Physics 255 Econophysics

Statistical Physics of the Financial Markets

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Econophysics is the application of ideas from statistical mechanics to the financial markets. Markets are complex self-adapting systems that are observed to undergo sudden transitions such as "booms" or "bubbles" and "busts" or "crashes". Transitions in system dynamics are associated with the nucleation and growth of fluctuations, together with a threshold in the state space of the system. Markets are also observed to obey scaling dynamics, an interesting example being the existence of the Pareto distribution of wealth among populations. In this course, we will introduce the dynamics of markets from a physics and systems perspective. We will discuss specific markets such as the equity stock markets (NYSE/Euronext, NASDAQ), the fixed income (bond) markets (Government and Municipals), and the commodities markets (CME and Futures). We will discuss time-dependent models for equity valuations such as the Black-Scholes equation that are used in options pricing (Black Scholes is actually a diffusion equation). We will also discuss stability and scaling of markets using ideas from the theory of phase transitions, nucleation and critical phenomena. We will discuss current ideas about agent-based simulations, the blockchain, and other recent models and innovations. Students will be expected to contribute actively to discussions, as well as complete a project using financial data and the models and analysis discussed in the course. Familiarity with some form of computer programming is mandatory.

Structure of Classes

Classes will involve both lectures and seminar-type discussions. Grades will be based on:

Class Participation	10%
Final Project	50%
Homework assignments	40%

Texts and Readings:

1. Sitabhra Sinha, Arnab Chatterjee, Anirban Chakraborti, and Bikas Chakrabarti, Econophysics, An Introduction, Wiley-VCH, Weiheim, 2011. ISBN 978-3-527-40815-3.
2. Rosario N. Mantegna and H. Eugene Stanley, *An Introduction to Econophysics, Correlations and Complexity in Finance*, Cambridge University Press, Cambridge, UK, 2000. ISBN 978-0-521-03987-1
3. Philip R. Bevington and D. Keith Robinson, *Data Reduction and Error Analysis for the Physical Sciences*, McGraw-Hill, NY. 2003. ISBN-13: 978-0-07-247227-1
4. Dietrich Stauffer and Amnon Aharony, *Introduction to Percolation Theory*, CRC Press, NY ISBN: 0-7484-0253-5