

**PhD Program in Economics and Finance
Tor Vergata University**

Lectures in Econometric Theory

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The course is intended for PhD Students in Economics and Finance. The duration of the course is 12 hours. It will be given during the two weeks period May 20 to May 31, 2019, in 2 classes per week, three hours each.

Course aims

The purpose of the course is to increase students' knowledge in Econometric Theory by deepening some of the topics that they may have learned earlier, or by introducing new concepts. Students should be able to better understand the theoretical basis of advanced estimation and hypothesis testing procedures proposed in the recent literature.

Outline of the course content

The course is dedicated to non-linear models, covering both aspects of estimation and testing. The topics which will be considered in the course will be presented in a unified framework for estimation and hypothesis testing methods. This framework is provided by the treatment of the so-called "Extremum Estimators". These are obtained by optimizing an appropriate objective function. Extremum Estimators methods include Maximum Likelihood, Pseudo-Maximum Likelihood, Nonlinear Least Squares, Instrumental Variable, and Generalized Method of Moments.

The course will also emphasize general testing parametric hypothesis as well as specification tests.

As an illustration, the results concerning estimation and hypothesis testing will be applied to some classes of models that are popular in empirical research.

Prerequisites

Exposure to undergraduate econometrics. Familiarity with the basics of Calculus and Real Analysis, Linear (Matrix) Algebra, Probability Theory and Mathematical Statistics.

Texts and Notes

There is no required single text, which will be followed closely. The course is based on a set of notes. However, the main references of the course are Wooldridge (2010) and Gourieroux-Monfort (1995). In addition, it is strongly recommended to complement with the textbooks by Peracchi (2001) and Wooldridge (2012). Additional references will be provided as and when the various topics will be addressed.

Main Reference books:

Gourieroux, Christian and Alain Monfort (1995), *Statistics and Econometric Models*, Volumes 1 and 2, Cambridge University Press
Wooldridge, Jeffrey M. (2010), *Econometric analysis of cross section and panel data* —2nd ed, MIT Press

Complement textbooks recommended

Peracchi, Franco (2001), *Econometrics*, John Wiley & Sons
Wooldridge, Jeffrey M. (2012), *Introductory Econometrics: A Modern Approach*, 5th Ed., South-Western

Grade

Grade for the course is based on a limited time written exam, which will take place during the exam period.

Econometric Theory

Detailed outline of the course

Nonlinear models

Background: *Differential calculus; Topics in Real Analysis; stochastic convergence concepts; conditional expectation.*

- **Extremum estimators**
 - o Motivation of the assumptions
 - o Master theorems for extremum estimators in nonlinear models
 - o Strong consistency
 - o Stochastic equicontinuity
 - o Asymptotic distribution
 - o Two-step extremum estimation procedure
- **M-estimation procedure**
 - o Master theorems for M-estimators
 - o Uniform Laws of Large Numbers
 - o Strong consistency
 - o Asymptotic distribution
 - o Two-step extremum estimation procedure
 - o Example: Nonlinear Least-Squares
 - o Example of M-estimation for stochastic process: autoregressive process of order 1
 - Consistency, illustrating stochastic equicontinuity
 - Asymptotic distribution, illustrating martingale's central limit theorem
- **Maximum likelihood estimation procedure (MLE)**
 - o Kullback and identification
 - o Strong consistency
 - o Asymptotic distribution
 - o Two-step MLE estimation procedure
 - o Concentrated likelihood
 - o Conditional likelihood (Background Sufficient statistics)
 - Examples: Dichotomous models, Tobit models, Quantile regression
 - o Dynamic models
 - Example: Model with autocorrelated disturbances
- **Pseudo Maximum Likelihood**
 - o Exponential families: a brief review
 - o Pseudo Maximum Likelihood of order 1 (PML1)
 - o Relation with Generalized Linear Models (GLM)
 - o Strong consistency

- o Asymptotic distribution
- o Two-step PML1 estimation procedure
- o Pseudo Maximum Likelihood of order 2 (PML2) or “Quasi-maximum likelihood” (QML) based on the normal distribution)
- o Consistency
- o Asymptotic distribution
- **Generalized method of moments (GMM)**
 - o GMM estimation procedure
 - o Strong consistency
 - o Asymptotic distribution
 - o Special case of conditional moment restrictions
 - o Strong consistency
 - o Asymptotic distribution
 - o Optimal GMM
 - o Applications of GMM: Dynamic panel data models

Hypothesis testing

- **Review within in the classical linear model**
 - o The classical tests: Wald, LRT, Score/LM,
 - o Hausman test omitted variables
- Within the IV-2SLS framework
 - o Testing for exogeneity
 - Expanded regression framework
 - Hausman-Wu test
- **Within the maximum likelihood framework**
 - o The classical tests: Wald, LRT, Score/LM and Hausman test
 - o Derivation and asymptotic equivalence under a sequence of local alternatives
 - o Examples of LM or Score test
- **Within the extremum estimators’ framework**
 - o Criteria equivalent to Wald, LRT, Score/LM and Hausman test
 - o Derivation and asymptotic equivalence under a sequence of local alternatives
 - o Application to optimal GMM