Universitat Autònoma de Barcelona

2019/2020

Quantitative Methods

Code: 40094
ECTS Credits: 15

Degree	Type	Year	Semester
4313805 Economic Analysis	OB	1	1

Contact

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Use of Languages

Principal working language: english (eng)

Teachers

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Prerequisites

There are no specific prerequisits.

Objectives and Contextualisation

This module provides students advanced quantitative tools. These tools are necessary for economic analysis. This module covers optimization, and probability, statistics . The module is organized in two sections. The first section covers the foundations of optimization theory. The second section provides students with the theoretical foundations of probability and statistics necessary for econometric and financial analysis.

Competences

- Capacity to articulate basic economic theory, analytically deriving them from mathematical reasoning
- Capacity to identify basic statistical analysis and econometric techniques deriving them from the laws of probability and statistics
- Conceptually analyse a specific economic problem using advanced analytical tools
- Possess and understand knowledge that provides a basis or opportunity for originality in the development and/or application of ideas, often in a research context
- Student should possess the learning skills that enable them to continue studying in a way that is largely student led or independent

Learning Outcomes

1. Describe statistical topics on which stochastic economic analysis and empirical analysis is based

2. Distinguish the element to be included and the necessary assumptions for proposing a decision-making problem with very simple strategic interactions
3. Framing an economic question of decision within a strategic context in simple math problem and derive its response through mathematical logic
4. Possess and understand knowledge that provides a basis or opportunity for originality in the development and/or application of ideas, often in a research context
5. Student should possess the learning skills that enable them to continue studying in a way that is largely student led or independent
6. Use of mathematics to analyse economic problems

Content

I. Optimization

1. Sets and Metric Spaces:

1) Ordered Sets (Equivalence Relations, Order Relations, Partially Ordered Sets, Weakly Ordered Sets)

2) Metric Spaces (Open and Closed Sets, Convergence)

2. Functions and Correspondences:

1) Monotonicity

2) Continuity

3) Fixed Point Theorems (Tarski, Banach, Brower)

3. Linear Spaces and Linear Algebra:

1) Subspaces

2) Basis and Dimension

3) Affine and Convex Sets

4) Normed Linear Spaces

5) The determinant

6) Systems of Linear Equations

4. Smooth functions, Optimization and Comparative Statics:

1) Linear Approximation and the derivative

2) Mean Value Theorem

3) Unconstrained Optimization, Equality and Inequality constraints

4) Envelope Theorem

5. Difference and Differential Equations:

1) Types and Solution concepts

II. Probability and Statistics

1. Probability

Combinatorics. Events and measurable spaces. Probability. Conditional probability. Theorem of total probability. Bayes' theorem.

2. Measure Theory

Lebesgue measure. Lebesgue-Stieltjes measures and distribution functions. Measurable functions. Integral with respect to a measure. Absolute continuity of measures and the Radon-Nikodym theorem. Product measures and Fubini's theorem.

3. Random Variables and Distributions

Random variables. Probability distributions. Distribution functionof a random variable. Discrete random variables and probability functions. Absolutely continuous random variables and densities. Random vectors and marginal distributions. Independent random variables. Generalized conditional probability and distribution.

4. Expectation

Mathematical expectation. Moments. Chebyshev's inequality. The moment-generating function of a random variable. Product moments. Mean and variance of linear combinations of random variables. Conditional expectation. The law of iterated expectations. Jensen's inequality.

5. Special Distributions

The discrete uniform, Bernoulli, binomial, Pascal, geometric, and hypergeometric distributions. The multinomial and multivariate hypergeometric distribution. Integration by parts and by change of variable to polar coordinates. The uniform, gamma, exponential, chi-square, and beta distributions. The normal and the multivariate normal distributions.

6. Functions of Random Variables

The distribution of a function of a random variable. The probability function of a function of a random variable. The density of a function of a random variable. Characteristic functions, moment-generating functions, and Laplace transforms of functions of random variables.

7. Stochastic Processes and Limiting Distributions

Stochastic processes. Filtrations and martingales. Markov processes. Convergence in probability, in mean square, in distribution, and almost sure convergence. Convergence of distribution functions and of probability measures. The Poisson distribution as the limit of binomial distributions. The standard normal distribution as the limit of standardized binomial distributions. Laws of large numbers. The central limit theorem.

8. Sampling

Random samples and statistics. The distribution of the sample mean. The distribution of the variance of a random sample from a normal population. The *t* distribution. The *F* distribution.

9. Estimation

Point estimation. Efficiency of estimators. The sample mean and sample variance as unbiased estimators. The Cramér-Rao lower bound for unbiased estimators. Asymptotic properties of estimators: consistent estimators. Sufficient estimators. The method of moments. Maximum likelihood estimation. Bayesian estimation. Interval estimation.

10. Hypothesis Testing

Statistical hypotheses and their tests. The power function of a test. The Neyman-Pearson lemma. Likelihood ratio tests. Acceptance intervals. The *p*-value.Contingency tables. Goodness of fit.

Methodology

• Theory classes

• Practical classes

• Learning based on problem solving

• Tutorials

• Personal study

• Study groups

• Textbook reading

• Article reading

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Problems sets, tutorials	112.5	4.5	1, 2, 3, 5, 4, 6
Theory classes	112.5	4.5	1, 2, 3, 5, 4, 6
Type: Autonomous			
Personal study, study groups, textbook readings, article readings	150	6	1, 2, 3, 5, 4, 6

Assessment

Final Exams 50%

A module consists of different courses which are evaluated through final exams, problem sets and assignments and other class activities sucha as class attendance, presentations, etc.

Class attendance and active participation 20%

Problem sets and assignments 30%

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Class Attendance and Problem sets and assignments	50%	0	0	1, 2, 3, 5, 4, 6
Final Exams	50%	0	0	1, 2, 3, 5, 4, 6

Bibliography

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DeGroot, M.H. and Schervish (2012), M.J., Probability and Statistics, Pearson.
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