6.2, pp. 197-206; Ch. 9, Sec. 9.1, pp. 304-310.  
Stock and Watson (2011). Ch. 8, Secs. 8.1-8.2, pp. 254-274.

#### **1. Marginal Effects of Continuous Explanatory Variables: Constant or Variable?**

NOTE 3: Marginal Effects of Continuous Explanatory Variables: Constant or Variable?

#### **2. Functional Form in the Variables: Linear or Logarithmic?**

NOTE 4: Functional Form in the Variables: Linear or Log?

### ***D. Coefficient Differences and Dummy Variable Regressors***

Wooldridge (2009). Ch. 7, Secs. 7.1-7.4, pp. 225-246.  
Wooldridge (2006). Ch. 7, Secs. 7.1-7.4, pp. 230-252.  
Stock and Watson (2011). Ch. 8, Secs. 8.3-8.4, pp. 274-294.

NOTE 5: Using Dummy Variable Regressors for Two-Category Categorical Variables.

NOTE 6: Using Dummy Variable Regressors for Multi-Category Categorical Variables.

NOTE 7: Dummy Variable Interaction Terms.

NOTE 8: A General Regression Model with Dummy Variable Interactions.

## **2. OLS ESTIMATION OF THE LINEAR REGRESSION MODEL: MATRIX FORMULATION**

NOTE 9: OLS Estimation of the Classical Linear Regression Model: Matrix Notation and Derivations.

Wooldridge (2009). Ch. 3, Sec. 3.2, pp. 73-83; Appendix E, Sec. E.1, pp. 799-801.

Wooldridge (2006). Ch. 3, Sec. 3.2, pp. 78-89; Appendix E, Sec. E.1, pp. 819-822.

Stock and Watson (2011). Ch. 18, Sec. 18.1, pp. 698-702.

## **3. INFERENCE (HYPOTHESIS TESTING) IN THE LINEAR REGRESSION MODEL: REVIEW AND EXTENSIONS**

NOTE 10: Testing Linear Coefficient Restrictions in Linear Regression Models: The Fundamentals.

Wooldridge (2009). Ch. 3, Secs. 3.4-3.5, pp. 94-104; Ch. 4, pp. 117-159; Appendix E, Sec. E.3, pp. 805-807.

Wooldridge (2006). Ch. 3, Secs. 3.4-3.5, pp. 99-109; Ch. 4, pp. 123-167; Appendix E, Sec. E.3, pp. 826-827.

Stock and Watson (2011). Ch. 7, Secs. 7.1-7.4, pp. 214-229; Ch. 18, Sec. 18.3, pp. 706-708.

## **4. LINEAR REGRESSION MODELS WITH HETEROSKEDASTIC ERRORS**

### ***A. Consequences of Heteroskedastic Errors for OLS Estimation and Inference***

NOTE 11: Heteroskedasticity-Robust Inference in Linear Regression Models Estimated by OLS.

Wooldridge (2009). Ch. 8, Sec. 8.1, pp. 264-265.

Wooldridge (2006). Ch. 8, Sec. 8.1, pp. 271-272.

Stock and Watson (2011). Ch. 5, Sec. 5.4, pp. 155-161.

***B. OLS With Heteroskedasticity-Robust Inference***

NOTE 11: Heteroskedasticity-Robust Inference in Linear Regression Models Estimated by OLS.

Wooldridge (2009). Ch. 8, Sec. 8.2, pp. 265-271.

Wooldridge (2006). Ch. 8, Sec. 8.2, pp. 272-276.

Stock and Watson (2011). Ch. 5, pp. 174-175; Ch. 18, Sec. 18.2, pp. 704-705.

***C. Tests for Heteroskedastic Errors***

NOTE 12: Testing for Heteroskedasticity in Linear Regression Models.

Wooldridge (2009). Ch. 8, Sec. 8.3, pp. 271-276.

Wooldridge (2006). Ch. 8, Sec. 8.3, pp. 278-284.

***D. GLS Estimation of Heteroskedastic Errors Models***

Wooldridge (2009). Ch. 8, Sec. 8.4, pp. 276-290.

Wooldridge (2006). Ch. 8, Sec. 8.4, pp. 284-295.

Stock and Watson (2011). Ch. 17, Sec. 17.5, pp. 683-688.

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## 5. MAXIMUM LIKELIHOOD ESTIMATION OF LINEAR REGRESSION MODELS

### *A. Fundamentals of Maximum Likelihood Estimation*

Wooldridge (2009). Appendix C, Sec. C.4, pp. 761-762.

Wooldridge (2006). Appendix C, Sec. C.4, pp. 778-779.

### *B. ML Estimation of the Classical Normal Linear Regression Model*

NOTE 13: Maximum Likelihood Estimation of the Classical Normal Linear Regression Model.

## 6. BINARY DEPENDENT VARIABLES MODELS

### *A. OLS Estimation: The Linear Probability Model*

Wooldridge (2009). Ch. 7, Sec. 7.5, pp. 246-251; Ch. 8, Sec. 8.5, pp. 290-293.

Wooldridge (2006). Ch. 7, Sec. 7.5, pp. 252-257; Ch. 8, Sec. 8.5, pp. 295-297.

Stock and Watson (2011). Ch. 11, Sec. 11.1, pp. 382-387.

### *B. Probit and Logit Models: Basic Features*

NOTE 14: Maximum Likelihood Estimation of Binary Dependent Variables Models: Probit and Logit.

Wooldridge (2009). Ch. 17, Sec. 17.1, pp. 575-578.

Wooldridge (2006). Ch. 17, Sec. 17.1, pp. 583-586.

Stock and Watson (2011). Ch. 11, Sec. 11.2, pp. 387-394.

***C. ML Estimation of Probit and Logit Models***

NOTE 14: Maximum Likelihood Estimation of Binary Dependent Variables Models: Probit and Logit.

Wooldridge (2009). Ch. 17, Sec. 17.1, pp. 578-579.

Wooldridge (2006). Ch. 17, Sec. 17.1, pp. 586-587.

Stock and Watson (2011). Ch. 11, Sec. 11.3, pp. 394-398.

***D. Interpreting Probit and Logit Coefficient Estimates***

NOTE 15: Marginal Effects in Probit Models: Interpretation and Testing.

Wooldridge (2003). Ch. 17, Sec. 17.1, pp. 580-587.

Wooldridge (2006). Ch. 17, Sec. 17.1, pp. 588-595.

***E. Statistical Inference in Probit and Logit Models***

NOTE 16: Testing Linear Coefficient Restrictions in Probit Models.

Wooldridge (2003). Ch. 17, Sec. 17.1, pp. 579-580.

Wooldridge (2006). Ch. 17, Sec. 17.1, pp. 587-588.