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Stock Hedging Using Strangle Strategy on Vanilla Options and Capped Options

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ABSTRACT

The financial market often experiences unexpected fluctuations that can impact stock values. Therefore, investors require hedging strategies to protect their investment values from unwanted price fluctuations. This study compares the hedging results using the strangle strategy on Vanilla options and Capped options on Micron Technology, Inc. (MU) stock. The methods used are Monte Carlo simulation and Black Scholes Merton to calculate the option prices. The research results indicate that the strangle strategy on Vanilla options has unlimited maximum profit potential, whereas on Capped options, the profit is capped above. However, the potential maximum loss on Capped options is lower than that on Vanilla options. Therefore, Capped options are preferred for hedging the MU stock. The research yields significant practical and theoretical benefits. Practically, it offers investors insights into more effective hedging choices for risk management and profit potential in the stock market. Opting for capped options allows investors to control risk better while preserving profit potential. Theoretically, the study enhances our understanding of cost efficiency and risk profiles across various options strategies, making a vital contribution to financial literature.

Keywords: Black Scholes Merton; capped option; hedging strategy; Monte Carlo simulation; stock value; vanilla option.

INTRODUCTION

In today's digital era, technology has become an inseparable part of human life, from daily activities and business to industry. In various aspects of life, technology has brought progress and made things easier that were previously difficult or even impossible to do.

The basic element of most modern technologies is semiconductor products. These semiconductors are used in various types of electronic devices, including smartphones, laptops, household appliances, and aeroplanes. Semiconductors enable electronic devices to process data quickly and efficiently and store large amounts of data. They can also be used to expand technological capabilities, such as in artificial intelligence (AI), the Internet of Things (IoT), and autonomous vehicles.

Micron Technology Inc (MU) is a company in the information and communication technology industry that specializes in producing main memory and storage technologies such as DRAM, NAND, and NOR [18]. This company continues to grow and develop along with the growth of technology and the need for increasingly sophisticated electronic devices. MU Company also continues to innovate and develop products to remain competitive in the increasingly competitive semiconductor market. This resulted in MU's stock fluctuating because the company's innovation and product developments, as well as conditions in the market, affect the stock price. This stock price fluctuation can cause risk for investors. There are some frameworks for investors or companies to manage risks, one of which is Enterprise Risk Management, as discussed in [15].

Stock means a unit of value in the form of paper leaflets. They are proof of a person's participation in company ownership or capital participation and may participate in the distribution of company profits obtained. Companies can trade stock in the form of derivative instruments. Based on the Indonesian Stock Exchange, derivative instruments mean contracts or agreements with values or profit opportunities related to the performance of other assets, often called underlying assets. According to McDonald, derivative instruments or products are financial instruments whose value depends on the underlying asset price [17]. Examples of derivative products include options, forward and futures contracts, swaps, and warrants. In this study, two options will be considered, i.e., the vanilla option and the capped option for hedging purposes. Vanilla options are options where buyers have the right to buy (call) or sell (put) the underlying asset at the price they have agreed on (strike price) at or before the expiration time. While the call and the put option on this vanilla option do not have any special features, the capped option is a convenient option with a predetermined profit limit in the contract [8].

A stock option may not be popular outside the European market, but there are stock index markets in Asia, such as Nikkei 225, Kospi, and Hangseng. In Indonesia, options trading was first carried out on October 6 2004, when the IDX was still separated into the Jakarta Stock Exchange (BEJ) and the Surabaya Stock Exchange (BES), where each of these exchanges had issued derivative investment products. BES organizes the LQ-45 Index Futures Contract exchange, while the BEJ organizes the Stock Option Contract (KOS) exchange [7]. Stock options traded on the IDX are called a Stock Option Contract (KOS) or Single Stock Options. The stock exchange authority determines the KOS price, which depends on the number of preference shares and the number of shares outstanding. As in another security, KOS is also traded between buyers of option contracts (taker) and option contract sellers (writer). Each KOS series' due date or expiry day for each month is the last trading day of the month concerned. Capped options, as one of many types of options, will surely be an exciting product in the market.

