# Applied econometrics

## Prof. Andrea Monticini

***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

This course investigates the main econometric methods as a tool for the quantitative analysis of economic and financial phenomena. The application of econometric models allows measuring variables that are not directly observable, studying their relationships and behavior, testing and comparing alternative theories, as well as forecasting and simulating the effects of different policies.

This course heavily emphasizes the importance of applications. A discussion of the main theoretical issues and a systematic analysis of econometric tools are intended as prerequisites for the investigation of a series of problems that are of particular relevance for economic and financial applications. For this reason, the theoretical lectures will be complemented by a systematic series of financial and economic applications in the electronic classroom, based on the use of both the R programming language and Python, through which the student will be in the position to autonomously develop econometric analysis, and perform empirical studies on financial and economic topics.

At the end of the course, students will:

* learn methods for estimating causal effects using observational data
* learn to evaluate the regression analysis of others – this means students will be able to read/understand empirical economics papers in other courses
* be able to be conversant with modern econometric theory and practice
* be able to prepare and independent empirical analysis using modern econometric techniques

### **Course Content**

Course outline and detailed learning goals:

1. *Regression Models:* brief review of regressions, along with a few reminders of things from statistics and probability theory.

 At the end of this section of the course the student will be able to:

– understand the nature and goals of econometric analysis, as well as the essential determinants of econometric models;

– recognize the different types of data (cross-sections, time series, pooled cross-sections, and panel) that are used in empirical analysis;

– specify a linear regression model;

– estimate a linear regression model by Method of Moments.

2. *The Geometry of Linear Regression.*

 At the end of this section of the course the student will be able to:

– understand the geometric interpretation of the OLS;

– understand the implications of the Frisch-Waugh-Lovell theorem.

3. *The Statistical Properties of Ordinary Least Squares*

 At the end of this section of the course the student will be able to:

– understand the concept of DGP;

– use the ordinary least squares method (OLS) to estimate the parameters of multiple regression models and to evaluate the goodness of a regression;

– derive the statistical and algebraic properties of the OLS estimators (unbiasedness and efficiency) and of their variances.

4. *Hypothesis Testing in Linear Regression Models*

 At the end of this section of the course the student will be able to:

– test hypotheses about a single population parameter (the t test), testing hypotheses about a single linear combination of parameters, and deriving confidence intervals;

– test multiple linear restrictions;

– understand the difference between exact and asymptotic test.

5 *Confidence Intervals*

 At the end of this section of the course the student will be able to:

– construct exact and asymptotic confidence intervals.

6. *Generalized Least Squares and Related Topics.* We consider models in which the disturbances can be heteroskedastic, or serially correlated, or both.

 At the end of this section of the course the student will be able to:

– derive the GLS estimator;

– derive tests for both heteroskedasticity and autocorrelation.

7. *Instrumental Variable Estimation*

 At the end of this section of the course the student will be able to:

– derive an instrumental variable estimator;

– test for endogeneous regressors.

8. *The Method* *of Maximum Likelihood*

 At the end of this section of the course the student will be able to:

– derive the MLE estimator for the linear regression model;

– derive three tests based on the MLE estimator.

### **READING LIST[[1]](#footnote-1)**

R. Davidson-J. MacKinnon, *Econometric Theory and Methods,* Oxford University Press, 2004.

The materials for the course can be found in a site I maintain on my own computer: *http://www.monticini.eu/teaching/apecon/.* There I will put PDF files containing the assignments as the term advances. Data files for the assignments are available there as well, and whatever other materials, links, and so on, that seem suitable.

### **TEACHING METHOD**

The course is based on lectures (56 hours) and on computer laboratory (20 hours). I will provide you with various assignments, probably nine of them, you will be under no obligation to hand them in. Nonetheless, students are strongly advised to work through the assignments as a study aid.

### **ASSESSMENT METHOD AND CRITERIA**

There is am online Blackboard test for all the students. Students must show to know the theory of the regression models; what happens when some of the hypothesis behind the regression model do not apply; how to estimate a regression model using an econometric software; how to use an estimated model for forecasting financial variables and for policy analysis. The final exam is based on an online Blackboard test composed by three sections: A) six True/False questions; B) six Multiple choice question; C) six questions on an estimated econometric model, this section is focused on the empirical application of the econometric methods. Part A) counts 25%, part B) counts 25%, and part C) counts 50% respectively of the final grade.

***NOTES AND PREREQUISITES***

Before entering the course, the student should be familiar with:

– random variables and the features of their probability distributions (mean, median, variance and standard deviation), as well as the features of joint and conditional distributions (covariance and correlation, conditional expectation and variance and their properties);

– normal and related distributions: Chi-square, t-distribution and F-distribution;

– the fundamentals of mathematical statistics: unbiasedness, consistency, and asymptotic normality;

– the fundamentals of hypothesis testing;

– the properties of some special functions (linear, logarithmic, exponential, quadratic), and the basic elements of differential calculus;

– the fundamental issues of micro and macroeconomics, as well as of financial theory and corporate finance.

In case of severe pandemic conditions, on-site lectures will be replaced by remote lectures. In this scenario, the information will be provided in due time

1. I testi indicati nella bibliografia sono acquistabili presso le librerie di Ateneo; è possibile acquistarli anche presso altri rivenditori. [↑](#footnote-ref-1)