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Information in Option Prices and the Underlying Asset Dynamics

We jointly estimate stochastic volatility (Heston) model parameters in both the physical and equivalent martingale measures, by exploiting all the information in a broad cross-section of option prices along with the dynamics of the underlying asset, using the exact probabilistic framework of the model. To this end, we derive the necessary joint transition density to draw from the latent volatility process conditioned on the observed returns. We answer questions along two dimensions. First, no study to date has used all the information in the exact transition densities from the stochastic volatility (Heston) model. Second, in the context of efficient estimation, how much of the mispricing may be attributable to parameter and state variable uncertainty? Finally, our metric for assessing the fit of the model is the predictive posterior on the implied volatility smile. Using this metric we assess directly the model's ability to capture the empirical smile, which is an important criterion in evaluating an option pricing model.

For the deep in-the-money, short-term call, parameter and state variable uncertainty give rise to a 90%ile band in the predictive posterior density of the implied volatility of 0.56%. But the data are on average 3.6% away from the predictive posterior density mean. By contrast a slightly in-the-money, intermediate term option has average pricing errors relative to the posterior mean of 0.26%, and parameter and state variable uncertainty imply that the predictive posterior density's 90%ile band width is 0.58% (suggesting an excellent model fit).