The Application for Spread Options Based on Three Underlying Assets Groups

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Keywords: Spread option, Monte-Carlo simulation, Black-Scholes Model.

Abstract: The varieties of spread options trading existing in the current futures exchange are much smaller than other types of options. To promote the development of the market, it is necessary to investigate the pricing and application of such exotic options. This paper, investigates the influencing factors of spread options and observes their corresponding market characteristics. In order to carry out simulations, the Monte-Carlo method and the Black-Scholes theorem are utilized for pricing and observation comparison of three groups of underlying assets. Based on the analysis, the assets in the group should be highly correlated in order to apply the spread options in the market. The intrinsic is that the higher the correlation is the more reasonable for the trader to construct the spread option, which can be used as the function of hedging. Besides, a well-performed spread option ought to possess the advantages of low-interest rates and easy prediction. These results shed light on spread option implementation in the future market.

1. Introduction

Spread option is a derivative contract from the vanilla option, which is based on the price spread of two or multiple underlying assets rather than a single one-price asset. There are multiple categories in the spread option, e.g., location spread, quality spread, calendar spread, and cross-bread spread. Thereinto, the cross-bread spread option is one of the most studied species, where price spread is obtained based on a group of two or more correlated assets today. This sort of spread option is typically favored to use by traders when the price difference in two or more underlying assets is beyond the historical range. Nevertheless, most spread options are traded over-the-counter (OTC) except the crack and coking spread options are traded in Chicago Mercantile Exchange (CME) [1, 2].

However, the whole market capacity and trading quantities of the spread option are rather small compared to other options [3, 4]. Thus, it is necessary to investigate the application of spread option that ranges from its payout, option price premium and certain arbitrage strategy, accordingly. On this basis, this study draws payouts of three underlying assets groups of spread options with different correlations, 0.92 in FO & WRO, 0.59 in Gold & Silver and -0.04 in Amperex & Goldfield. According to the results, high correlation between a group of underlying assets has cheaper price premium and speculate certain arbitrage strategy in term of this findings. These results are meaningful for exploring a larger market for spread options.

The rest of the paper is organized as follows: Section II describes the data origination and simulation methods (Monte-Carlo & Black-Scholes Model); Section III presents the results of three underlying assets groups: Gold & Silver, Amperex & Goldfield and FO & WRO; Section IV explains the results and evaluates the characteristics of spread option as well as the research limitation; Section V gives a summary eventually.

2. Data and Method

2.1 Data

To investigate spread options applications, three groups of underlying assets are chosen as research targets. The three sets of data are Fuel Oil (FO) and WTI Raw Oil (WRO), Gold and Silver, Contemporary Amperex Technology Co. and Limited and Goldfield Industries Inc, respectively. The daily close prices of each underlying asset are collected from the website listed in Ref. [5]. The time range is from 10/06/2020 to 10/06/2021. To visualize the data, the close price evolutions for the three assets group are shown in Figs. 1~3 accordingly.

Figure 1. The close price evolution for Gold & Silver

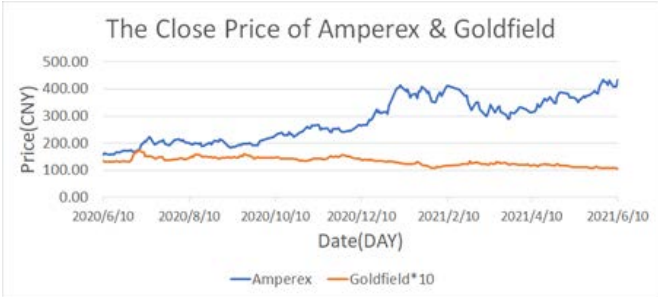

Figure 2. The close price evolution for Amperex & Goldfield

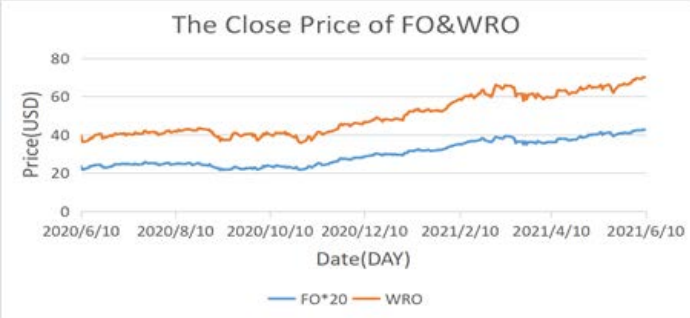

Figure 3. The close price evolution for FO & WRO

Generally, the effectiveness of spread options requires a rather high correlation for the corresponding assets. To verify the statement, the three groups selected in this paper have different correlation levels, as listed in Table 1. Thereinto, the FO & WRO group has the largest correlation coefficient (reaches 0.92), while the Amperex & Goldfield group has the smallest one close to 0.

