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Hedging strategy in emerging market: Application long straddle option in gold price index

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Abstract

This research was conducted to test the implementation of gold price index option contracts using the Black Scholes and GARCH models with a long straddle strategy. The testing is done by looking at the comparison of the results of the calculation from the historical volatility value and the GARCH volatility. The results of the study are displayed by looking at the comparison of the Average Mean-square Error (AMSE) percentage values of the two models. From the research that has been done, it shows that the Black Scholes model has a better gold price index option contract than the GARCH model for maturities of 1 month, 2 months and 3 months.This is shown from the AMSE value of call options and put options in the Black Scholes model which is always smaller than the GARCH model for each contract maturity period. In addition, the potential for maximum profit by implementing the long straddle strategy in gold price index option contracts in the range of 2008-2018 is 54.98 percent with an average profit potential of around 25-30 percent.

Kata kunci:
Pasar berkembang; Harga emas; Kontrak opsi; Straddle strategy

Abstrak

Penelitian ini dilakukan untuk menguji implementasi kontrak opsi indeks harga emas menggunakan model Black Scholes dan GARCH dengan strategi long straddle*. Pengujian dilakukan dengan melihat perbandingan hasil perhitungan dari nilai volatilitas historis dan volatilitas GARCH. Hasil penelitian ditampilkan dengan melihat perbandingan nilai persentase* Average Mean-square Error *(AMSE) kedua model. Dari penelitian yang telah dilakukan didapatkan hasil bahwa model Black Scholes memiliki kontrak opsi indeks harga emas yang lebih baik dari pada model GARCH untuk jangka waktu 1 bulan, 2 bulan dan 3 bulan, hal ini ditunjukkan dari nilai AMSE* call options *dan put option dalam model Black Scholes yang selalu lebih kecil dari model GARCH untuk setiap periode jatuh tempo kontrak. Selain itu, potensi keuntungan yang maksimal dengan menerapkan strategi* long straddle *pada kontrak opsi indeks harga emas pada kisaran tahun 2008-2018 adalah sebesar 54,98 persen dengan potensi keuntungan rata-rata sekitar 25-30 persen.*

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1. Introduction

Gold is one of the common commodities invested by most people. Gold is also a promising investment because the selling price of gold is quite high and the risk level is quite low compared to other commodities investments. But behind the benefits, there are some shortcomings of gold investment. The price of gold can be volatile and is greatly influenced by the exchange rate of USD/IDR. Based on the gold price index in the last 5 years (2014-2018), it can be seen in Figure 1 that in the last 5 years, the highest gold price strengthening and weakening occurred in 2014 with a range of -10.072 percent to 13.219 percent per day. Yields on gold prices that occurred between 2015 and 2018 ranged from -5 percent to 6 percent. It can be concluded that fluctuations tend to occur almost throughout the year and volatility is quite common. Thus, it can be concluded that the price of gold often changes drastically in the 2014-2018 period.

Fluctuations in the price of gold indicate a high level of volatility and an impact on the possibility of a high risk of loss. Volatility in financial markets shows fluctuations in the value of an instrument within a certain period. The emergence of volatility causes the emergence of risks and uncertainties that can cause the interest of market participants of making investments to become unstable. Volatility can occur because capital markets are very sensitive to fiscal and monetary policies, political stability and security factors. Hull (2009) stated that inevestor can hedge they investment by using derivatives are instruments. Derivative transactions are agreements between two parties known as interrelated parties, where one party is the buyer and the other party is the seller. There are several types of

