

Lévy Processes and Applications

Master Programme in Mathematical Finance

2019/2020

1 - Introduction

- 1.1. Main concepts
- 1.2. Main applications
- 1.3. Brief history

2 – The imperfections of the Black-Scholes model

- 2.1. The empirical distribution of returns
- 2.2. The implied volatility

3 – Lévy processes: definition, basic properties and examples

- 3.1. Infinitely divisible distributions
- 3.2. The Lévy measure
- 3.3. The Lévy-Khintchine formula
- 3.4. Stable distributions
- 3.5. Lévy processes - definition
- 3.6. Lévy processes – basic properties
- 3.7. Stable processes
- 3.8. Subordinators

4 – Stochastic calculus for Lévy processes

- 4.1. Poisson random measures
- 4.2. Poisson integrals
- 4.3. The Lévy-Itô decomposition
- 4.4. Stochastic integrals with respect to semimartingales
- 4.5. Stochastic integrals of Lévy-type
- 4.6. Itô formula for Poisson integrals and Lévy-type integrals
- 4.7. Stochastic exponentials
- 4.8. Exponential martingales
- 4.9. Martingale representation Theorems

5 – Lévy processes in mathematical finance

- 5.1. Change of measures and Girsanov Theorem
- 5.2. Lévy processes in asset pricing models
- 5.3. Incomplete markets, equivalent martingale measures and the Esscher transform
- 5.4. Some Lévy processes: Variance Gamma, NIG, hyperbolic and the CGMY process.

6. Option pricing with Lévy models

- 6.1. Option pricing with Lévy models: basic ideas
- 6.2. Option pricing using the Fourier Transform
- 6.3. Parameter estimation and exotic option pricing
- 6.4. Numerical simulation techniques

6.5. Integro-differential equations for option pricing

6.6. Lévy models with stochastic volatility

Main Bibliography

_Applebaum, D. (2009), Lévy Processes and Stochastic Calculus, 2nd Edition, Cambridge University Press.

_Cont, R. and Tankov, P. (2003), Financial modelling with Jump Processes, Chapman & Hall / CRC Press.

_Guerra, J. (2012), Lecture Notes - Lévy Processes and Applications, Texto didático, ISEG.

Secondary bibliography

_Oksendal, B. and Sulem, A. (2007), Applied Stochastic Control of Jump Diffusions, 2nd. Edition, Springer.

_Papapantoleon, A. (2008), An introduction to Lévy processes with applications in finance. Lecture notes, TU Vienna, 2008, <http://arxiv.org/abs/0804.0482>

_Sato, K.-I. (1999), Lévy Processes and Infinitely Divisible Distributions, Cambridge University Press.

_Schoutens, W (2003), Lévy Processes in Finance, John Wiley & Sons.

Assessment

Group assignment (50%) + Final exam (50%). Minimum grade point at final exam: 8.

At the final exam, the students can bring some notes (up to a maximum of 5 sheets A4 (10 pages)).