The methodology used in this paper is the Black Scholes model and Monte Carlo simulation for the purpose and background of the research. The argument of this paper is based on a relevant and valid theory, concept, or idea. The research or similar intellectual work that underlies this paper has been well-designed and highly scientific. The method used is accurate and can estimate the fair value of options with accuracy and objectivity. These methods have also been tested and widely used by academics and practitioners.

The strangle option strategy is in which investors buy or sell call options and put options simultaneously on the same underlying asset with the same maturity time but different strike prices. Hayes Adam defines strangle option strategy as "an option strategy in which an investor holds a position where both call options and put options are at different strike prices but with the same expiration date and the same underlying asset." [11].

In this study, the authors discuss the hedging of stock of Micron Technology Inc (MU) to compare the advantages of the strangle strategy using two types of options, namely the Vanilla option and the Capped option. There still needs to be more previous research discussing the use of capped options. No research has discussed how capped options are compared with other financial instruments. The method used in this study to price the capped option is Monte Carlo simulation because the simulation can consider the uncertainties and variations that may occur in the parameters that affect the results of a system. After that, we will consider the best strategy for hedging MU stock so that investors can make smarter investment decisions and reduce the risk of their portfolios.

The selection of Micron Technology (MU) stock price as a research subject has very relevant reasons. MU is a leading company in the semiconductor industry, and it is known for its high price fluctuations. In fast-moving, high-risk markets, understanding how to protect investments is critical. An analysis of hedging options on MU shares provides practical insight into how investors can address these risks. By comparing Vanilla and Capped options, this research offers an in-depth understanding of the most effective strategies for dealing with stock market volatility. Therefore, this analysis provides valuable guidance to investors, helping them make smart and informed investment decisions amidst the market.

RESEARCH METHOD

Call and Put Option

An option is an agreement between two parties in which one party acts as an option buyer, and the other acts as an option seller. In this agreement, the option buyer is given the right to buy (call option) or sell (put option) one or more shares at a predetermined time and price [23].

A European call option is a contract that gives the buyer the right to buy particular stock at a certain amount and price at the contract's expiration [25]. The Equation can express the payoff of the European call options:

$$C = \max\{S_T - K, 0\} \tag{1}$$

where
C = call option payoff
S_T = underlying asset market price at time T
K = strike price

A European put option is a contract that gives the buyer the right to sell specific stock at a certain amount and price at the contract's expiration [9]. The payoff of the put option can be written in the following Equation [19]:

$$P = \max\{0, K - S_T\} \tag{2}$$

where
P = put option payoff
S_T = underlying asset market price at T
K = strike price

Vanilla Option

Vanilla options are European and American-type options that give the right to buy or sell an underlying asset before or at maturity. Vanilla options are call options and put options that have no special features [5]

Capped Option

Capped options are vanilla options with added limits on the maximum profit that can be achieved [24]. Capped options are a type of exotic option that is more complicated than regular options. This option is appealing to investors who want to play safer because the price of capped options tends to be cheaper. Companies also tend to use capped options to reward employees because the benefits for employees can be limited by the company [2]. The payoff of the capped option is as follows [12]:

$$\bar{C}(S,T) = \min\{\max(S_T - K, 0), x\} \tag{3}$$
$$\bar{P}(S,T) = \min\{\max(K - S_T, 0), y\} \tag{4}$$

where
$\bar{C}$ = capped call option payoff
$\bar{P}$ = capped put option payoff
S_T = underlying asset market price
K = strike price
x = call option upper cap
y = put option upper cap

In capped options, more liability can be collared by the cap. Whereas the higher the cap, the more similar it will be to a vanilla option in terms of collaring liability [3]. In this research, a limit of 200% of the strike price is set to make a more comparable difference between the capped option and the vanilla option.