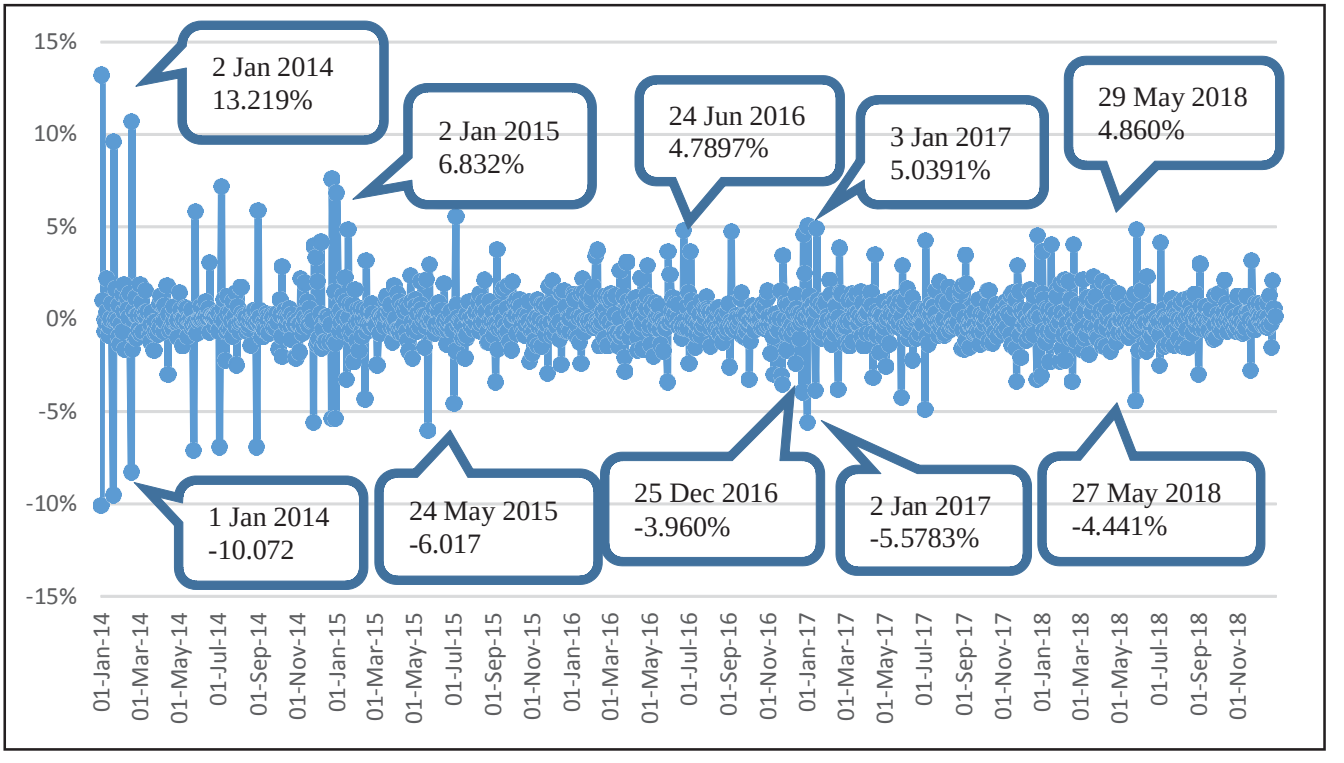

Figure 1. Gold price yield of 2014-2018

derivative instruments that are commonly used, including future, forward, swap, and option contracts.

Hull (2009) explained, an option contract is an agreement that gives the owner the right, but not the obligation to buy or sell certain assets at a price and for a certain time. Generally, there are two types of option contracts, namely the stock buy option contract (call option) and the stock sell option contract (put option). Call option is an option contract that gives the holder the right to buy shares in a certain amount at a specified price and time, while a put option is an option contract that gives the holder the right to sell shares at a specified price and time. The price agreed on the put option can also be called the exercise price or strike price, while the time agreed on the contract is called the expiration date or maturity date.

One type of volatility that is often observed is stock price volatility and stock return volatility. Stock price volatility is very important to be observed for investors because it becomes the basis for calculating stock return volatility. Volatility of stock returns illustrates the level of fluctuation in the difference between the price of daily observations in a given observation period. The ability of investors to predict whether there is volatility can affect the returns that investors get.

