IOP Conf. Series: Materials Science and Engineering **242** (2017) 012094 doi:10.1088/1757-899X/242/1/012094

# Study of Agricultural Product Options Pricing

**Qiu HONG**

School of Economy and Management, Tianjin University of Science & Technology, Tianjin, China

Corresponding author:qiuhong_1991@126.com

**Abstract**: China is a large agricultural country, and the healthy development of agriculture is related to the stability of the whole society. The agricultural production and management of agricultural products are confronted with many risks, especially the market risks. Option contract is the object of option market transaction, so it is very important to study the option contract of agricultural products. Option trading separates the risk and profit, so that the trader can avoid the risk while retaining the opportunity to obtain income. The option has the characteristics of low transaction cost, simple and efficient, so it is suitable for small and medium investors.

## 1 Introduction

At the end of 2016, China Securities Regulatory Commission formally approved the Dalian Commodity Exchange soybean meal futures options and Zhengzhou Commodity Exchange sugar futures options. The Chinese derivatives market will officially open the option era. To soybean meal, sugar as the representative of the agricultural options listed for China has an unusual significance. It brings new tools and ways for China's agriculture related subject risk management and service of the real economy [1,2]. At the same time, this is also an indispensable step for the construction of commodity pricing in China.

The agricultural product options are kinds of commodity options. They are financial derivative tools with agricultural products. They have the characteristics of low cost, low risk and high profit. The low cost and high income of agricultural products have attracted the attention of the hedge, the speculative and the arbitrage[3,4]. They play an important role in stabilizing the price of agricultural products and avoiding the market risk.

The so-called option, also known as the right to choose, is the right of the buyer within the agreed period, according to a predetermined price, buy or sell a certain number of specific goods or financial instruments[5,6].Options are the basic risk management tools of the international derivatives market, and constitute a complete risk management tool system for futures markets together with futures, forwards and swaps.

## 2 The importance of agricultural product options

In the actual agricultural products trading, the agricultural market price fluctuations are relatively large, seasonal strong. Farmers worry that the price of agricultural products fell, the rise in agricultural prices means that their income will increase, but if the price falls, will give them economic losses. Therefore, in the options market, farmers often buy the put options to lock in prices caused by the risk and gain the benefits of rising prices of agricultural products, and the price of a call option to pay a certain fee options.

In the agricultural options, the farmer as the option buyer, the agricultural market is higher than the agreement price, the farmers giving up the implementation of the option, engaged in the spot market product transactions, to obtain more benefits. The price is only paid to the enterprise. The final stop is limited to the option fee.

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The farmer chooses to execute the option contract and transfers some of the risk of falling prices to the firm through the contract when the market sentiment is lower than the agreed price, which ensures that the proceeds are higher than those of the non-taking option contracts. As an option contract, the seller's enterprise, whether farmers choose to execute the option, can receive an option fee, as a profit guarantee, to a certain extent, avoiding the operational risk. The use of agricultural option model, on the one hand, can ensure that farmers do not lose access to higher income, on the other hand, compensate for the enterprise price fluctuations caused by the cost risk.

## 3 The emergence of agricultural product options market

Option market is a kind of advanced market form, which has the functions of price discovery, risk transfer and risk redistribution. The beginning of the world's options market can be traced back to the tulip trade in Holland in seventeenth Century.

The construction of agricultural product options market can not only improve the market system of agricultural products in China, but also guide the production, trading and consumption of agricultural products spot market, becoming a regulator of stable spot price of agricultural product and long-term supply and demand.

The agricultural product option market is the normative and the flexibility. Its contract price has the characteristics of advanced nature, continuity, openness, competition and high risk management performance.

