UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Introduzione alle Serie Storiche M

2526-1-F8206B008

Learning objectives

The course is offered to students enrolled in the first year of the Master's Degree in Statistical and Economic Sciences (CLAMSES). The course contributes to the achievement of the educational objectives of the CLAMSES degree program in the area of Economic Statistics and Econometrics.

As this course is designed to serve as an introduction to the subject, it may be appropriate for students interested in pursuing a statistical analysis of time series and who have a fundamental understanding of descriptive statistics, probability calculus, and inference.

For students currently enrolled to CLAMSES: the course is offered to those who have obtained a bachelor's degree in a field other than statistics and econometrics/empirical economics. As an introductory course, it provides the knowledge necessary to adequately understand the content of compulsory courses offered in subsequent periods of the master's program (e.g., Economic Time Series M and Economic Statistics M). Therefore, it is recommended that students complete this course prior to attending subsequent exams.

Students not formally registered in the CLAMSES program are hereby informed that this course is designed to serve as an introductory module on the analysis of time series from a statistical point of view. Prospective participants are encouraged to enroll in the module and to consider incorporating its content as part of their academic program. It should be noted that, given the nature of this course as a master's degree program, prerequisite knowledge of descriptive statistics, probability calculus, inference, and linear algebra is essential. Students who lack these skills, or only possess a subset of them, may request supplementary materials to facilitate their learning and ensure they acquire the necessary competencies.

The two primary objectives of the course are as follows:

1. To introduce students to the fundamentals of linear regression models and econometric methods for time series data
2. To introduce students to the analysis of univariate time series using methods derived from "classical" and "modern" econometric statistics. The course begins with an examination of the fundamentals of discrete-

time stochastic processes and progresses to address the following topics: exploratory statistical analysis for time series data, the identification and modeling of structural components (trends, seasonality, cycles, and structural breaks), Seasonal Auto-Regressive Integrated Moving Average (SARIMA) models, and regression models for time series data.

The methods introduced during the lectures will be applied to analyze real data and empirical case studies for both interpretative and predictive purposes in socio-economic, energy, and environmental phenomena through the use of appropriate statistical software.

The combination of theoretical concepts and empirical applications (with software) will enable students to improve their analytical skills and knowledge of various application contexts, as well as their problem-solving skills when faced with real case studies. With respect to soft skills, students will have the opportunity to enhance their critical and judgmental abilities by integrating their understanding of diverse application contexts with a data-driven and quantitative perspective.

Contents

The summary contents (macro-themes) of the course are as follows:

1. Insights and key concepts on economic, social, environmental, and energetic time series
2. Introduction to stochastic processes for temporal data
3. Introduction to linear regression models (assumptions, estimation methods and interpretation) with emphasis on temporal data
4. Exploratory analysis (EDA) for temporal data
5. Identification and modeling of time series structural components (decomposition)
6. Seasonal Auto-Regressive Integrated Moving Average (SARIMA) models

Detailed program

The detailed contents of the course are as follows:

1. Insights and key concepts on economic time series (taxonomy of time series concepts, observable and unobservable components)
2. Recalls on linear models and linear regression (Gauss-Markov Theorem, parameter estimation with OLSE/MLE, diagnostic tests and hypothesis violations)
3. Introduction to stochastic processes (definition, properties and examples) and recall of probability for time series: autocovariance functions and autocorrelation
4. Exploratory analysis (EDA) for time series: graphical analysis, indexes and tests on the characteristics of data, trend analysis (parametric and nonparametric linear models), seasonality analysis (harmonic regression), Box-Cox transformation and heteroschedasticity in time series
5. Stationarity, unit roots, ADF tests, differentiation
6. Classical decomposition of time series: additive and multiplicative models
7. Wold's theorem and genesis of AR, MA and ARMA processes.
8. Stationary processes and ARMA models: identification, parameter estimation, diagnostic tests, prediction theory
9. Integrated processes and ARIMA models.
10. Seasonal processes and SARIMA models.
11. Linear regression models with ARIMA errors (regARIMA).

Prerequisites

There are no formal prerequisites, but it is expected that the student possesses a minimum knowledge of descriptive statistics, probability calculus (random variables), statistical inference and linear algebra (matrix calculus).

Teaching methods

The course provides 6 ECTS (of which, 5 are frontal teaching and 1 laboratory), corresponding to 47 hours sudvided as follows:

- In-presence frontal teaching (modalità erogativa) for theoretical content: about 31 hours
- In-presence laboratory class with R statistical software for the analysis of real case studies: about 6 hours
- Remote (syncro) laboratory class with R statistical software for the analysis of real case studies: about 10 hours

Assessment methods

Students will be evaluated by:

1. Development of an individual project covering most of the topics covered in the course. The case study on real empirical data should be coordinated (and periodically validated) with the lecturer. Weight: 50% of the final grade.
2. Individual Assignment in which each student must answer 2 theoretical questions drawn from a pre-defined pool. The questions will be completed unsupervised (at home) and will then be commented on at the oral exam. Weight: 15% of the final grade.
3. Oral examination in which the project, assignment questions, and additional questions on the content covered in the course will be exposed. Weight: 35% of the final grade.

Textbooks and Reading Materials

1. Slides and further materials from the lecturer
2. Essential textbooks

- Theory (with same notation used in the slides) on time series: "Time series analysis - Univariate and Multivariate Methods" (William W.S., 2006), 2nd ed
- Applications with R and recall on theory: "Forecasting: principles and practice" (Hyndman and Athanasopoulos, 2018), 2nd or 3rd ed
- Linear regression and linear models: "Modello Lineare - Teoria e applicazioni con R" (Grigoletto et al., 2017), 1st ed

3. Adavanced textbooks

- "Time series analysis and its applications" (Shumway and Stoffer, 2017), 4th ed.

Semester

I semester, II cycle

Teaching language

Italian

Sustainable Development Goals

QUALITY EDUCATION