Hendrawan (2018) explains that fluctuations in the yield data indicate that the volatility that occurs is very high. In addition, Kartika (2010) in her research mentioned that the existence of volatility causes the risks and uncertainties faced by investors to be greater, thus causing instability of investor interest in investing. Therefore, we need a risk management to anticipate the volatility of stock prices so that the risk of losses that may arise can be minimized. Carr & Lee (2009) states that an option contract is an investment that must be owned if you want to compete and survive in the financial markets today. With an option contract, an investor will get the same benefits as a direct stock or commodity but with a smaller risk.

Based on the background and phenomenon described above, it can be observed that it is necessary to take action in an investment to respond to fluctuating gold prices so that the potential for losses due to gold investment can be minimized. This research was conducted to test and investigate the implementation of option contracts on gold price index objects for the period 2008 to 2018 using the Black Scholes and GARCH models with a long straddle strategy. The strategy applied in this research is the long straddle strategy. The choice of this strategy is based on that the potential benefits with that strategy will be unlimited. Therefore, this study will also observe the accuracy of the strategy in providing significant benefits for option contracts on the gold price index.

2. Hypotheses Development

Several previous studies have been conducted to observe and test the volatility of gold prices including Hasanah et al. (2019), Bratha et al. (2017), Kristjanpoller & Minutolo (2015), Bentes (2015), Basher & Sadorsky (2016), Kaminski (2013) and Ahmad & Sara (2012). In addition, there are also several studies that focus on the comparison of the Black Scholes and GARCH models.

Zhang et al. (2019) who compared the two models on the Shanghai 50ETF index. The results stated that modeling an option contract with the Black Scholes model resulted in a lower AMSE value than GARCH Model. There area also several other studies comparing Black Scholes and GARCH Model that have been studied by Jiratumpradub & Chavanasporn (2016), Bhat & Arekar (2016), Kaminski (2013) and Hendrawan (2017).

Hendrawan (2010) made a comparison of the Black Scholes and GARCH models on 4 stocks listed in IDX (Indonesian Stock Exchange). The result shows the GARCH model is more appropriate to be used for low and medium maturity option contract, while the Black Scholes Model is more ap-

propriate for long term contracts. Not only the contract , but also the option strategy plays an important role in determining the benefits.

Black Scholes option model

Option pricing theory is one of the terms of reference in today's financial theory. The first option theory was introduced by Bachelier (1900) where the option theory used a mathematical approach in calculating prices. Black & Scholes (1973) illustrates the initial basis in the formation of option prices by developing a new model called the Black-Scholes model. The Black-Scholes model provides a solution to the problem of calculating option values to obtain better results in terms of theoretical and practical.

The Black Scholes equation for calculating call options is as follows:

$$C = SN(d1) - e^{-R_f T} XN(d2) \quad \text{.....(1)}$$

Whereas the calculation of put options is obtained by the following equation:

$$P = Xe^{-R_f T} XN(d2) - SN(-d1) \quad \text{.....(2)}$$

Where,

$$d1 = [\ln \frac{\left[\frac{S}{X}\right] + [R_f - \frac{\sigma^2}{2}]}{\sigma\sqrt{T}} T \quad \text{.....(3)}$$

$$d2 = d1 - \sigma\sqrt{T} \quad \text{.....(4)}$$

Where, S= stock price; X= strike price; T= maturity period; Rf= risk-free interest rates; σ = stock price variance; N= cumulative standard of normal distribution

GARCH option model

The GARCH (Generalized Autoregressive Conditional Heteroscedasticity) model is a development of the ARCH (Autoregressive Conditional Heteroscedasticity) model introduced by Engle (1982). The ARCH model was developed by Bollerslev (1986) into a GARCH model in which volatility is not only determined based on the error from the previous volatility, but also from the previous volatility. In addition, Kallsen & Taqqu (2002) in their research tried to develop the GARCH continuous time method using Monte Carlo simulation. This method was developed in response to the time discrete-based GARCH method. The results show that the GARCH continuous time model can be implemented for the GARCH model.