Black Scholes Merton Model

The Black-Scholes Merton model is an innovation discovered by Fischer Black and Myron Scholes in 1973 to accurately calculate the value of European options based on the underlying asset's value [12]. This study uses the model to find the price of call options and put options on vanilla options. The Black-Scholes Merton model has several assumptions as follows [10], [12]:

1. The evaluated option is a European option, which can only be exercised at the expiration date.
2. The asset price follows a Geometric Brownian Motion model, representing the expected return (drift) and the standard deviation of the asset price return.
3. There are no transaction costs or taxes for buying or selling options.
4. There are no barriers to short selling, meaning selling in the stock market that has been borrowed from other investors.
5. The risk-free interest rate, r, is constant during the option's contract period.
6. The underlying asset does not pay dividends during the derivative's lifespan.
7. There is no risk-free arbitrage opportunity in the asset market. Arbitrage is a trading strategy that exploits price discrepancies between two or more securities.

Based on the Black-Scholes Merton model, the price of European options is given as follows [12]:

$$c = S_0 N(d_1) - Ke^{-rT} N(d_2 \tag{5}$$
$$p = Ke^{-rT} N(-d_2) - S_0 N(-d_1) \tag{6}$$

with

$$d_1 = \frac{\ln\left(\frac{S_0}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} \tag{7}$$
$$d_2 = \frac{\ln\left(\frac{S_0}{K}\right) + \left(r - \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} = d_1 - \sigma\sqrt{T} \tag{8}$$

where
S_0 = initial stock price
K = strike price
T = expiration date
σ = volatility rate
r = risk-free rate
c = call option price
p = put option price
N = cumulative probability distribution function of the standard normal distribution with a mean of 0 and a variance 1.

The volatility used in the Black-Scholes framework is assumed to be constant. Nevertheless, the volatility value is not observed in the market, so it needs to be estimated. There are some methods to estimate volatility. One is to use historical volatility as proposed in [12]. Time series methods are also widely used to estimate the volatility value [20].

Monte Carlo Simulation

Monte Carlo simulation has become essential in analyzing financial products as these financial products become more complex. This method is utilized for pricing financial instruments and plays a crucial part in risk analysis [16]. Monte Carlo simulations assume that market prices are influenced to some extent by a random factor, which can be represented by a random walk [6]. Monte Carlo is an essential technique in finance for pricing European options and American options, characterizing the geometric Brownian motion, estimating the stock prices, financial crisis, etc. [13]. Monte Carlo is the practice of approximating the characteristics of a distribution by analyzing the random samples from the distribution and calculating the average of those samples [22].

In option pricing, Monte Carlo simulation involves simulating the future movement of the stock prices and using this simulation to estimate the expected option value. This method assumes that the future movement of the stock price follows a stochastic process called the geometric Brownian model. Monte Carlo simulation allows for the incorporation of complex features, such as stochastic volatility and jumps, which cannot be captured by closed-form solutions [12].

Monte Carlo simulation relies on risk-neutral pricing as its foundation, where asset prices are simulated assuming that assets generate returns equivalent to the risk-free rate [17]. To evaluate the value of a derivative dependent on a single market variable S with a payoff at time T (maturity time), assuming constant interest rates, the following steps can be taken [12]:

1. Generate a random path for S within a risk-neutral world.
2. Determine the derivative's payoff based on the generated path.
3. Repeat steps 1 and 2 multiple times to obtain numerous sample values of the derivative's payoff in the risk-neutral world.
4. Calculate the average of the sample payoffs to estimate the expected payoff within the risk-neutral world.
5. Discount the estimated expected payoff at the risk-free rate to obtain an estimate of the derivative's value.

Suppose stock prices follow a stochastic process denoted by S and expressed in the following Equation [12]:

$$dS = \mu S dt + \sigma S dz \tag{9}$$

where dz is a Wiener process, expectancy rate is denoted by μ, and volatility is denoted by σ.

Let T be the maturity time, and the interval $[0, T]$ is divided into M sub-interval. Then, each sub-interval has a length of $\Delta t = \frac{T}{M}$, so the previous stochastic process can be discretized into the following Equation:

$$S(t + \Delta t) - S(t) = \mu S(t)\Delta t + \sigma S(t)\varepsilon\sqrt{\Delta t} \tag{10}$$

$S(t)$ is the stock price at time t, and ε is the standard normal distributed random variable.