Table.1. Pearson Correlation for the close prices of different asset groups

Assets group	**Correlation coefficient**
Amperex & Goldfield	-0.04
FO & WRO	0.92
Gold & Silver	0.59

2.2 Method

For the sake of obtaining the spread option price, Monte-Carlo simulations are carried out for each group. It is a numerical simulation method that considers probability distributions as the research object based on random number generators [6, 7]. To generate the random number, NORMSINV (RAND ( )) function is utilized to calculate unknown characteristic quantity by using sampling survey. Since the two underlying assets are correlated, the generated random number of the two assets are also correlated following the efficiency listed in Table 1. On account of ensuring accuracy, this paper simulates each group 1000 times.

The option pricing is based on Black-Scholes (BS) Model [8]. On this basis, the price of the option satisfies:

$$S_T = S_0 e^{\left(\alpha - \frac{\sigma^2}{2}\right)T + z\sigma\sqrt{T}} \quad (1)$$

Here, ST is the option price at the delivery date; S0 is the option price at the beginning date; Z is a normal distributed random number; α is the expected rate of return minus dividend rate (α=0 in Futures); σ is the volatility and T is the number of days.

The B-S model is derived following certain assumptions. Primarily, stock price follows a lognormal distribution. Besides, there is no risk-free arbitrage and securities trading is continuous. Finally, investors can borrow at a risk-free rate.

In the spread option, the call payout and put payout are calculated as Max [S-K] and Min [K-S, 0], respectively [9]. Here, K is the strike price on the spread option; S is the ultimate spread price at the delivery date on the spread option.

3. Results

To visualize the payouts of three groups of two underlying assets in the spread option, this study draws the payout graphs on each group of two underlying assets.

3.1 Gold and Silver

Figure 4. The payout of Gold & Silver spread option

This research presents the result of the payout of Gold & Silver spread option in Fig. 4. According to the graph, as for the group with correlation closing to 0.52 (listed in Table 1), the call payout of its groups went up as the spread price was over 5247 (the strike price that is assumed), while the put payout went down as the spread price was below the 5247.

Table.2. The summary of Gold & Silver price and their spread option after 1000 times simulation

	Max	Min	Average
Gold	446.84	352.82	391.94
Sliver	6658.00	5327.83	4151.00
Call Option	7510.43	0.00	824.32
Put Option	3605.38	0.00	592.46

The results of the payout of Gold & Silver spread option after the 1000 times simulation are given in Table 2 and shown graphically in Fig. 4. From the historical data, it can be concluded that the price of gold is cheaper than silver. It also manifests that the value of the call option is lower than the value of the put option in Gold & Silver spread option.

3.2 Amperex & Goldfield

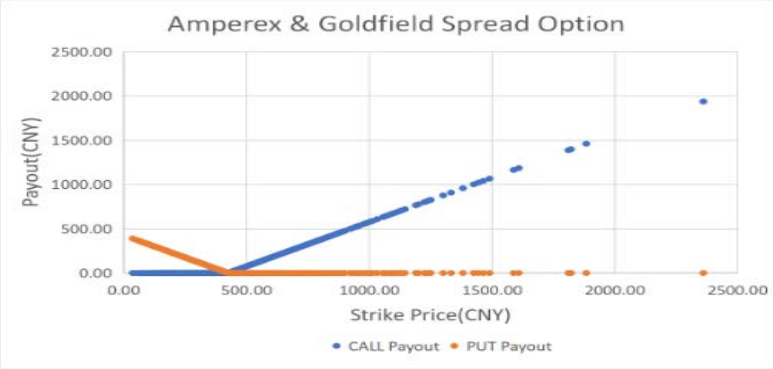

Figure 5. The payout of Amperex & Goldfield spread option

Fig. 5 illustrates the payout based on two assets whose correlation is closed to 0 (Table 1). One sees the payout of this group spread option changed in the 1000 times simulation (both call and put). The underlying formula is that Amerex price substrate Goldfield price. According to this picture, when the strike price was increasing over 423.99 (the strike price that is assumed), the call option price was rising companied with the change of strike price, vice versa.

Table.3. The summary of 1000 times in Amperex & Goldfield price and their spread option value

	Max	Min	Average
Amperex	2372.61	53.12	433.17
Goldfield	27.73	3.02	10.16
Call option	1936.16	0.00	96.37
Put option	388.53	0.00	98.36

In Table 3, it shows the summary of 1000 times in Amperex & Goldfield, including maximum, minimum, and average value. Since the fluctuations of Amperex were bigger than Goldfield, the option value's rise and fall mainly depend on Amperex's price. The put option maximum value is approximately 4.98 times larger than that of the call option, but the gap of their average is small (only 1.99 CNY).

3.3 FO and WRO

Figure 6. The payout of Amperex & Goldfield spread option

In Fig. 6, FO and WRO have a high correlation that is closed to 1 (seen from Table 1) as underlying that shows the payout of this group spread option changed in the 1000 times simulation (included call and put). According to the results, it can be seen that when the strike price increased

over 68 (the strike price that is assumed), the call option price was rising companied with the change of strike price while the put option decreased.