Volatility modeling in the GARCH method (1,1) is calculated from the average value of long variance, (V_L), previous volatility value (σ_{n-1})and the return value of the previous day (u_{n-1}). According to Hull (2009), the GARCH equation (1,1) can be formulated as follows:

$$\sigma_n^2 = \gamma V_L + \alpha u_{n-1}^2 + \beta \sigma_{n-1}^2 \quad \text{.....(5)}$$

If ã represents V_L, α represents u_{n-1}^2, and β β represents σ_{n-1}^2, then the entire constant follows the following equation:

$$\gamma + \alpha + \beta = 1 \quad \text{.....(6)}$$

If specified that $\omega = \gamma V_L$, then the GARCH (1.1) model can be written as:

$$\sigma^2 = \omega + \alpha u_{n-1}^2 + \beta \sigma_{n-1}^2 \quad \text{.....(6)}$$

After ω, α, and β, which are estimated multipliers, you can determine γ as 1–α–β. Long variance V_L can be calculated as ω/γ. A stable GARCH process will be reached if an equation α+β < 1 is gotten.

Long Straddle Strategy

Hull (2009), exlained the long-straddle strategy is a strategy that will benefit the buyer/investor if the estimated share price expired from the option contract will move far upward on the call-

option from the current price value plus the value of the call-option premium or move far down on the put- option from the current stock price value reduced by the value of the put option premium.

The profit value in this strategy is unlimited because regardless of the share price at the expiration date of the option contract, the investor will only buy at the current stock price (position at the money). The maximum loss value of this strategy is the premium value of both call-options and put-options. Figure 2 above shows a graph of the potential advantages and disadvantages of a long straddle strategy.

3. Method, Data, and Analysis

This study uses quantitative methods because this study calculates numbers using equations in the GARCH model and the Black Scholes model. In this study, the author compares the error resulting from calculations between the Black Scholes method with historical volatility and the Black Scholes method with GARCH. In addition, the author also makes a comparison of the results of the calculation of option contracts on the price of gold using each model for a contract period of 1 month, 2 months and 3 months.

The data used is the daily gold price index from January 1, 2008 to December 31, 2018. The research step was carried out by modeling historical volatility and GARCH volatility. After obtaining the two volatility values, an option contract is tested by entering each of the volatility variables into the Black Scholes formula. After obtaining the results of the option contract testing, the calculation of yields is carried out using a long straddle strategy to determine the potential benefits. Finally, an analysis of the best model is performed by comparing the AMSE (Average Mean-Square Error) value of each model.

Error value testing

The analytical method used is the average percentage square root error or the average percentage mean-square error (AMSE). It means the smaller the value of the AMSE, the better the model will be. The AMSE formula used is as follows:

$$AMSE = \frac{1}{N}\sum_{t=1}^{N}\left(\frac{APt - SPt}{APt}\right)^2 \quad \text{..... (8)}$$

Where, APt= actual option premium value; SPt= calculated premium value; N= number of experiments performed

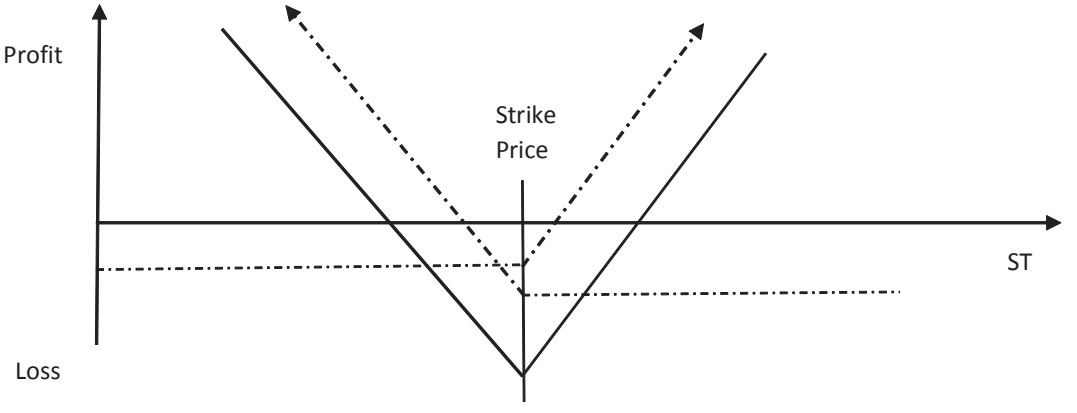

Figure 2. Long straddle option strategy

This error value calculation is performed on each option contract calculation with 2 different volatility (GARCH volatility and historical volatility). After obtaining the respective error values, the conclusion can be drawn from the best option contract model.

