ECONOPHYSICS

Program: "Interregional Cooperation at Scientific Computing in Interdisciplinary Science" – ICoSCIS – B2 – 3.3

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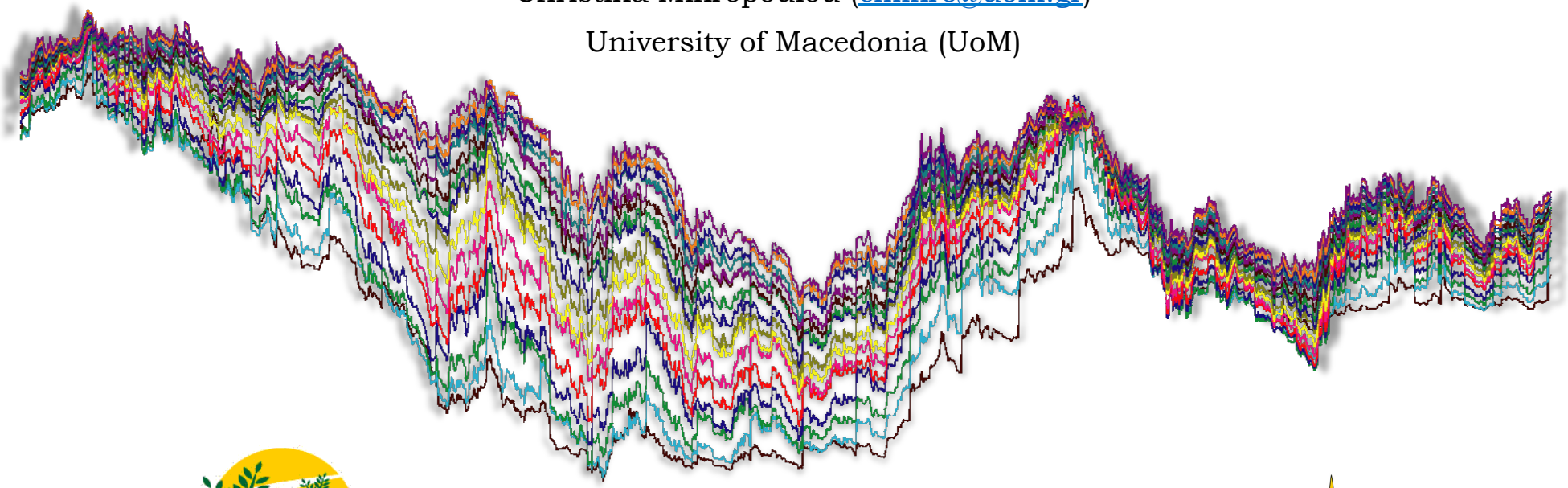

European Territorial Cooperation Programme
Greece-Bulgaria 2007-2013
INVESTING IN OUR FUTURE

European Territorial Cooperation Progamme
Greece - Bulgaria 2007 - 2013
This Project is co-funded by the European Union (ERDF)
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HELLENIC REPUBLIC
UNIVERSITY OF MACEDONIA

Theoretical Framework

Why Econo(mics)physics?

- Similarities between Physical & Economical Systems
- Notions & Methods from Physics in Economics
- Complexity & Fractality

Efficient Market Hypothesis & Limitations

- Introduction to Efficient Market Hypothesis (EMH)
- Stylized facts
- Limitations of the mainstream approach

Heterogeneity

- Homogeneity vs. Heterogeneity: Related topics
- Behavioral Finance
- Agent-based modeling

Financial Risk

- New considerations about Volatility
- Types of risk
- Bubbles and Crashes

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Quantitative Methods

Introduction to Applied Econometrics

- Stationarity
- Descriptive statistics
- (Auto)Correlation

Measuring Financial Market Inefficiencies

- Volatility study
- GARCH models

Heterogeneous structures

- Fractal analysis
- Trading strategies
- Feedback

Quantifying Financial Risk

- Risk assessment tools
- Efficient frontier
- Causality & Feedback

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Short description

The courses deal with both traditional and interdisciplinary approaches about the operation of the markets, asset management and investors' behaviour. Special attention is given on alternative interpretations of the financial turbulences and the possibilities of designing efficient economic strategies during fragile periods, by using notions and methods drawn from physical sciences (Physics, Biology, etc) and time series analysis.