LnS is used to calculate a more accurate simulation . Based on Itô's Lemma, the generalized Wiener process followed by $\ln S$ is as follows:

$$d \ln S = \left(\mu - \frac{\sigma^2}{2}\right) dt + \sigma dz \tag{11}$$

Then Equation (11) is transformed into:

$$\ln S(t + \Delta t) - \ln S(t) = \left(\mu - \frac{\sigma^2}{2}\right)\Delta t + \sigma\varepsilon\sqrt{\Delta t} \tag{12}$$

and can be simplified into

$$\ln\left(\frac{S(t+\Delta t)}{S(t)}\right) = \left(\mu - \frac{\sigma^2}{2}\right)\Delta t + \sigma\varepsilon\sqrt{\Delta t} \quad 13)$$

From Equation (13), we have

$$S(t + \Delta t) = S(t)\exp\left[\left(\mu - \frac{\sigma^2}{2}\right)\Delta t + \sigma\varepsilon\sqrt{\Delta t}\right] \tag{14}$$

Stock price simulation is run by partitioning the option lifetime $[0, T]$ into N sub-intervals with each sub-interval length of Δt. Monte Carlo simulation uses the risk-neutral principle when calculating stock prices. Risk-neutral valuation is a method for valuing financial assets. This valuation calculates the value of assets by bringing the expected return value in the future to the present value at the risk-free interest rate [14].

The results obtained from the simulation process will be converted to present value using a predetermined risk-free interest rate. The following Equation gives the stock price at simulation-i:

$$S_{t+\Delta t}^i = S_t^i \exp\left[\left(r - \frac{\sigma^2}{2}\right)\Delta t + \sigma\varepsilon\sqrt{\Delta t}\right] \tag{15}$$

S_t^i is the stock price at time t for iteration-i with $t = 0, \Delta t, 2\Delta t, \dots, (N-1)$ and iteration is done M times. The simulated stock price is used to calculate the option payoff and then multiplied by the discount factor with the risk-free interest rate. Prices for call options and put options for capped options are:

$$c = e^{-rT}\min\{\max(S_T - K, 0), x\} \tag{16}$$

$$p = e^{-rT}\min\{\max(K - S_T, 0), y\} \tag{17}$$

Strangle Strategy

The strangle option strategy is one of the variations of the straddle option strategy. The strangle strategy is an options strategy where both call and put options are bought or sold simultaneously on the same underlying asset with the same expiration date but different strike prices. James Chen defines the strangle strategy as "an options strategy where an investor holds a position in both call and put options with different strike prices but the same expiration date and underlying asset." [6].

The call and put options do not have the same strike price (K). The strike price for both options is assumed to be out-of-the-money at expiration (For call option: $S_0 < K_c$ and for put option: $S_0 > K_p$) [1].

The strangle strategy is divided into Long Strangle Strategy and Short Strangle Strategy. The Long Strangle Strategy involves buying both a call option and a put option simultaneously on the same underlying asset with the same expiration date but different strike prices [21]. In contrast, the Short Strangle Strategy involves selling both a call option and a put option simultaneously on the same underlying asset with the same expiration date but different strike prices [21].

Profit in strangle strategy using n call option and n put option is given in the following formula [9]:

For the Vanilla option:

$$P_v(S_T) = \begin{cases} n(K_1 - S_T - (c_v + p_v)) & \text{if } S_T < K_1 \\ n(-(c_v + p_v)) & \text{if} \leq S_T < K_2 \\ n(S_T - K_2 - (c_v + p_v)) & \text{if } S_T \geq K_2 \end{cases} \quad (18)$$

For the Capped option:

$$P_c(S_T) = \begin{cases} n\left(\min\left((K_1 - S_T), 2K_1\right) - (c_c + p_c)\right) & \text{if } S_T < K_1 \\ n(-(c_c + p_c)) & \text{if } K_1 \leq S_T < K_2 \\ n\left(\min\left((S_T - K_2), 2K_2\right) - (c_c + p_c)\right) & \text{if } S_T \geq K_2 \end{cases} \quad (19)$$

where

S_T = underlying asset market price
K_1 = strike price put option
K_2 = strike price call option
T = expiration date
c_v = vanilla call option price
p_v = vanilla put option price
c_c = capped call option price
p_c = capped put option price

Data Source

This research uses data from the MU stock for five years, with weekly stock price data from February 5, 2018, to February 9, 2023. The MU stock data is obtained from the website http://finance.yahoo.com [27]. The risk-free interest rate data used in this research is the risk-free interest rate of the American bank.

