Executive Summary

Problem Statement

Since the introduction of the Black–Scholes model, asset pricing models have risen to be essential tools for carrying out hedging strategies and calibrating parameters for the application in pricing complex options. Due to their major importance, many model types have emerged and been analysed thoroughly in the literature. One of the model types consists of pure diffusion stochastic volatility models, which are divided into an affine and a non-affine class. Due to their individual advantages and disadvantages, a debate about which class is more suitable for practical use has occurred. The present thesis analyses non-affine stochastic volatility models with an emphasis on the Inverse Gamma stochastic volatility model. It is primarily compared to the Heston stochastic volatility model throughout the thesis. This contrasting juxtaposition is desired, as it can provide direct evidence in favour of the preference of non-affine stochastic volatility models over their affine counterparts.

Approach

To conduct the analysis of non-affine stochastic volatility models, on the one hand empirical evidence from the literature is gathered and summarized in an overview of existing empirical results. On the other hand, a Taylor expansion is employed to implement the non-affine Inverse Gamma stochastic volatility model in Matlab. The implemented Inverse Gamma model is then applied to market data to substantiate the argumentation in the literature. The parameters of the model are calibrated daily over a sample period of one year to data of European options on the Swiss Market Index using a local optimization algorithm. Additionally, the affine Heston stochastic volatility model is implemented in Matlab, figuring as a benchmark to the Inverse Gamma model. Here, Fourier transforms are employed. The parameters of the Heston model are calibrated to the same data set as the Inverse Gamma model, using the same calibration procedure with local optimization. The resulting pricing performances of the calibrations are then compared to each other across the whole data set for one thing, by five categories of maturity for another thing, and finally, by three categories of moneyness.

Results

There is a lot evidence in the literature clearly favouring non-affine stochastic volatility models over their affine analogues. The main arguments put forward comprise unrealistic volatility densities produced by affine stochastic volatility models, inflexibility of affine stochastic volatility dynamics, and affine models failing to capture the nonlinear nature of market dynamics. Analysing the volatility of the Swiss Market Index shows that the distribution is better fitted by an inverse gamma distribution than by a gamma distribution, which is consistent with evidence from the literature for the volatility of the S&P 500.

The comparison of the pricing performances obtained through the calibration of the Inverse Gamma model and the Heston model, however, do not match the findings in the literature. The Heston model outperforms the Inverse Gamma model for the whole data set as well as for each of the five maturity categories and for each of the three moneyness categories. Nonetheless, the gap between the pricing performances is found to be smallest for short maturities of up to 30 days and for at-the-money options. Possible explanations are pointed out and forwarded to be analysed by future research.

General Assessment

The concept of non-affine stochastic volatility models must remain an object of investigation despite the unfavourable calibration to Swiss Market Index data in this thesis. The debate in the literature is evidently pointing towards favourability of non-affine models over affine models, motivating further research to improve implementation methods or extend existing models to jumps or two-factor volatility.