Objective: bridge the gap between mainstream Economics and the Science of Complexity.

Short description

Goal: Introduction and general overview of Econophysics.

The way that information is disseminated, the behaviour of investors, the nature of speculation and the specific characteristics of shocks hitting the markets raise several questions concerning the efficiency of the mainstream approaches. According to Efficient Market Hypothesis (EMH), the market constantly fulfils investors' expectations and absorbs instantly incoming news. However, as recent experience brought into light, the aforementioned mechanisms induce more complex structures and drive prices away from their fundamentals.

Short description

The current availability of huge amounts of financial and economic data permit us to study, in detail, the underlying dynamics of the data generating processes.

Several examples and applications will be demonstrated to equip the participants with new tools and techniques that can be widely used on the time series analysis.

Some notions that will be introduced are:

- Statistics & Distributions
- Correlations & Scaling behaviors
- Linear & Nonlinear Modelling
- Causality

Datasets: Standard & Poor's 500 market index, US stock daily prices, Gold, Crude oil, International stock market indices, Commodities.

Team

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Associate Researcher at Univ. of Strasbourg (BETA) & Univ. of Paris 10 (EconomiX) & ISC-Paris

Research Interests: Macrofinance; Financial Instability; Quantitative Methods; Nonlinear Analysis; Energy Markets; Behavioral Finance; Interest rate dynamics; Agent-based Approaches; Economic Complexity and Policy

ICoSCIS position: Scientific Responsible

Michalis Maragkakis

Postdoctoral Researcher at Department of Physics – Aristotle University of Thessaloniki

Research Interests: Complex Science; Applications of networks in complexity science; C programming; Solid State Physics; Computational Physics

ICoSCIS position: Senior Researcher and Manager

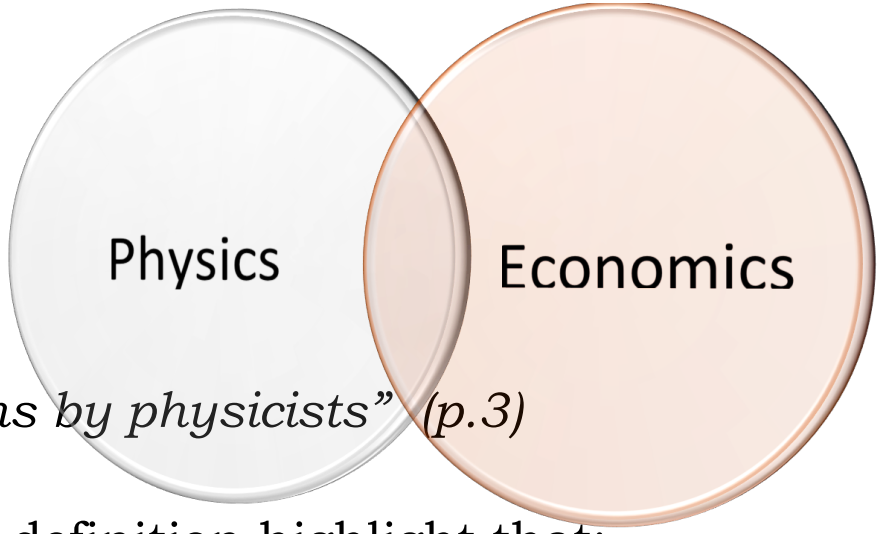
Christina Mikropoulou

PhD Student at Department of Economics - University of Macedonia

Research Interests: Financial Markets; Macroeconomy; Econometrics; Complexity; Behavioral Economics

ICoSCIS position: Junior Researcher

Why Econo(mics)physics?
Definitions



Bertrand Roehner (2005) defines it simply as:

"the investigation of economic problems by physicists" (p.3)

Mantegna and Stanley (2000) in a less general definition highlight that:

"The word econophysics describes the present attempts of a number of physicists to model financial and economic systems using paradigms and tools borrowed from theoretical and statistical physics" (p. 355).

The term "econophysics" is widely used (since 90s) to denote a new field of interdisciplinary research, where methodologies and tools from Physics, mainly Statistical Physics and dynamic systems, applied to solve several financial puzzles.