Research Stages

The analysis steps conducted in this research using RStudio software are as follows:

1. Retrieve the closing price data of MU stock from February 5, 2018, to February 9, 2023.
2. Calculate the returns of the MU stock using the following formula [26]:
$$R_t = \ln\left(\frac{S_t}{S_{t-1}}\right) \quad (20)$$
3. Perform a normality test on the return data using the Shapiro-Wilk test. The Shapiro-Wilk test can be performed using the following formula [28]:
$$W = \frac{\left(\sum_{i=1}^{n} a_i y_i\right)^2}{\sum_{i=1}^{n}(y_i - \bar{y})^2} \quad (21)$$
4. If the data follows a normal distribution, proceed to calculate its volatility. High volatility indicates significant variance in short-term stock prices. This will give the stock price a higher chance of hitting the strike price. Therefore, the volatility will directly affect the option price [12]. Common volatility measures include standard deviation, skewness, and kurtosis [4]. Annual volatility can be calculated using the following formula [12]:
$$\hat{\sigma} = \frac{s}{\sqrt{\Delta t}} \quad (22)$$
where Δt represents the number of trading periods in a year. Since the data is weekly, the trading period is also weekly with $\Delta t = \frac{1}{52}$, and s is the standard deviation.
5. Calculate the Vanilla option price using the Black-Scholes-Merton model.
6. Calculate the capped option price using Monte Carlo simulation.
7. Calculate the strangle strategy based on the capped and vanilla options prices and determine the best strategy.
8. Analyze the strategies to identify which options have the best profits and losses.

RESULTS AND DISCUSSION

MU Stock Price and Return Data

MU stock prices used in the study are given in Figure 1.

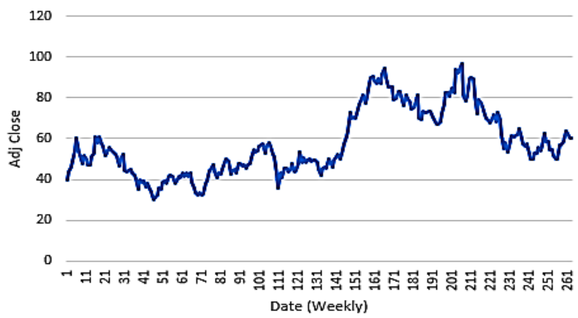

Figure 1. MU stock price movement

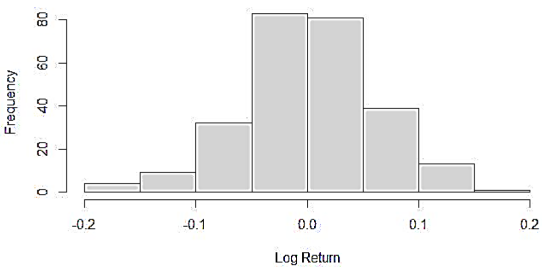

Figure 2. MU stock price return histogram

From Figure 1, the data used is weekly data with 263 weeks. Figure 2 depicts the histogram of MU stock return calculated using Equation (20).

To apply the Monte Carlo and Black-Scholes-Merton methods, it is necessary to have data that has a normal distribution. Therefore, a normality test was conducted on MU stock return using RStudio with Equation (11). We obtained the p-value of 0.5511 using $\alpha = 0.05$. Because the p-value $\geq \alpha$, it can be concluded that the data is normally distributed. After that, we calculate the stock price volatility using Equation (12), and we obtain the volatility is $\sigma = 44.165\%$ per year.

