Robust Option through Binomial Tree Method

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ABSTRACT

This study proposes a robust approach for pricing a European option using the binomial tree method. This method considers stock up and down prices in a closed and convex region, called the uncertainty region, defined by the covariance matrix of high and low stock prices. The option model uses this uncertainty region for pricing instead of spot prices. The method proposes an interval of prices for an option considering incidences of the worst and the best states of the stock price. The interval is flexible as it takes into account the covariance of the historical data of a stock’s high and low prices and the radius of an uncertainty region.

Keywords: Binomial Tree, Europe, Option Pricing, Robust Approach

1. INTRODUCTION

One of the issues faced by investors is the risk of price changes in the future. An important tool for confronting the risk of price changes in the future is an option. Upon entering a contract, an investor will either make a profit or take a loss that will be a fixed amount. The investor has the right to buy or sell a certain asset on a certain date at a specified price which does not impose an obligation on the investor to buy or sell (Hull, 2009).

The price of an option is always one of the major concerns of investors as their losses and benefits due to changes in the stock prices depend upon option pricing. In order to enter an option contract, the purchaser must pay a fee to another party which is called an option premium (Hull, 2009).

The two best-known methods of option pricing are the Black-Scholes model and binomial tree methods. Both methods specify a spot price of the stock to calculate the option price. Prediction of good news about a stock would make investors more willing to enter into the contract

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hoping to make a profit. On the other hand, if the investors expect bad news about a given stock, they would not be much willing to enter into the contract. The willingness and reluctance of investors require an appropriate level of flexibility in option pricing models lack which can be considered as an important weakness in those models.

This study is presented in six sections: after introduction, Section 2 presents a review of previous models. In Section 3, the robust model is proposed. In Section 4, the call option value of ten companies is calculated using the robust model proposed. In Section 5, innovation and efficiency of option pricing model with a robust view are discussed. Section 6 presents the conclusion.

2. LITERATURE REVIEW

In this section, the option pricing models and the importance of flexibility in such models are discussed. Many researchers like Sprenkle (1961), Ayers (1963), Boness (1964), Samuelson (1965), Baumol, Malkeil and Quandt (1966) and Chen (1971) have worked on warrant pricing, but their formulae were incomplete. Since they all incorporated one or more arbitrary parameters (Black & Scholes, 1973), Black and Scholes (1973) proposed the first model for pricing a European option. There is one basic assumption in their studies: the stock price follows a random walk, and the stock price distribution at the end of each finite interval is log-normal (Black & Scholes, 1973).

Black-Scholes model’s inability in pricing American options, its inflexibility against future price fluctuations, and offering a spot price as the option price are among its limitations and drawbacks.

Cox et al. (1979) proposed the binomial tree model which is a simple model in discrete time for pricing an option. They also indicated at the end of their study that by increasing the steps, the binomial tree model gets close to Black-Scholes (BS) model. Due to its discrete time structure, a binomial tree is applicable to American options (Cox, Ross, & Rubinstien, 1979). The model’s complexity due to the existence of many steps and offering a spot price for the option are some of its limitations and weaknesses.

Levy (1985) determined the top and bottom of an option pricing through stochastic dominance view considering utility functions (Levy, 1985). Although Levy operationalized the idea of one interval for price instead of a spot price, the existence of utility functions makes it difficult to apply.

Schepper and Heijnen (2007) depicted that how an option can be priced out without considering a complete distribution for the price of underlying asset. Instead of one specific value for option price, they found a closed range for that with upper and lower bounds. They could show that in many cases, the BS Option Pricing Model works well, but there are also conditions that the price of this model is different with the market price of option of underlying asset (Schepper & Heijnen, 2007).

Amster et al. (2005) about the pricing of option, that includes transaction cost, too, presented a model that presents the upper and lower solutions for option price (Amster, Averbuj, Mariani, & Rial, 2005).

Lo (1987) for the call and put options, found an upper bound which depends only on the mean and variance of the stock price. The interesting result of his research is the very little difference between the price of BS model and the upper bound of his model for the deeply out of money options (Lo, 1987).

Chung et al. (2010) found a tight bound for the price of American option. The length of this range for short term options is very small. The results of their research illustrated that the calculated hedge ratios from their model is very close to the market price of American options (Chung, Hung, & Wang, 2010).
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