# Econometrics

## Prof. Consuelo Rubina Nava; Prof. Valentina Colombo

***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 series of financial and economic applications, based on the use of both the R programming language, 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 conduct empirical analysis using econometric techniques

***COURSE CONTENT***

1st module (part Prof. Nava)

1. *Statistics and probability theory review*

2. *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 and Maximum Likelihood

3. *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.

4. *The Statistical Properties of Ordinary Least Squares*

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

– 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.

– interpret the estimates of an OLS model also in the presence of dummy independent variables

5. *Hypothesis Testing in Linear Regression Models and Confidence Intervals*

 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;

– construct exact and asymptotic confidence intervals.

– test multiple linear restrictions (F test);

– understand the difference between exact and asymptotic test.

2nd module (part Prof. Colombo)

5. *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:

– apply the GLS estimator;

– derive tests for both heteroskedasticity and autocorrelation.

6. *Strong and weak multicollinearity.*

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

– detect the presence of a strong or weak multicollinearity issues;

– propose solutions to strong or weak multicollinearity issues.

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. *Stationary univariate time series*

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

– identify the model;

– estimate AR, MA, ARMA, ARIMA models and used them for forecasting;

– detect the present of unit root and test for stationary

9. Panel Model

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

– identify a panel model;

– estimate a model with fixed effects or random effects.

***READING LIST***

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

Faraway, J. J., Practical regression and ANOVA using R (Vol. 168). University of Bath, 2002.

[R. C. Hill](https://www.wiley.com/en-us/search?pq=%7Crelevance%7Cauthor%3AR.+Carter+Hill), [W. E. Griffiths](https://www.wiley.com/en-us/search?pq=%7Crelevance%7Cauthor%3AWilliam+E.+Griffiths), [G. C. Lim](https://www.wiley.com/en-us/search?pq=%7Crelevance%7Cauthor%3AGuay+C.+Lim), Principles of Econometrics, 5th edition, Wiley.

D.N. Gujarati, *Essentials of Econometrics,* McGraw- Hill, 2009.

M. Faliva-M.G. Zoia, *Lecture in Econometric Theory,* EDUCatt, Milano, 2016.

***TEACHING METHOD***

The course is based on lectures.

### **ASSESSMENT METHOD AND CRITERIA**

There is a written examination 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 a written examination composed by the following sections: A) short open questions (18 marks); B) Multiple choises and interpreting regression output or numerical question. Part A) refers to the 1st module, while part B) to the 2nd one.

***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.