Vanilla Option Price Calculation

The Vanilla option price will be calculated using the Black-Scholes-Merton model in Equation (5), Equation (6), Equation (7), and Equation (8) with the following inputs:

Initial stock price (S_0)	= \$40.0013
The strike price for the put option (K_1)	= \$32.0010
Strike price for call option (K_2)	= \$48.0016
Expiration date (T)	= 1 year
Risk-free rate (r)	= 5.25%
Volatility (σ)	= 44.165%

Using RStudio software, the price for the call option is $c = \$5.0180$, and the price for the put option is $p = \$2.4630$.

Capped Option Price Calculation

Using RStudio software, Capped option prices are calculated using Monte Carlo simulation with the following input:

Initial stock price (S_0)	= \$40.0013
The strike price for the put option (K_1)	= \$32.0010
Strike price for call option (K_2)	= \$48.0016
Expiration date (T)	= 1 year
Risk-free rate (r)	= 5.25%
Volatility (σ)	= 44.165%

Table 1. Prices of Call options and Put Options

Iteration	Call Option Price	Put Option Price
10000	4.9033	2.3824
20000	4.9927	2.4464
30000	4.9212	2.4602
40000	4.9884	2.3872
50000	4.9313	2.4567
60000	4.9775	2.4584
70000	4.9989	2.4330
80000	4.9956	2.4473
90000	4.9187	2.4606
100000	4.9921	2.4511

Table 1 provides the results of the Monte Carlo simulation for capped call options and capped put options.

Based on Table 1, data with 100000 iterations is used to calculate the option price, and the call option price is $c = \$4.9921$ while the put option price is $p = \$2.4511$. This option price will be used to calculate the strangle strategy's profit and cost.

The Cost of the Strangle Strategy for Unsecured and Secured Positions

The costs for unsecured positions are calculated to compare the secured position between the strangle strategy using vanilla and capped options. At time T, n underlying assets of price S_T will be purchased. Then, the cost for unsecured positions is given as follows:

$$C(S_T) = nS_T$$

In this study, the number of assets used is 100 units, so the cost function for unsecured positions is as follows:

$$C(S_T) = 100S_T$$

The cost function for secured positions in the strangle strategy is formed from the sum of the unsecured positions and the profit function and is given as follows.

For the Vanilla option:

$$P_v(S_T) = \begin{cases} n(2S_T - K_1 + (c_v + p_v)) & \text{if } S_T < K_1 \\ n(S_T + (c_v + p_v)) & \text{if } K_1 \leq S_T < K_2 \\ n(K_2 + (c_v + p_v)) & \text{if } S_T \geq K_2 \end{cases}$$

For the Capped option:

$$P_c(S_T) = \begin{cases} n\left(S_T - \min\left((K_1 - S_T), 2K_1\right) + (c_c + p_c)\right) & \text{if } S_T < K_1 \\ n(S_T + (c_c + p_c)), & \text{if } K_1 \leq S_T < K_2 \\ n\left(S_T - \min\left((S_T - K_2), 2K_2\right) + (c_c + p_c)\right) & \text{if } S_T \geq K_2 \end{cases}$$

where

S_T = stock price at time T
K_1 = put option strike price
K_2 = call option strike price
T = maturity date
c_v = vanilla call option price
p_v = vanilla put option price
c_c = capped call option price
p_c = capped put option price

Assume that the hedger purchases 100 call options and put options on Vanilla options with the strike price for the call option being $K_2 = \$48.0016$ and the strike price for the put options being $K_1 = \$32.0010$ with a call option price of \$5.0180 and a put option price of \$2.4630. Then, the cost function for the secured portfolio at time T is:

$$P_v(S_T) = \begin{cases} 100(2S_T - K_1 + 7.4811) & \text{if } S_T < K_1 \\ 100(S_T + 7.4811) & \text{if } K_1 \leq S_T < K_2 \\ 100(K_2 + 7.4811) & \text{if } S_T \geq K_2 \end{cases}$$

