UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Statistics for Finance - 1

2627-2-E1808M009-T1

Learning objectives

Knowledge and understanding
This course provides a rigorous and systematic introduction to regression analysis, probability theory, and statistical inference. The primary goal is to equip students with the conceptual framework and essential quantitative tools to support logical-scientific reasoning and decision-making under uncertainty.
Upon completion of the course, students will have acquired:

- The probabilistic foundations necessary to model random phenomena.
- The formal logic underlying parameter estimation and hypothesis testing.
- A theoretical understanding of linear regression models (simple and multiple) as a tool for analyzing relationships between variables.

Applying knowledge and understanding
All the methods covered in this course are accompanied by examples illustrating their applications in economics and finance. Students will develop the skills to:

- Formulate statistical models suitable for describing and forecasting simple economic phenomena.
- Handle real-world datasets, measuring the impact of specific variables (e.g., the effect of marketing spending on sales or the assessment of financial risk).
- Correctly apply inferential techniques to draw valid conclusions about the entire population from sample data.

Making judgements
Students will learn to critically evaluate the results of analyses based on the methods taught and question the underlying assumptions. The course aims to transform students from "formula executors" to critical analysts. Students will learn not to passively accept the output of their calculations, software, or reports, but will develop the ability to critically evaluate the validity of their results..

Communication skills

Students will learn to communicate the results of analyses based on the methods they have learned using rigorous, simple, and clear language. Knowing how to conduct rigorous analysis is meaningless if it is not conveyed. Students will acquire the ability to communicate the results of the models they have learned by combining scientific rigor, simplicity, and clarity.
Specifically, they will be able to:

- Translate complex technical concepts (such as p-values, confidence intervals, or regression coefficients) into strategic insights and practical recommendations that are accessible to even a non-specialist audience (e.g., managers or clients).
- Use formal and appropriate statistical language when engaging with other analysts.
- Present data in a visually effective manner through the appropriate use of graphs and summary tables.

Learning skills
Students will be encouraged to independently expand their theoretical knowledge should they need it to address problems not covered in the course. The course aims not only to provide immediate knowledge, but also to lay the methodological foundation for ongoing self-study. Students will develop the autonomy needed to:

- Independently extend their skills to more complex and advanced statistical models (e.g., time series, nonlinear models, machine learning techniques) when required by their professional or research context.
- Critically consult statistics manuals, scientific literature, and data analysis software documentation.
- Flexibly adapt the methodologies learned to new and unconventional empirical problems.

Contents

The first part of this course is about regression analysis based on the least squares method. This part introduces widely used methods and descriptive statistics and illustrates applications in economics and finance.

The second part of this course deals with the modeling of stochastic phenomena. This part introduces probability theory according to Kolmogorov's axiomatic approach as well as basic concepts such as random variables, distributions, quantiles, joint distributions, expected value, variance, covariance, moments and moment generating functions. Some well known distribution families will be introduced too (Bernoulli, hypergeometric, binomial, trinomial, multinomial, geometric, negative binomial, Poisson, exponential, gamma, normal, lognormal and Pareto).

The third and final part of this course deals with statistical inference. It introduces basic concepts such as population, random sample, estimator and point estimate. Confidence intervals for means and proportions are also discussed. The course concludes with a brief introdution to statistical hypothesis testing.

Detailed program

First part:

- Regression analysis: definition and aims
- Description of the main steps in a regression analysis: data preparation, the choice of a class of functions, the choice of a loss function, evaluation of the goodness of fit, interpretation of the regression function and hints about the range of applications.
- The least squares method and least squares regression lines
- Properties of residuals of least squares regression lines
- The deviance decomposition
- The coefficient of determination

- The linear correlation coefficient
- Interpolation with power functions
- Least squares regression planes
- Properties of residuals of least squares regression planes
- The deviance decomposition for the least squares interpolation plane
- The coefficient of determination of the least squares interpolation plane
- The coefficient of multiple correlation
- Partial correlation coefficients

Second part:

- The three main interpretations of probability: classical, frequentist and subjective
- Kolmogorov's axioms
- Classes of events, fields and sigma-fields
- The basic laws of probability
- Basic concepts of combinatorics
- Conditional probability, (global) independence, total probability law and Bayes' theorem
- Random variables, distribution functions, probability mass functions, density functions and quantiles
- Joint distribution functions, (globally) independent random variables, joint probability mass functions, conditional probability mass functions, joint density functions
- Expected value, variance and covariance
- Widely used discrete distributions: Bernoulli distributions, hypergeometric distributions, binomial distributions, trinomial distributions, geometric distributions, negative binomial distributions and Poisson distributions
- Widely used continuous distributions: exponential distributions, gamma distributions, normal distributions, lognormal distributions and the Pareto distributions
- Moments and moment generating function as a tool for simplifying proofs.

Third part:

- Estimation problems, sample random variables, estimators
- Mean square error, unbiasedness, efficiency and consistency
- Sample mean, sample proportion and the sample variance
- Confidence intervals for means and proportions
- Introduction to statistical hypothesis testing

Prerequisites

Basic knowledge about mathematics and statistics.

Teaching methods

56 hours of frontal lessons (each lesson is of either 2 or 3 hours) and 12 hours of interactive exercise lessons.

Assessment methods

The exam is written and oral. The oral exam takes place some days after the written one. The oral and written exams contribute to the final grade in the same way.

In the written exam students are required to answer two open questions and to solve four exercises. The open questions test students' ability to explain the relevance of the course contents. Exercises test students' ability to solve concrete problems. These include simple questions that require the application of specific principles, or questions that require analyzing a phenomenon and rationalizing it through the combination of multiple analytical methods. The oral exam is an open conversation about the course contents.

Students can choose to split the written exam into two parts which take place towards end of April (the first part) and concomitantly with the regular exam sessions of June or July (the second part). Both written parts are made up of one open question and two exercises. Student who choose to split the written exam are required to take just one oral exam which takes place after the second written part.

Textbooks and Reading Materials

Lecture notes

M. Zenga “Metodi statistici per l’Economia e l’Impresa”, Ed. Giappichelli; 1994
M. Zenga “Modello probabilistico e variabili casuali”, Ed. Giappichelli, 1995;
M. ZENGA, Elementi di Inferenza, Vita e Pensiero;
S.M. ROSS, Introduzione alla Statistica, Apogeo 2008, (solo capitolo 9)

Semester

Second semester.

Teaching language

Italian

Sustainable Development Goals

QUALITY EDUCATION