Doctoral Program in Economics

UNIVERSITÀ DEGLI STUDI FIRENZE | UNIVERSITÀ DI SIENA | UNIVERSITÀ DI PISA

Academic year 2026/27

ECONOMETRICS I

Period:
First term: November/December 2026

Course hours: 20

Teachers:
Caterina Pisani (10 hours)
Angela Parenti (10 hours)

Exam methods:
Written test

Prerequisites:

Knowledge of elementary mathematics. Basic notions of differential and integral calculus.

MODULE I: Elements of Probability Theory – Caterina Pisani

Program

Probability space

*S*ample space, events and set theory. Probability. Conditional probability. Independence.

Random variables

Discrete random variables: probability mass function and cumulative distribution function. Continuous random variables: probability density function and cumulative distribution function. Examples of discrete and continuous random variables. Distribution of functions of a random variable

Expectation

Expected value. Expectation of a function of a random variable. Moments.

Multiple random variables

Joint and marginal distributions. Conditional distributions and independence. Covariance and correlation

Basic concepts on distributions of functions of random variables.

Limit theorems and convergence concepts

Convergence in probability. Weak and strong law of large numbers. Almost sure convergence. Convergence in distribution. The central limit theorem.

Educational objectives
The main objective of this module is to provide students with the foundations of probability theory. At the end of the module, students will be able to use probability models, to compute moments of random variables and to derive the marginal and conditional distributions of bivariate random variables. Students should also be familiar with convergence results.

Bibliographical references
Rinamann, W.C. (1993). *Foundations of Probability and Statistics*. Saunders College Publishing.

MODULE II: Statistical Inference – Caterina Pisani

Program

Point estimation

Point estimators. Finite sample properties of point estimators (unbiasedness, mean squared error, efficiency). Asymptotic properties of point estimators (asymptotic unbiasedness, consistency, asymptotic efficiency). Maximum likelihood estimators and their properties.

Interval estimation.

Interval estimator. Pivotal quantity method for building confidence intervals. Confidence intervals based on the asymptotic properties of maximum likelihood estimators.

Testing hypothesis

Hypothesys system, parametric hypothesis system. Test and test statistic. Rejection and acceptance region. Type I and type II errors. Power function. Test of prefixed significance level. Test properties. P-value. Likelihood ratio test.

Educational objectives
The aim of the module is to enhance the knowledge of the main statistical-inferential methods adopted in economic, social and financial analysis. At the end of the module, students will be able to properly deal with the main statistical inferential techniques, such as estimators, confidence intervals and hypothesis testing.

Bibliographical references
Rinamann, W.C. (1993). *Foundations of Probability and Statistics*. Saunders College Publishing.

MODULE III OLS regression

Teacher : Angela Parenti , 10 hours

Program
The course will cover the following topics:

- Classical Linear Regression Model
  - Least squares estimation
  - Assumptions of OLS
  - Statistical properties
  - Goodness of fit

- Violations of OLS assumption
- Omitted variable bias
- Functional form and nonlinearity
- Multicollinearity
- Heteroskedasticity

- Hypothesis testing
  - Wald Test
  - Lagrange Multiplier Test
  - Likelihood Ratio Test

- Introduction to Instrumental Variable regression

Educational objectives
The module aims to introduce regression methods, particularly ordinary least square regression (OLS). Its topics will show the properties of OLS regression, the assumptions needed, and the methods to adopt in case of violation of these assumptions.

References:

- Introductory Econometrics: A Modern Approach, by Jeffrey M. Wooldridge, 2016
- Econometric Analysis, by William H Green, Ed. Prentice Hall, 7th edition.

Additional material and references will be provided during the lessons.