Phenomenology and modelling of financial markets

Michael Benzaquen – Ecole Polytechnique / CNRS

Course : 18 hours - TP : 0 hours

Objectives

The objective of this course is to present the financial markets from the point of view adopted by physicists over the last fifteen years. The topics covered overlap, of course, with those of financial mathematics and econometrics, but the methodology and highlights are different. Rather than a rigorous formalism, the aim is to develop intuition about orders of magnitude, phenomena and models, links with market practice, and open problems.

Outline

- **Financial market phenomenology and statistical models** - Different markets; characteristic times, overnight, intraday. Statistical description: distribution of returns, jumps and heavy tails, skewness and kurtosis, Student's Law. Independent returns and central limit theorem. Stochastic volatility, GARCH, long memory and abnormal kurtosis. Leverage effect and abnormal skewness. Synthesis: Multifractal model, advantages and limitations, time reversal invariance, multi-scale GARCH model.
- **Correlations and multivariate models** - Multivariate normal distribution, correlation matrix, portfolio theory, residuals. Random matrices, Wishart set, Marcenko-Pastur's law and generalization, edge of spectrum, Tracy-Widom's law. Asynchronous correlations, Singular values. Multivariate Student's law, maximum likelihood, eigenvalue spectrum. Correlations of extremes, stable multivariate laws. Laplacian correlations: equities and yield curve.
- **Market Microstructure** - Specialist Markets vs. Electronic Markets. Bid-Ask range; classical models, order book and order dynamics. Intraday seasonality. Impact and execution costs. Transitional impact, permanent impact. Micro-efficiency and liquidity "molasses". Impact and volatility; impact and bid-ask spread. Optimal execution profile.
- **Options: beyond Black-Scholes** - The world of Black-Scholes: zero risk and disappearance of drift, two fragile "miracles". Hedging strategies: risk minimisation and other criteria. Pricing options in the presence of non-Gaussian effects: smile theory and residual risk. Monte-Carlo "hedgée" method. Term structure of volatility and skewness. Comparison with options markets. Sticky delta/sticky strike.

Bibliography

- BACRY E., DELOUR J. and MUZY J.F. (2001) : *Multifractal random walk,* Phys. Rev. E 64, 026103.
- BOUCHAUD J.P. and POTTERS M. (2004) : *Theory of Financial Risk and Derivative Pricing*, Cambridge University Press.
- DACOROGNA M., GENCAY R., MULLER U., OLSEN R. and PICTET O. (2001) : *An Introduction to High-Frequency Finance*, Academic Press, London.
- MUZY J.F., DELOUR J. and BACRY E. (2000) : *Modelling fluctuations of financial time series: from cascade process to stochastic volatility model,* Eur. Phys. J. B 17, 537-548.
  Les articles accessibles sur www.cfm.fr (en particulier sur les matrices aléatoires et la microstructure).