4. Results

Results of variable volatility values model

From the results of observations and calculations that have been done, the results and graphs of Historical Volatility (1 month, 2 month and 3 month) values and GARCH Volatility values are obtained. Figure 4 shows the comparison of the results of the calculation of the value of volatility between historical volatility and GARCH volatility. From the figure 3 below, it can be seen that the historical volatility value tends to have a higher value than the GARCH volatility value.

If observed in Table 1, it appears that the greater the contract period in the calculation of historical volatility, the average value will be even greater. But this is inversely proportional to the maximum value and range in the historical volatility value where the longer the contract period, the maximum value and range of values will decrease. It also appears that the greater the contract period, the range of values in historical volatility will be closer to the range of values in the GARCH volatility.

Test results for the Black Scholes and GARCH models

After obtaining volatility data using the historical and GARCH model, the next step is to test the option contract using a predetermined formula. The results of the observed test are the average mean-square error (AMSE) value of the option contract testing using historical and GARCH volatility.

Table 2 above shows the comparison of the AMSE value of the Black Scholes and GARCH model option contracts for the 1-month contract period. From this table, it can be seen that the Black Scholes model is better than the GARCH model where the AMSE Black Scholes value is smaller than the GARCH. The average mean-square error (AMSE) value in the Black Scholes model for call options is 5.10 percent and put options are 3.30 percent, while

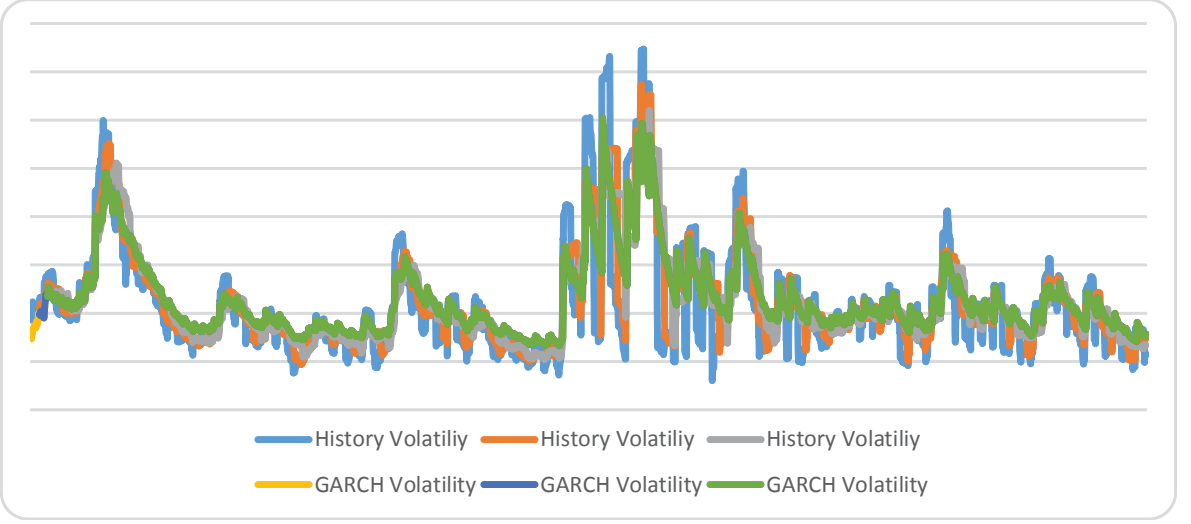

Figure 3. Comparison of historical and GARCH volatility

the GARCH model has an AMSE value of 5.84 percent for call options and 3.84 percent for put options.