Table.4. The summary of 1000 times in FO&WRO price and their spread option value

	Max	Min	Average
FO	2.14	1.08	1.50
WRO	70.29	35.79	50.01
Call Option	1.23	0.00	0.22
Put Option	1.00	0.00	0.07

In Table 4, it lists the summary of 1000 times of FO&WRO, including maximum, minimum and average value. The maximum value of the call option is 1.23 times larger than the put options while they have the same minimum value.

3.4 Comparisons of different group

Table.5. The summary of 1000 times in three underlying assets' spread options value and multiple

	Max (call)	Max (put)	Multiple	Correlation
Gold&Sliver	7510.43	3605.38	2.08	0.59
Amperex&Goldfield	1936.16	388.53	4.98	-0.04
FO&WRO	1.23	1.00	1.23	0.92

According to Table 5, it gives that the greater their correlation is, the smaller the multiple relationships is. For example, in Table 5, it can be seen that FO&WRO's correlation is 0.92, but their multiple is only 1.23. However, Amperex & Goldfield has a -0.04-correlation coefficient, their maximum value of call option is 4.98 times larger than the minimum value of the put option.

4. Discussion

According to the analysis, this research uses the Monte Carlo method and B-S model to price three spread options constructed by different groups of assets with different correlations in 1000 times statistic simulation. Comparing the spread options based on three underlying assets groups of different correlations (0.92, 0.59, -0.04), this paper analyzes the application feasibility of implemented such spread options. In general, three aspects of concern are derived as listed in the following.

Firstly, the spread option possesses a greater price advantage. As summarized in Table 5, a higher correlation makes spread lower option price premium in terms of lower multiple. Moreover, it only needs to pay a premium once when you ought to buy two correlated assets options.

Secondly, it can reduce the uncertainty of price fluctuation and satisfy the options arbitrage strategy because the spread price change between a group of two correlated underlying assets was easier to predict than two separate assets, e.g., Fuel oil and WTI raw oil (Fuel oil is retracted from the WTI raw oil). If the seller worries about the price of WTI raw oil goes down, but the fuel oil price goes up, the seller can buy the spread call option to avoid the price risk and satisfy the arbitrage strategy for the seller. The same strategy is also feasible to the spread put option [10].

Thirdly, the maximum loss is controlled in the spread option, because if the overall market is not beneficial to the spread option buyer, the buyer has the right to not perform the spread option and only pay the option premium. For example, if the price of WTI raw oil and fuel oil go adversely, the buyer of the spread option has the right to not perform and pays the option premium once [10].

Based on the above analysis, the advantage of spread option application has the features of higher combination, lower premium and easier to predict that it can be beneficial for investing in high correlation arbitrage.

Since the mechanism of the spread option is based on a group of two correlated underlying assets, it limits this research on the following aspects:

(1) It is only viable when the correlation of the group of underlying assets is relatively high.

(2) The underlying assets ought to have the same trading time.

(3) The price spread of the assets should vary significantly.

In the future, it is hoped that this research can provide more ideas and suggestions for exploiting the contract of spread option in the exchange and finance market.

5. Conclusion

In summary, this paper discusses certain applications of spread options based on three groups of underlying assets in the research. According to the existing spread option groups in the market, it chooses three underlying asset groups with different correlations as experimental controls: high correlated (FO & WRO), medium correlated (Gold & Silver) and low correlated (Amperex & Goldfield), respectively. Subsequently, the B-S model is utilized to calculate the corresponding results of spread options and the Monte Carlo simulations are carried out 1000 times for the three asset groups. By comparing the maximum value in the call side and counterpart in the put side of the three options, it is obvious that a higher correlation between a group of assets has a lower multiple relationships, which can be used as one advantage in option price premium. On account of its features, some arbitrage strategies can be performed to avoid price fluctuation and risk. These results offer a guideline for putting forward the extension development of the spread option in the exchange and finance marke in following points.

(1) In the context of China's rapid economic development, the young financial market needs more abundant products to adapt the economic development and cope with the fierce competition in the capital market. It is necessary to launch the new financial derivatives such as spread options timely to enhance the competitiveness of the exchange. [2]

(2) At present, the breadth and depth of the options trading products developed by CME are not deep in China, partly because the underlying futures already had enough depth to meet the demand for arbitrage. However, with the launch of various derivatives, such as cross-variety options, which can better meet the demand for arbitrage of traders and improve short-term returns when correlation between a group of underlying assets tends to be larger, so we can see the enlightenment effect brought by financial innovation, especially for domestic traders who are not familiar with futures arbitrage. Therefore, the publicity effect brought by the launch of our new products can help the development of futures arbitrage activities attached to options. [9]

(3) The spread option can help investors to increase their investment choices, and investors can use the spread option to obtain income or hedge risk management. [2]

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