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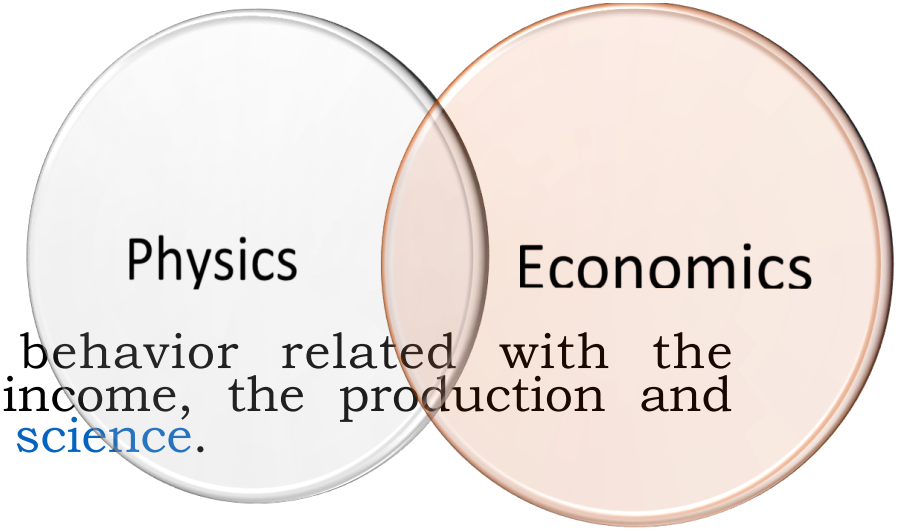
Why Econo(mics)physics?

From Physics to Economics



Economics is a subject about human behavior related with the management of the resources, finances, income, the production and consumption of goods and services. A social science.

Physics tries to construct a picture of the movement of the whole nature. Mechanism is the first topic cared by physicists. A natural science.

First steps in Econophysics: the hybrid

- describe and understand the phenomena appeared in Economics using "Physical tools"
- empirical studies of different phenomena to discover some universal or special laws
- construct models and mechanism

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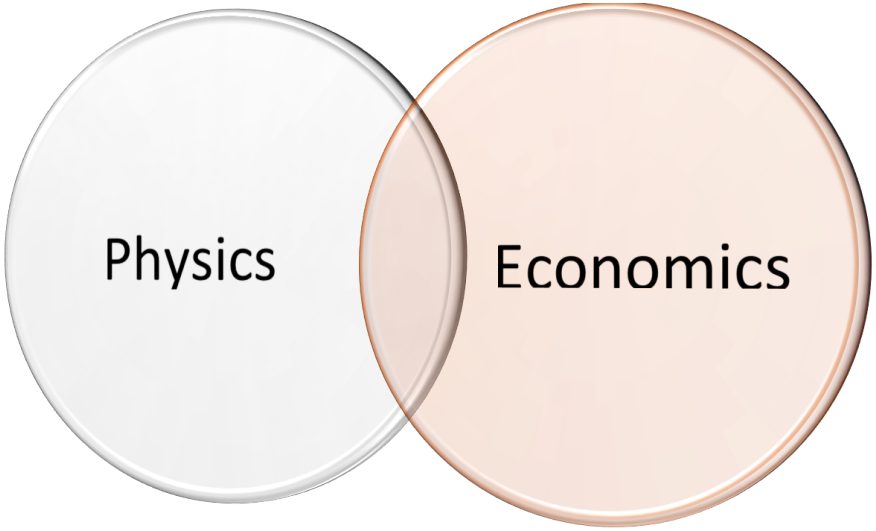
Why Econo(mics)physics?
Names and Keywords



Names

- ✓ Vilfredo Pareto (1897)
- ✓ Louis Bachelier (1900)
- ✓ Copernicus (1526)
- ✓ Daniel Bernouli (1738)
- ✓ Laplace (1812)
- ✓ Newton (1669 – 1701)
- ✓ Halley (1963)
- ✓ Mandelbrot (1963)

Keywords

- ✓ Emerging behaviors
- ✓ Power-law distribution
- ✓ Heterogeneity
- ✓ Self-similarity
- ✓ Phase transitions

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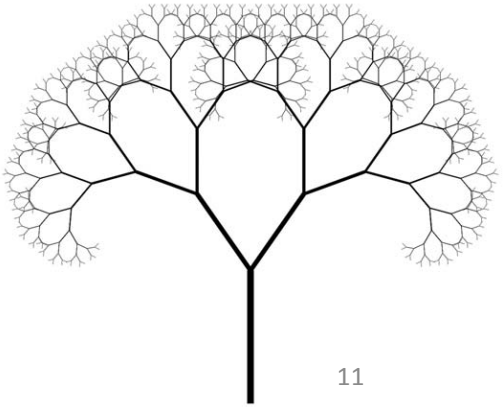
Why Econo(mics)physics?
Chaos and Fractality

Chaos theory has shown that unpredictable time series can arise from deterministic nonlinear systems.