Meanwhle, the test results with a maturity of 2 months show that the calculation of option contracts using the Black Scholes model is better than the GARCH model where the AMSE value for Black Scholes is smaller than GARCH. Table 2 above shows the average mean-square error (AMSE) value in the Black Scholes model for call options at 4.52 percent and put options at 2.26 percent, while the GARCH model has an AMSE value at 5.01 percent for call options and 2.98 percent for put options.

Furthermore, the test results with a maturity of 3 months show that the calculation of option contracts using the Black Scholes model is still better than the GARCH model where the AMSE value for Black Scholes is smaller than GARCH. Table 2 above shows the average mean-square error (AMSE) value in the Black Scholes model for call options of 7.55 percent and put options of 4.09 percent, while the GARCH model has an AMSE value of 8.95 percent for call options and 4.95 percent for put options.

Test results of profit for the Black Scholes and GARCH models

After the data from the calculation of option contracts is obtained from two different models, the next step is to apply the results of the calculations of the two models to the long straddle strategy. By entering this strategy, the percentage of profit gained from each of the option contract calculation models will be shown. Table 3 below shows a comparison of the level of potential benefits for each model. It can be observed that the profit area for all models is smaller than the loss area.

The level of profit of option contracts with a long straddle strategy based on the test results is quite low. This is because the average percentage of profits only stands at 25-30 percent with a maximum profit percentage of 30.90 percent. Meanwhile,

Table 1. Comparison of historical and GARCH volatility values on 1 month, 2 months, 3 months contract periods

	Average (%)	Max (%)	Min (%)	Delta (%)
History Volatility 1 Month	21.73	74.73	6.18	68.55
GARCH 1 Month	23.06	60.37	13.29	47.08
History Volatility2 Months	22.25	67.42	9.40	58.02
GARCH 2 Months	23.10	60.37	13.29	47.08
History Volatility 3 Months	22.52	62.02	10.47	51.55
GARCH 3 Months	23.12	60.37	13.29	47.08

Table 2. Comparison of AMSE Black Scholes and GARCH with 1-month maturity

Model	AMSE (%)	
	Call	Put
Black Scholes 1 Month	5.10	3.30
GARCH 1 Month	5.84	3.84
Black Scholes 2Months	4.52	2.66
GARCH 2 Months	5.01	2.98
Black Scholes 3Months	7.55	4.09
GARCH 3Months	8.95	4.95

for the same contract period, the Black Scholes model has a greater profit percentage than the GARCH model. The longer the maturity of the Black Scholes contract model, the smaller the profit percentage. This is inversely proportional to the GARCH model where the longer the contract maturity, the greater the profit percentage.

For the all year observation, from Table 4 shows a comparison of the profit potential of the two option contract models with a maturity of 1 month, 2 months, 3 months in each observation year. From the table, it can be seen that the biggest potential for profit occurred in 2011 with a 3-month contract maturity, which amounted to 54.98 percent. The smallest potential profit occurred in 2017 with a 3-month contract maturity, which is 2.65 percent. From Table 6 it can be seen that most of the value of the percentage of potential profit from option contracts at the price of gold is below 50 percent.

5. Discussion

From the research and testing of option contracts that have been carried out on the gold price index with a long straddle strategy, it appears that the Black Scholes model has an average mean-square error (AMSE) value smaller than the GARCH model for all the maturity periods tested (1 month, 2 months and 3 months). In addition, testing an option contract with a maturity of 2 months has the lowest AMSE value compared to a maturity of 1 month and 3 months. If observed in the potential

Table 3. Percentage of potential profit/loss of Black Scholes and GARCH model option contracts

Maturity	Model	Profit Area	Loss Area	Profit Percentage
1 Month	Black Scholes 1 Month	869	1943	30.90
	GARCH 1 Month	720	2092	25.60
2 Months	Black Scholes 2 Months	839	1953	30.05
	GARCH 2 Months	725	2067	25.97
3 Months	Black Scholes 3 Months	830	1942	29.94
	GARCH 3 Months	782	1990	28.21

