Statistical methods for financial models driven by Lévy processes

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Abstract

During the past and this decade, a new generation of continuous-time financial models has been proposed in a quest to incorporate the stylized empirical features of asset prices such as fat-tails, high kurtosis, volatility clustering, and leverage. Lévy and Poisson point processes have become important building blocks in this enterprise. The scope of models goes from simple exponential Lévy models to Stochastic Differential Equations with Poisson jumps both in the volatility and in the price process itself. Several inference methods have been proposed in the literature to deal with these models. In this set of lectures we will review classical statistical methods, such as maximum likelihood using FFT, and some more recent nonparametric methods, including low-frequency methods based on inverse Fourier formulas and high-frequency methods based on realized variations of the process.

Tentative program

1. Background on Lévy processes *(1 lecture):*
   (a) Basic definitions and properties including simulation of Lévy processes.
   (b) Stochastic integration and stochastic calculus for jump processes.
2. A guided tour of financial models driven by Lévy processes *(1 Lecture)*:
   (a) Exponential Lévy models (CGMY, generalized hyperbolic, Rosinski's tempered stable process)
   (b) Time-changed Lévy models
   (c) Stochastic Volatility driven by non-Gaussian Ornstein-Uhlenbeck processes (Barndorff-Nielsen and Shephard).

(d) Sato's self-similar additive process

(e) Semimartingale models with jumps

3. Standard parametric method and their pitfalls *(1 Lecture)*

   (a) Maximum likelihood estimation. Approximation using FFT and short-term asymptotic expansions.

   (b) Methods of moments

4. Nonparametric methods based on low- and high-frequency sampling *(2 Lectures)*

   (a) Methods based on the mutipower variations: Testing for jumps.

   (b) Threshold quadratic variations: Disentangling jumps

   (c) General variations: An application to the non-parametric estimation of the Lévy density

   (d) Low-frequency nonparametric methods

   (e) Discussion about robustness and practicality

   (f) Some methods under the presence of Microstructure noise