Fractals:

- Geometrical objects generally with non-integer dimension
- Self-similarity (contains infinite copies of itself)
- Structure on all scales (detail persists when zoomed arbitrarily)

Nowadays, studies of chaos, self-organized criticality, cellular automata and neural networks are seriously taken into account as economical and financial tools.



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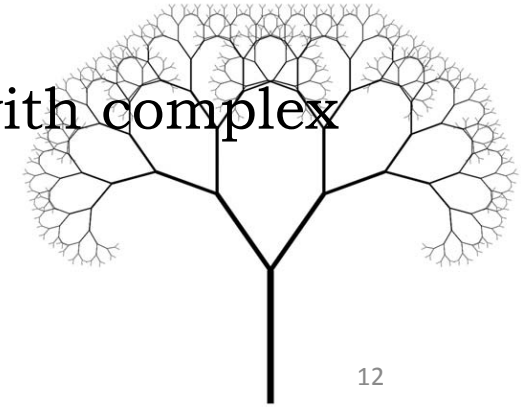
Why Econo(mics)physics?
Complexity in Economics

Economy is a rather populated environment including individuals, firms, countries, goods, and subsystems as financial system, manufacturing, agriculture, service industry.

- ✓ All of them interact with each other and produce an outcome.
- ✓ A general way to describe such a system is Complex Networks.
- ✓ Stock markets share several characteristics with complex systems.



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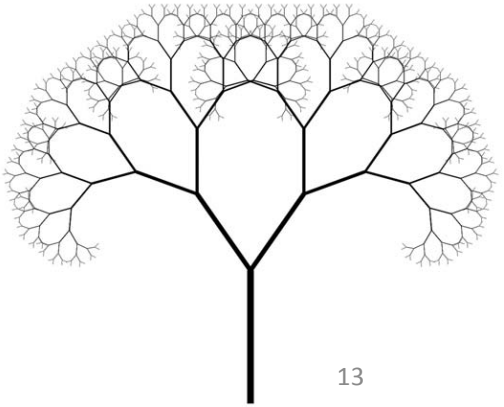
Why Econo(mics)physics?
Complexity in Economics

A system is complex when:

- It is open (can be affected by both internal and external perturbations).
- Have many components that affect with each another (interact nonlinearly in the presence of feedback).
- Its components are nonlinearly connected.
- Exhibit positive feedback dynamics.



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Why Econo(mics)physics?

Comparison between Physical and Economical systems

Financial Markets

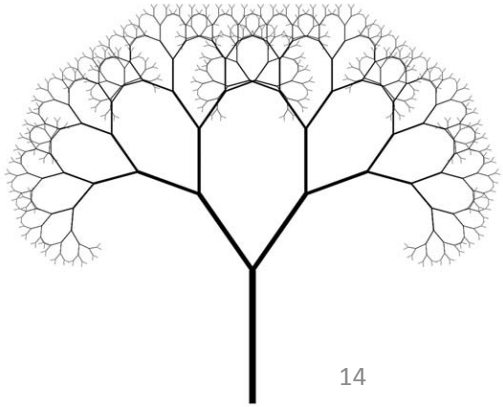
i. power-law distributions,
ii. correlations,
iii. scaling,
iv. unpredictable time series, and
v. random processes

Statistical Physics

i. phase transitions,
ii. statistical mechanics,
iii. nonlinear dynamics, and
iv. disordered systems

Stanley et al. (1999, p.157):

> *"…in contrast to standard economics, econophysicists begin empirically with **real data** that one can analyze in some detail but **without prior models**…"*



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An non-exhaustive list…

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"an anomaly is a deviation from the presently accepted paradigms that is too widespread to be ignored, too systematic to be dismissed as random error, and too fundamental to be accommodated by relaxing the normative system".

Tversky and Kahneman (1986:252)