Level: bachelor

Course title: Econophysics

Status: elective

ECTS: 6

Requirements: Mathematics III, Statistical physics

Learning objectives

Acquiring the basic knowledge in stochastic calculus and learning the methods of statistical physics used in economy.

Learning outcomes

After taking the course, the student should have developed:

General abilities: basic knowledge of this field, following the literature, analysis of various solutions and the choice of the most adequate solution, application in practice and other subjects**.**

Subject-specific abilities:

- basics of economic theory, capital markets and financial institutions;
- basics of stochastic processes and stochastic calculus which is used in econophysics;
- application of the models and methods of statistical physics used in econophysics.

Syllabus

Theoretical instruction

Brief history of development of economic theory, capital markets and financial institutions. The basic concepts of microeconomics: preferences and utility function, supply and demand, Walrus equilibrium, welfare theorems and Pareto optimum, financial balance, behaviour under uncertainty. Risk and return. Portfolio theory of the average value and variance. CAP model and factor models. Derivatives. Market efficiency. Models of asymmetric information. Mathematical basis (sigma, algebra, measure, event space, Borel sigma algebra and Lebesgue measure, measurable mapping, random variable, the statistical moments of random variables, random vectors, the basic inequalities of probability theory and concepts of convergence, independence of random variables, conditional probability and the conditional expected value, limit theorems, Lebesgue integral, martingales in discrete and continuous time, martingale measure). Stochastic processes. Standard and generalized Brownian motion. Stochastic integral. Ito lemma. The fundamental partial differential equation for options evaluation. Black-Scholes-Merton formula for European options. Kolmogorov equation. Heat transfer equation. Feynman-Kac theorem. Models of interest rates time structure. Neural networks. Connectivity networks. Selforganized criticality. Complex systems and the scaling laws (Gibrat’s law of distribution companies by size, logistic law of growth and diffusion, Pareto’s law of wealth distribution, Mandelbrot’s self-similar stochastic processes, 1/f scaling in economics, reproduction of empirical laws of financial markets). Adaptive and evolutionary learning. Minority game. Genetic algorithms in the economy. Cellular automata. Ising models. Spin glass models.

Practical instruction

Homework and seminars.

Weekly teaching load				Other:
Lectures: 3	Exercises: 1	Other forms of teaching: 1	Student research:	