Furthermore, If the hedger purchases 100 call options and puts options on capped options with the strike price for the capped call option being $K_2 =$ \$48.0016 and the strike price for the capped put option is $K_1 =$ \$32.0010 with a capped call option price of \$4.9921 and a capped put option price of \$2.4511, the cost function for the secured portfolio at time T is:

$$P_c(S_T) = \begin{cases} 100\left(S_T - \min\left((K_1 - S_T), 2K_1\right) + 7.44\right) & \text{if } S_T < K_1 \\ 100(S_T + 7.4432) & \text{if } K_1 \le S_T < K_2 \\ 100\left(S_T - \min\left((S_T - K_2), 2K_2\right) + 7.44\right) & \text{if } S_T \ge K_2 \end{cases}$$

Figures 3 – 5 further depict the cost function. In those figures, the profits for unsecured and secured positions are compared.

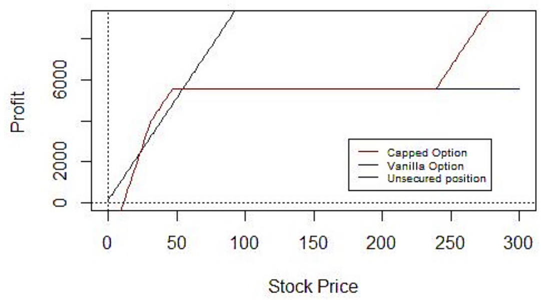

Figure 3. Comparison of the cost of Vanilla and Capped Options

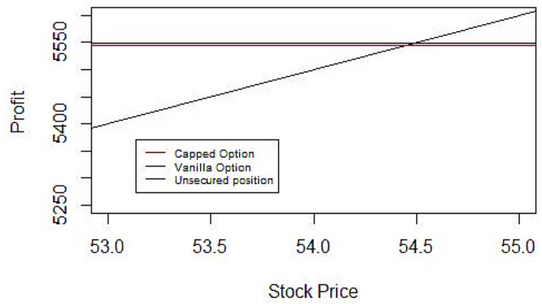

Figure 4. Comparison of the Vanilla and Capped Options cost over the \$53 to \$55 stock price range

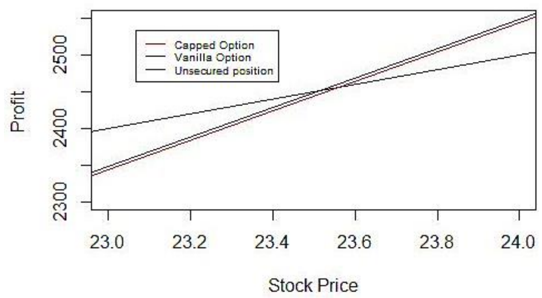

Figure 5. Comparison of the cost of Vanilla and Capped Options over the \$23 to \$24 stock price range

Based on Figures 3, 4, and 5, if the stock price is between \$23.5 and \$54.5, the lowest cost is achieved when no options strategy is exercised. If the stock price is less than \$23.5 or more than \$54.5, the lowest cost is achieved by using the capped option. However, at a stock price greater than \$143.5, the vanilla option provides a constant and lower cost than that of the capped option.

The Profit of the Strangle Strategy for Secured Positions

The profit of the strangle strategy is formed from call options and put options with different strike prices where the strike price for the put option is smaller than the strike price for the call option, and the expiration time is the same for both options.

The profit function of the strangle strategy for using vanilla options can be written using Equation (18) for the case of 100 options. The strike price for the call option is $K_2 =$ \$48.0016, and for the put option, $K_1 =$ \$32.0010, where the call option price is \$5.0180 and the put option price is \$2.4630. Thus, the profit function can be formulated as follows.

$$P_v(S_T) = \begin{cases} 100(K_1 - S_T + 7.4811) & \text{if } S_T < K_1 \\ 100(-7.4811) & \text{if } K_1 \le S_T < K_2 \\ 100(S_T - K_2 - 7.4811) & \text{if } S_T \ge K_2 \end{cases}$$

