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Business Computing and Global Informatization (BCGIN), 2011 International Conference on

The strategy and operation research of power forward options

Abstract

The introduction of power forward option transaction in the power market not only provides a richer revenue mix for the participants ,but also plays an important role in dispersing and avoiding those uncertainties of the market that they have to face,improving the controllability of transaction and enhancing the stability of the power market operation.In this paper,the strategy using of power forward option and its trading operations in the power market is analyzed and specific examples are presented.

Introduction

The optional power forward contract which combines with option theory renders a more flexible and elastic option for both parties of the market transactions. This is a contract model which its fundamental thinking is based on the option trading theory. It makes the power forward contract (not power itself) directly as the subject matter of an option contrast to have free trade during the

In the operation of actual power market, it is allowed by the market rules that both parties of the power transactions may enter into forward contract of power exchange at the future time of T according to their willingness. Now we suppose that: (1)Based on the forward information of market publicly available or the information of the market coordination and arbitrator which approved by the parties to the contract, they will have a similar estimate between the probability distribution function and probability density function of the power spot prices P in the future time T [1]. (2)The forward price in the power forward contract is F and the delivery price which aims to make the contract's value to zero is K. At the time when forward contract is signed, F=K, and with time goes by, K keeps the same, F may change, but at last, when it reaches the contract's due date, it converges to spot price [2].

For the forward option is a right, not the obligation, the holders will obtain the forward contracts with the determined forward price before the specified date. In particular, the holders of bullish forward option have the rights to obtain the long position of forward contract in accordance with the specified price; the holders of bearish forward option have the rights to obtain the nominal of forward contract in accordance with the specified price [3].

Therefore, the contract of power forward option offers greater freedom choice for both parties of contract, and the various market participants are available through the purchase of forward option to obtain their desired rights. When bullish forward option is carried out, the benefit of investors carrying out option equals to

forward spot price minus the strike price of option; when bearish forward option is carried out, the benefit of investors carrying out option equals to the strike price of option minus forward spot price. The due date of forward option is generally the same day or few days earlier of the earliest delivery date of the subject's forward contract.

II. THE STRATEGY ANALYSIS OF POWER FORWARD OPTION PORTFOLIO

Power forward option has the function that it may produce a wide range of different profits status.

If the strike price of power forward option could be any possible price, it may create any form of profit and loss state in theory, which is very attractive to the capital investment which is outside the power market. In fact, unilateral or bilateral model of optional power forward contracts are only two strategies of the portfolio in the model of power forward option contract.

The model of unilateral optional forward contract between power companies and users only allows the power supply interruption to the users when the spot price is higher, and the power companies pay the price of disruption (equals to premium Q). If it is explained by the thought of option synthesis, the power companies is equivalent to sell a forward contract and simultaneously buy a bullish forward option. Its profit and loss state is shown in Figure1, K is the delivery price of forward contracts, X is the strike price, and Q is the premium [4].

As a consequence, the synthesis option is equivalent to buy a bearish forward option which its premium is (X+Q-K) by the side of power company. Because of (X+Q-K)>0, We may get X>(K-Q).

Figure 1. Synthesis option constructed by the forward and bullish forward option

Similarly, the bilateral model of optional power forward contract can be explained by the option synthesis application. At this time, the seller is equivalent to selling the bearish forward option by a certain strike price, while buying bullish forward option with a higher strike price of the same forward contract and selling forward option which its delivery price is between the two previous strike prices, thus its synthesis option constituting the two-period option policy of trading strategy. The profit and loss state of seller is shown in Figure 2, which its expected

return and potential losses are (K-Xl) and (X2-K).Therefore, making K close to X2 is profitable in terms of the seller.

Figure 2. the synthesis option constructed by forward and bullish, bearish forward option

The above analysis of the two options strategy is just tip of the iceberg. If the strike price of power forward option can be any possible price, it may establish any form of profit and loss state in theory. For example, according to hold the long position or nominal of the same or different option, it will form the spread option, combination option and other complex option, while the plentiful profit and loss status will be generated. Among that, such as butterfly spreads, strangle and straddle are very interesting and attractive trading strategy [5].

Butterfly spreads: The butterfly spreads is composed of three forward option positions with different strike prices. It can be constructed as follows: To purchase a bullish forward option with lower strike price X1 and a bullish forward option with higher strike price X3, then sells two bullish forward options with the strike price X2= (X1+ X3)/2. Generally speaking, X2 is very close to the delivery price of forward contract. The profit and loss status of this investment strategy is shown in Figure 3. Using the strategy will be profitable if forward price remains at near term of X2, while there will be a small loss if the forward price has greater volatility in any direction. As a result, butterfly spreads is a nice choice for those investors who consider that the power forward price cannot be subject to significant volatility.

Figure 3. Butterfly spreads constructed by bullish forward option

Strangle: Simultaneously buying the bullish forward option and bearish forward option with the same maturity but different strike prices will construct the strategy. The profit and loss status is shown in Figure 4. The strike price X2 of bullish forward option is higher than the strike price X1 of bearish forward option. So the strategy could be used when the investors expect that there are significant changes in power forward price without any ideas about its direction [6]. The benefit of this strategy is unlimited when the forward price is changing towards a favorable direction. On the contrary, its losses are limited smaller when the forward price changes into the negative direction.

Figure 4. Strangle constructed by bullish and bearish forward option

If the strike prices of bullish and bearish forward option are the same in the strategy (X1=X2), it will constitute a common straddle. The difference between the two combination options is that: The investors can only benefit when changing level of forward price in strangles strategy is greater than in the normal straddle: At the same time, the loss of strangle is smaller when the forward price ends in the central parity with a minor movement. Actually, the farther apart from X1 and X2, the smaller the potential losses suffered. In order to obtain the same profit, the changes of forward price need to be even greater.

