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Estimation and prediction under local volatility jump diffusion model

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Abstract

Volatility is an important factor in operating a company and managing risk. In the portfolio optimization and risk hedging using the option, the value of the option is evaluated using the volatility model. Various attempts have been made to predict option value. Recent studies have shown that stochastic volatility models and jump-diffusion models reflect stock price movements accurately. However, these models have practical limitations. Combining them with the local volatility model, which is widely used among practitioners, may lead to better performance. In this study, we propose a more effective and efficient method of estimating option prices by combining the local volatility model with the jump-diffusion model and apply it using both artificial and actual market data to evaluate its performance. The calibration process for estimating the jump parameters and local volatility surfaces is divided into three stages. We apply the local volatility model, stochastic volatility model, and local volatility jump-diffusion model estimated by the proposed method to KOSPI 200 index option pricing. The proposed method displays good estimation and prediction performance.

Keywords: Option pricing, Local volatility model, Jump-diffusion model, KOSPI 200 index option

1. Introduction

Modeling and forecasting volatility is important to market practitioners because volatility is a crucial factor in an investment decision. Financial institutions face the need to forecast volatility in stock prices for pricing derivative securities. Financial derivatives can be used for a number of purposes including risk hedging, asset allocation, and investment. These activities are necessary for stable operation of the enterprise. An option contract is one of the typical financial derivatives. Various volatility models have been developed for pricing options in [4, 7, 9, 13, 15, 20]. Local volatility models, which express volatilities as a deterministic function of current stock prices and time, explain the volatility smile phenomenon well. However, the deterministic local volatility function has several drawbacks. First, many empirical studies have shown that the local volatility function performs poorly for hedging in [1, 12]. Second, local volatility models cannot explain the jump phenomenon in financial markets. Many recent studies have demonstrated the existence of jumps and shown their market effect in [3, 11, 17, 23].

As discussed in [5, 11, 16, 25], models with both stochastic volatility and jumps would be the most reasonable kind to use to explain the real world. However, these models are difficult to use numerically, and calibrating their parameters is slow without analytic solutions.

Andersen and Andreasen [2] proposed a simple alternative by which stock dynamics can be described by a jump-diffusion process in which diffusion volatility is the deterministic volatility function of time and stock price. They developed a forward PIDE (Partial Integro-Differential Equation) for the efficient calibration of parameters. They also developed an efficient ADI (Alternating Direction Implicit) finite-difference technique

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