Monte Carlo Calibration to Implied Volatility Surfaces

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Abstract:

The full calibration problem of implied volatility surfaces amounts to solving a high dimensional optimization problem. This paper provides a two-step method to solve this problem in the environment of random volatility. The first step consists of using the recent Fourier transform method (Malliavin and Mancino (2009)) for estimating model parameters of stochastic volatility models under the physical probability measure. The second step aims to solve an optimization problem under a risk-neutral probability measure by means of efficient Monte Carlo methods, including martingale control variate method and randomized quasi Monte Carlo method.

This two-step calibration method is based on stochastic approaches and eligible for dimension separation. Comparing with the fast Fourier transform method (Carr and Madam (1999)) and the perturbation method (Fouque et al. (2003)), our method demonstrates better and robust performances to fit implied volatility curves and surfaces of, for example, S&P 500 index options, known as European type. In addition, it is natural to generalize our calibration procedure to American options. An example of S&P 100 index American option is demonstrated.

Keywords: stochastic volatility model, Fourier transform method, martingale control variate method, model calibration, implied volatility surface

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