Table 4. Profit potential comparison of Black Scholes and GARCH model option contracts 2008-2018

Year	1 Month		2 Month		3 Month	
	Black Scholes (%)	GARCH (%)	Black Scholes (%)	GARCH (%)	Black Scholes (%)	GARCH (%)
2008	48.28	51.29	38.21	42.92	34.90	36.98
2009	42.06	36.51	39.68	36.11	33.73	32.14
2010	40.08	29.37	40.48	37.70	39.29	39.68
2011	51.39	47.01	51.00	45.42	54.98	49.40
2012	36.11	27.38	29.76	20.63	39.29	33.73
2013	32.94	22.35	36.47	29.41	35.29	38.04
2014	19.85	9.92	6.49	3.82	3.44	4.20
2015	17.80	15.15	21.59	17.42	26.52	22.73
2016	35.85	32.45	40.38	36.98	37.74	35.47
2017	10.98	10.23	10.61	7.58	3.79	2.65
2018	8.75	4.56	19.39	12.55	23.95	19.77

for profit, the Black Scholes model with a maturity of 1 month provides maximum profit compared to other models and maturity periods.

In addition, the potential benefits that can be obtained from option contracts with a long straddle strategy on gold prices are not too maximal, both for option contracts with a period of 1 month, 2 months and 3 months. This is proven in the profit potential data which is only around 25-30 percent. If the data is dissected into annual data, then most of the profits will be below the 50 percent level. This indicates that the implementation of the long straddle strategy is not appropriate to be used for gold price option contracts because there is no potential for a maximum profit.

The results of this study support and are in line with the results obtained by Zhang et al. (2019) where the Black Scholes model gives better results than th GARCH model for the Shanghai 50ETF index. In addition, several others study also gave the same results as those examined by Jiratumpradub & Chavanasporn (2016), Bhat & Arekar (2016) and Kaminski (2013). Meanwhile, the results obtained by researcher oppose the results obtained by Narayan et al. (2016) and Hendrawan (2010) where they prove that the GARCH Model and its derivatives are better than the Black Scholes model for each research object. Research from Gong et al. (2010) also gives different results from those obtained by researcher where Gong states that the GARCH model is more suitable to be implemented for contract with short-term maturities and Black Scholes model is more suitable to be implemented for contracts with long-term maturities.

This study focuses on looking at the application of gold option contracts which has not been studied comprehensively in some previous researches. Most of the research that has been done has focused on comparing the effectiveness and error of the Black Scholes Model and GARCH model with each object under research. The differences made by researchers in this study were not only comparing the effectiveness and error of those two models but also looking at the potential percentage of profits obtained by applying the straddle strategy. It is expected that the results of this research are comprehensive and can be implemented in hedging.

Furthermore, another focus of this research is to examine other alternatives in hedging the value of the gold commodity. In general, the futures contract is a type of derivative instrument used for gold investment commonly. The results of this research illustrate that the theory of options contract can also be used to hedge the gold price, so the possibility of losses due to gold investment can be minimized. The results obtained show that with the long straddle strategy, the percentage of profit opportunities can reach above 50 percent. The application of the right model and strategy in determining the option contract can provide high potential profit given the volatility of gold which is quite volatile.

6. Conclusion

From the results of the research that has been done, it can be concluded that the application of an option contract with a term of 1 month, 2 months and 3 months would be better by using the Black Scholes model than the GARCH model. This can be seen from the AMSE values for call options and put options on the Black Scholes model with a maturity of 1 month, 2 months and 3 months having a smaller value than the GARCH model. The application of the long straddle strategy to options contracts with gold price index objects does not provide significant benefits. This is proven by the potential profit which is only around 25-30 percent. In addition, when viewed in 2008-2018, the biggest potential for profit occurred in 2011 with a 3-month contract maturity, which is 54.98 percent. The smallest potential profit occurred in 2017 with a 3-month contract maturity, which is 2.65 percent.

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