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Applied econometrics

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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 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.

Course content

1. *The nature of econometrics and of economic data*
 - 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;
 - understand the importance of the notions of causality and ceteris paribus analysis for econometric studies.
2. *Regression analysis with cross-sectional data: estimation*
 - evaluate the ceteris paribus effect of a specific independent variable;
 - 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.
3. *Multiple regression analysis: inference*
 - 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 (the F test);
 - evaluate the overall significance of a regression.
4. *Multiple regression analysis: OLS asymptotics*
 - show the consistency of the OLS estimators;
 - show that the t and F statistics asymptotically hold even in the absence of the assumption of normal distribution of the error terms.
5. *Multiple regression analysis: functional forms, specification issues, selection of regressors, goodness-of-fit*
 - understand the effects of data scaling, and derive beta coefficients;
 - use and interpret econometric models based on non-linear functional forms (logarithmic functional forms, models with quadratics, models with interaction terms);



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del Sacro Cuore

- evaluate the effects of the introduction of further regressors in an econometric model (adjusted R^2);
 - analyze the implications of including too many factors in regression analysis, and that of adding regressors to reduce the error variance.
6. *Multiple regression analysis with qualitative information: dummy variables*
- use qualitative and ordinal information in regression analysis and evaluate alternative policy programs;
 - study regression models with a binary dependent variable (the linear probability model), and understand their drawbacks.
7. *Heteroskedasticity*
- compute standard errors and tests that are robust to heteroskedasticity of unknown form;
 - derive tests for heteroskedasticity: Breusch-Pagan and White tests;
 - derive weighted least squares estimators (WLS) when heteroskedasticity is known up to a multiplicative constant and evaluate their properties;
 - derive generalized least squares estimators (feasible GLS) when the heteroskedasticity function must be estimated.
8. *Regression analysis with time series data*
- understand the conceptual differences between cross-sectional and time series data;
 - formulate the econometrics models for time series most widely used in economics and finance (AR, MA and ARMA models), and derive the finite sample properties of the OLS estimators under the classical assumptions;
 - use non-linear functional forms and dummy variables in time series applications and event studies, and deal with trends and seasonality;
 - recognize stationary and weakly dependent time series, and derive asymptotic properties of OLS;
 - test for unit roots and cointegration;
 - use highly persistent time series (unit root processes) in regression analysis;
 - understand the idea of correlation in variances (ARCH) in financial data.
9. *Serial correlation and heteroskedasticity in time series regressions*
- understand the properties of OLS with serially correlated errors;
 - perform tests to detect the presence of serial correlation;
 - perform inference that is robust to the presence of serial correlation and heteroskedasticity.

Reading list

R. DAVIDSON-J. MACKINNON, *Econometric Theory and Methods*, Oxford University Press, 2004.
J.H. STOCK-M. WATSON, *Introduction to Econometrics*, Pearson (last edition).
G.S. MADDALA-K. LAHIRI, *Introduction to Econometrics*, Wiley, 4th ed.

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 theoretical lectures (56 hours) and on computer laboratory (20 hours).



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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 to the regression model when some of the hypothesis behind the regression model do not apply, how to use an estimated model for forecasting and for policy analysis. The final exam is based on a written examination composed by four sections: A) five True/False questions; B) six Multiple choice question; C) one (out of two) open question; D) six questions on an estimated model. Part A) counts 16,67%, part B) counts 16,67%, part C) counts 16,67%, and part D) 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