University of Rome Tor Vergata; Department of Economics and Finance

Econometrics I

Ph.D. in Economics and Finance

Syllabus, Fall 2026

Instructor: Antonio Raiola
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Office Hour: by appointment

Objectives: The aim of the course is to develop familiarity with a wide range of statistical and econometric techniques, useful in applied contexts. Theoretical results are developed in order to allow students to apply general principles to their own research problems. The material discussed is a reasonable definition of the minimal acquitance that a well-trained economics and finance Ph.D. should know.

Prerequisites: Familiarity with calculus, linear (matrix) algebra and basic mathematical statistics is expected.

Grading: Problem sets will account for 20% of the final grade. There will be a final exam that accounts for 80% of the final grade.

Textbooks and Notes: Lecture slides will be provided. Good textbooks that can be useful for this course are:

Hansen, B. (2022), *Econometrics*, Princeton University Press.

Davidson, R. and J. G. MacKinnon (2004), *Econometric Theory and Methods*, Oxford University Press.

Hayashi, F. (2000), *Econometrics*, Princeton University Press.

White, H. (2001), *Asymptotic Theory for Econometricians*, Academic Press.

Course Outline:

1. The Mechanics of Ordinary Least Squares: vector spaces and projections (motivation, vector spaces, matrices as linear maps, projections, generalized inverses, projection maps in the standard linear model).
2. Properties of the Least-squares Projection (fitted values, residuals, measure of fit, the Frisch-Waugh-Lovell Theorem).

3. The Basic Linear Model; Finte-Sample Results (model and assumptions, properties of the least-squares estimator, the Gauss-Markov Theorem, Estimation of the variance of the errors, LUS residuals, recursive residuals.
4. Restricted Least-Squares (the restricted OLS estimate, consequence of misspecification, geometric interpretation).
5. A Brief Review of Asymptotic Results (convergence in probability, order of magnitude, convergence in distribution, martingale differences, etc.).
6. The Basic Linear Model; Asymptotic Results (the Mann-Wald Theorem, consistency, asymptotic normality; test statistics and confidence intervals).
7. Instrumental Variables (instruments and estimators, the GIVE estimator, two-stage interpretation).
8. Generalized Methods of Moments (Linear and nonlinear GMM, optimal weighting matrix, efficient GMM, Overidentification tests)
9. Non-Spherical Errors (heteroskedasticity and autocorrellation consistent (HAC) standard errors, GLS estimator, geometric interpretation of GLS, Feasible GLS).
10. Difference Equations (first-order difference equations, second-order difference equations, lag operator).
11. Time Series Models (stationarity, autocovariance and autocorrelation, ARMA processes, maximul likelihood estimation, Granger cauality).

Selected Readings: The asymptotic results covered in this course (5–6) are discussed in detail in White, H. (2001), *Asymptotic Theory for Econometricians*. For the remaining material, see Hansen, B. (2022). For a more advanced treatment of time-series models, see Hayashi, F. (2000), *Econometrics*, Princeton University Press. For a more advanced treatment of GMM, see Davidson, R. and J. G. MacKinnon (2004), *Econometric Theory and Methods*, Oxford University Press.