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Mispricing of the Black-Scholes-Merton Formula of Option Price when the Underlying Asset is distributed as a Bi-modal Distribution

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A B S T R A C T

This research proposes a new option pricing model. The model revises the unimodal probability distribution assumption used in the past, and proposes a bimodal probability distribution for option pricing. The bimodal probability distribution proposed in this study can be degenerated to a unimodal probability distribution under some special conditions. Such that, the option pricing model derived from the unimodal probability distributions will be a special extreme case of that estimated result of the model in this study. On the other hand, the bimodal probability distribution can be used to explain why the distribution has a fat-tail probability when some factors, such as the financial crisis, the trade war between the United States and China, the spread of the COVID-19 epidemic, etc., which continue to affect the price changes of the underlying asset written on options. In this situation, the distribution does not necessarily decrease gradually like the tail of the unimodal distribution; on the contrary, there will be another local mode. In the simulation calculations in this study, the traditional Black-Scholes-Merton model has a situation where the option price is incorrectly estimated (overestimated or underestimated) whenever the distribution of underlying asset's future prices is not unimodal. However, adding the assumption of bimodal probability distribution can properly explain this mis-estimation phenomenon and make corrections.

Keyword: Option pricing model, Bimodal distribution; Skewness parameter; Volatility
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