

Statistical Methods for Economics

*Ph. D in Economics
Department of Economics
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Syllabus

Statistical Inference: from Data to Models and back F. Dotto

Probability Theory:

Basics of Probability Theory, Random Variables, Transformations and Expectations, Multiple Random Variables. Examples with the R statistical software

Statistical Inference:

Statistical Models for discrete random variables, Statistical Models for continuous random variables, Statistical Models for Continuous Random Variables; Delta Method.

Likelihood Function MLE estimators, Asymptotic properties of Estimators, Confidence Intervals, Test.

R programming for statistical inference

Basics for R programming: vectors, matrices, data frame, lists, own defined functions.

Basic R functions

R for statistical inference: computing confidence intervals with R and statistical tests.

Basics of data simulation and parallel computing.

Optimizing a function in R: define and optimize the likelihood function

Statistical Linear Modelling F. Solari

Linear Model

Matrix formulation of the linear model, partial correlation coefficients, geometry of least squares, inference, restricted and unrestricted regression, prediction, error specification, model evaluation and diagnostic tests, tests for parameter constancy, tests for structural change.

Time Series Analysis

First-order and higher-order difference equations, stationary ARMA processes, forecasting techniques.

Panel Data Models

Fixed effects models, random effects models, models with specific variables and both individual and time-specific effects.

Relaxing the Linear Model Assumptions

Linearity

Visual diagnostics, nonlinearity tests, model augmentation: polynomial regression, transformations, spline functions.

Homoscedasticity

Graphical detection and tests for heteroscedasticity; remedies: transformations, weighted least squares, robust regression.

Independence

Visual inspection and tests for autocorrelation; estimation with autocorrelated disturbances: time series models, panel data models, generalized least squares.

Normality

Visual diagnostic tools and hypothesis tests; solutions: data transformations, robust regression, resampling methods, generalized linear models.

Multicollinearity

Detection: correlation matrices, variance inflation factors, tolerance values, condition indices and eigenvalues; remedies: principal component analysis, ridge regression, lasso regression.

R Programming for Statistical Modelling and Assumption Relaxation

R packages and functions for model estimation (linear models, generalized linear models, linear

mixed models, time series models, panel data models), hypothesis testing and model diagnostics, tools for checking and addressing violations of model assumptions.

Suggested Books

Agresti A., Kateri M. (2022), *Foundations of Statistics for Data Scientists, With R and Python*, Routledge Taylor&Francis Group.

Casella G., Berger R. L. (2002), *Statistical Inference*, 2nd Edition, Duxbury Advanced Series in statistics and decision sciences.

Dalgaard P. (2008), *Introductory Statistics with R*, Springer.

Hamilton J. D. (1994), *Time Series Analysis*, Ed. Princeton.

Lütkepohl H. (2005), *New Introduction to Multiple Time Series Analysis*, Springer.

Magnus J. R., Neudecker H. (2019), *Matrix Differential Calculus with applications in statistics and econometrics*, 3th Edition, John Wiley & Sons.

Wooldridge J. M. (2002), *Econometric Analysis of Cross Section and Panel Data*, MIT Press