Furthermore, the profit function of the strangle strategy for using the capped option can be written using Equation (19) for the case of 100 options. The strike price for the capped call option is $K_2 =$ \$48.0016, and for the capped put option, $K_1 =$ \$32.0010, where the capped call option price is \$4.9921 and the capped put option price is \$2.4511. Thus, the profit function for the use of the capped option can be written as follows.

$$P_c(S_T) = \begin{cases} 100\left(\min\left((K_1 - S_T), 2K_1\right) - 7.44\right) & \text{if } S_T < K_1 \\ 100(-7.4432), & \text{if } K_1 \le S_T < K_2 \\ 100\left(\min\left((S_T - K_2), 2K_2\right) - 7.44\right) & \text{if } S_T \ge K_2 \end{cases}$$

The portfolio's profit using vanilla and capped options are compared in Figure 6 and Figure 7.

Based on Figures 6 and 7, the difference in the vanilla and capped options' profit is insignificant until they reach a stock price of \$239.0200. At a lower stock price of \$239.0200, the capped option is more profitable than the vanilla option. At stock prices over \$239.0200, capped options provide constant profits, while vanilla options provide greater returns. Therefore, capped options are better used to hedge stock risk than vanilla options. Profit comparison of capped options and vanilla options with 100 options can be seen in Table 2.

According to Table 2, the vanilla option has a maximum loss of \$748.1064, while the capped option has a maximum loss of \$744.3200. The maximum profit for a vanilla option has no upper limit, while the capped option has a maximum profit of $18456.3097. Therefore, capped options are better used to hedge stock risk than vanilla options.

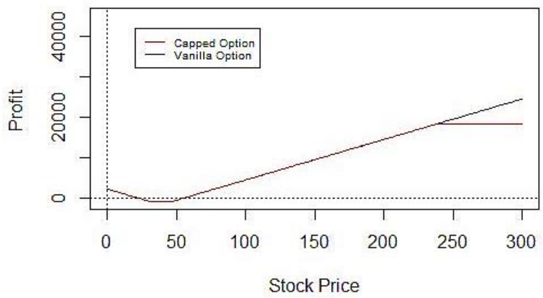

Figure 6. Plot of profit comparison between Vanilla and Capped options

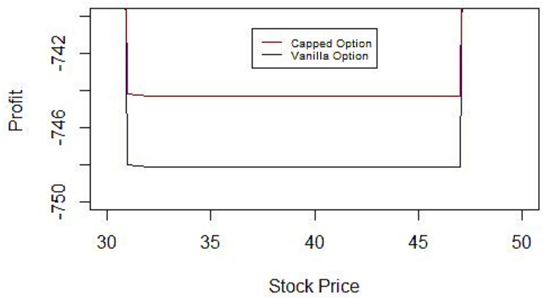

Figure 7. The plot of profit comparison between Vanilla and Capped options at maximum loss

Table 2. Differences in Profits for Vanilla and Capped Options

Option Types	Maximum Profit	Maximum Loss
Vanilla Option	∞	748.1064
Capped Option	18456.3097	744.3200

The capped option is better than the vanilla option in terms of risk control and premium price. This indicates better cost-efficiency and risk profile. Investors can control their risk tolerance by adjusting the price cap and risk-reward profile to create a more balanced portfolio.

CONCLUSION

The strangle strategy using the vanilla option has no upper limit for the potential profit, while the use of the capped option for the strangle strategy has a limited potential profit. The potential maximum loss for the use of capped options is less than that of the use of vanilla options. Furthermore, the capped option used for the strangle strategy provides a lower cost than the vanilla option to some extent. Capped options can control risk and premium prices. This shows better efficiency and risk control by adjusting the cap price. Therefore, the capped option is better used to protect MU stock risk.

Capped options are widely used in European and American financial markets. Its use in Indonesia is still small and less common than the vanilla option. Using capped options on derivative products is safer because they provide a specific cap limit so that losses can be better minimized. This research is hampered by limited sources of information and journals that discuss capped options. There are many opportunities for further research by developing models to calculate option prices, using different cap price limits, different hedging strategies, and capped options in other stock data.

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