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Inverse problems in option pricing: a probabilistic solution via random mixtures of martingales.

The inverse problem of recovering an option pricing model (or *implied* process) from a set of market prices of derivative securities, is usually treated either as an exact inversion in presence of continuum data or by applying deterministic optimization methods to a (regularized) least squares formulation. These methods yield a single set of model parameters fitted to market data and ignore the non-uniqueness of the solution.

We propose a probabilistic construction which takes into account the multiplicity of solutions. Starting from a prior distribution on models and a set of option prices, we construct a random mixture of a set of reference martingales, whose expectation yields an arbitrage-free pricing rule consistent with the observed option prices and whose dispersion properties can be used to quantify model uncertainty. A Monte Carlo algorithm is proposed for computing prices under this model and its limit behavior is shown to possess a dual interpretation in terms of minimization of "model risk". Our approach yields a non-trivial posterior distribution, instead of a single price, for exotic options and allows to simulate from this posterior distribution. A stochastic volatility model with jumps is treated as an example. (Received September 04, 2007)