Rough volatility financial models

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A growing body of empirical research indicates that volatility fluctuates more rapidly than Brownian motion, which is inconsistent with standard semimartingale models. Fractional volatility models, such as the **rough Bergomi and the rough Heston models**, have emerged as compelling alternatives. Even though tractability can be a challenge for these *non-Markovian, non-semimartingales models*, recent studies have developed numerical methods suitable for their implementation.

The main purpose of this course module is to introduce the numerical techniques necessary for the implementation of rough volatility models and the calibration of their volatility surfaces to market data. In particular, we will focus on the simulation methods for the rough Bergomi model (Cholesky and Hybrid schemes) and the Fourier transform methods for the rough Heston model. For the latter case, we will study the numerical approximation to solutions of convolution equations (Adams method). At the end of the module we will examine how these models can be approximated by high dimensional Markovian models where classical simulation and pricing techniques can be employed. In all cases, we will study the performance of the models through calibration of VIX futures and options prices, as well as index option prices.

The module will be structured as follows:

1. Motivation for rough volatility modeling
2. The Bergomi and rough Bergomi models
3. Simulation of fractional Brownian motion and application to pricing in the rough Bergomi model
4. The Heston and rough Heston models
5. Fourier techniques for pricing in the (rough) Heston model
6. Markovian approximation of rough volatility models and implementation
7. Calibration of rough volatility models to market data on VIX and index derivatives

References: Related material can be found at

https://sites.google.com/site/roughvol/home/risks-1

Prior knowledge: Stochastic analysis, mathematical finance, and numerical finance at MSc level.

Assessment: Written examination and/or projects.