From the above analysis, we can see that many trading strategies of forward options will not only provide a richer revenue mix for both parties of the contract in the power market and improve the controllability of the transaction, but also disperse the market price risks in the power market because of price, load and other uncertainties, which is conducive to the smooth price and stable operation of the power market.

III. OPERATION AND CALCULATION CASE ANALYSES OF POWER FORWARD OPTION

A. Operation of power forward optio

In order to better illustrate principles of operation of the power forward option trades, let's assume that in a random power market there are four market participants :a, b, c and d which are supposed to be independent power producers, power companies, investors outside the market and users respectively. Their relationships with each other is shown in Figure 5. There is a power forward contract between a and c, b and d respectively, and the contracts have the same signing time, contract size, maturity date T and delivery price K. Assume that all participants in the market have the awareness and ability to fulfill the contracts on schedule, and that the transaction costs of the contract in the profit and loss analysis are ignored [7]. Let's consider a strategy that uses the strike price of bullish forward option to gain lower limit protection: in order to avoid or reduce interests losses caused by possible rises in power present price, B purchases a forward option contract from C based on the forward contract between A and C in which the option fee and strike price is Q and X1 respectively; A and D won't sign

any contracts with other market participants apart from their own forward contracts which they already have.

Figure 5. Power forward option model

In this model, B gains the lower limit protection of strike price by selling a forward option and buy a bullish forward option, and at the same time B keeps his opportunity to gain benefits when the electricity price in the market goes for positive changes. According to the analysis above, we can conclude that:

$X \square\square (K \square\square Q)$

If the spot price of time T is smaller than the strike price X of forward option, B will lose option fee by giving up option; if $S_T \square X$ at time T, B will carry out bullish forward option and gain $S_T - X \square$benefits. Thus, the benefits B will gain by carrying out bullish forward option is:

$$\begin{aligned} S_T - X &= (S_T - X) + (K - K) \\ &= (S_T - K) + (X - K) \end{aligned}$$

(1)

The formula (1) is made up of two parts. The first part $(S_T - K)$ represents long position of forward option B gets from A and the benefits B gets by settlement and delivery; the second part $(X \square\square K)$ represents the benefits D gets during the settlement and delivery as forward option contract long position from the long position of contract of B, especially when $(X \square\square K) \square\square 0$,that is, when the strike price X of bullish forward option is smaller than the delivery price K of forward contract and under this condition, the benefits D gets from B is negative, that is, D pays B $(K \square\square X)$.

Above all, when bullish forward option is carried out in power forward option, the loss and benefit of the two contract parties is as follows (option fee paid when buying the option excluded).

If $K \square\square X \square\square (K \square Q)$, then the long position benefit of this potion contract is $(S_T - X) \square$, among which the benefit from long position by delivering forward contract is $(S_T - K)$ and the benefit from nominal of option contract; and the loss of nominal of option contract is $(K \square\square X)$. If $X \square\square K$, then the long position benefit of this option contract is $(S_T - X) \square$, among which the benefit from long position by delivering forward contract is $(S_T - K)$ and the payment to option contract of nominal $(X \square\square K)$ is needed; and the nominal benefit of option contract is $(X \square\square K)$. Similarly, we can analogize the loss and benefit condition of long

position and nominal when bearish forward option is carried out and we won't give any unnecessary details here.

B. Analysis of calculation cases

Assume that the date is 15th, March, a power company signs a forward contract with the user stating that it will sell 1,000,000MWh electricity and at the same time, buy a bullish option of a forward contract which has the same signing time, contract size, maturity date T and delivery price K. In this forward contract, delivery price K=300RMB/MWh, bullish forward option fee Q1=10RMB/MWh when strike price X1=310RMB/MWh and bullish forward option fee Q1=25RMB/MWh when strike price X1=290RMB/MWh; the strike price is decided by the spot price at contract's due date by the two parties of option contracts. Suppose that the spot price of electricity =350RMB/MWh at time T, Table 1 and 2 lists the loss and benefit condition of the contract's two parties when power company carries out option under different strike prices.

TABLE I. WHEN X=310RMB/MWH, THE LOSS AND BENEFIT OF EVERY PARTICIPANT PER MWH(E) (UNIT:RMB/MWH)

TABLE II. WHEN X=290RMB/MWH, THE LOSS AND BENEFIT OF EVERY PARTICIPANT PER MWH(E) (UNIT:RMB/MWH)

Thus, if the power company doesn't take any protection measures, when spot price in the market S_T =350RMB/MWh at time T, it will lose: 50RMB/MWh×1,000,000MWh= 50,000,000RMB; if the power company takes the strategy of using the strike price(X=310RMB/MWh)of bullish forward option to gain lower limit protection, its loss will turn into 10RMB/MWh×1,000,000MWh=10,000,000RMB, and at the same time add its costs in buying forward option C=10RMB/MWh×1,000,000MWh=10,000,000RMB.
In this way, it will lose less than when it doesn't take any protection measures by 30,000,000RMB(time value of option fee excluded). Specially, when the strike price is high enough, the benefits of carrying out option by the power company may exceed the net benefit which is brought by the loss of forward contract.

IV. CONCLUSION

The results of the analysis show that: The introduction of power forward option transaction in the power market not only provides a richer revenue mix for the participants ,but also plays an important role in dispersing and avoiding those uncertainties of the market that they have to face, improving the controllability of transaction and enhancing the stability of the power market operation. It can be anticipated that power forward option will be popular among the main market participants as a significant risk management tool in the power market and by various trading strategies.

ACKNOWLEDGMENT

Supported by Leading Academic Discipline Project of Shanghai Municipal Education Commission, Project Number :J51302.

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