The emergence of agricultural options is later than financial options, although agricultural futures are early. In April 1973, the Chicago Board Options Exchange launched a stock option contract. The emergence of agricultural options was late for ten years. By 1983, the Chicago Board of Trade for the first time launched a corn option deal, and then in 1984 launched a soybean option deal. Since then, agricultural options trading has gradually developed, a number of futures exchanges have opened with its listing futures related to the options business. Brazil, Argentina and many other developing countries, regional futures exchanges, have also carried out agricultural options trading. The option contract has basically become a related contract for the futures contract, with a certain size of the futures contract has a corresponding option contract. At present, there are more than 60 varieties of agricultural products in the world, such as corn, wheat, soybean, soybean oil, rapeseed, cotton, sugar and orange juice.

The subject of an option transaction is a right. The option buyers pay the option fee and thus enjoy the right to buy or sell an asset at a fixed price in the future. Different options and futures, the option buyer has no obligation to the seller only option right. The seller of the option is only the obligation and no right futures. They must be carried out in accordance with the provisions of the liquidation or delivery of a futures contract. The rights of both sides is also an obligation. The rights and obligations enjoy by both parties are reciprocal.

Option trading is of great significance to form a perfect futures market system and risk management system. Option trading, as a risk management tool for futures trading, will not produce new risks outside the futures transaction. The biggest risk to the option seller is the risk of futures trading and no risk of amplification. At present, the international commodity futures market option contract is very common. The option transaction shows a growing trend, fully embodies the strong demand in the market.

Since the 80s of last century, options trading has developed at an alarming rate. According to the statistics of the American futures industry association, the global turnover contract reached 8 billion 550 million hands in 2016, nearly 60% of turnover in the same year contract, 45 times in 1985, and an average annual growth rate of 13.5%. In the past a long period of time, the agricultural options trading volume has been stable in the fourth place trading volume. In 2016, the agricultural product options trading volume was 78 million, an increase of 2.8%. CBOT is the world's largest agricultural futures exchange, a large number of spot traders, farmers and enterprises to participate in options trading, hedging.

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## 4 Empirical study

The basket price of agricultural products at maturity date is $\left(S\left(T\right)-K\right)^{+}$. The price of the basket option of the agricultural products is as follows

$$C\left[K,T\right]=e^{-rT}E\left[S\left(T\right)-K\right]^{+}$$

We consider corn and wheat as 2 basket options for agricultural products with a storage ratio of 0.5% and 0.6%, where $r=6\%$, $v=0.9$. The model parameters and weights are shown in the table. The expiration date of the option is 6 months. The execution price $K$ is 4600. The initial price $S_i\left(0\right)$ is the unit (per ton price).

**Table1** 2 underlying assets of agricultural product options

| | 1 | 2 |
|---|---|---|
| $S_i\left(0\right)$ | 3000 | 3500 |
| $\mu_i$ | 0.006 | 0.009 |
| $\sigma_i$ | 0.2 | 0.09 |
| $\omega_i$ | $\frac{1}{2}$ | $\frac{1}{2}$ |

Using the Monte Carlo method to simulate $10^5$ times, the agricultural option price are 34.4698 and 39.6895 respectively by Black-Scholes model and Variance Gamma model. The value of the Variance Gamma model is higher.

The Black-Scholes model and the Variance Gamma model are compared by a set of execution prices, where $K\in[4550,4650]$. The results of the simulation are shown in the Table2.

**Table 2.** Call price of agricultural products

| $T$ | $K$ | $BLSC\left[K,T\right]$ | $VGL\left[K,T\right]$ |
|---|---|---|---|
| Six months | 4550 | 84.3512 | 88.6987 |
| | 4555 | 72.5412 | 76.3258 |
| | 4560 | 68.2541 | 72.2415 |
| | 4565 | 62.1354 | 66.3548 |
| | 4570 | 57.2154 | 61.2543 |
| | 4575 | 52.3147 | 57.3591 |
| | 4580 | 47.3564 | 52.2367 |
| | 4585 | 42.2574 | 47.6584 |
| | 4590 | 37.2698 | 41.2368 |
| | 4595 | 32.6121 | 37.2514 |
| | 4600 | 27.6354 | 31.2635 |
| | 4605 | 22.0354 | 26.3214 |
| | 4610 | 17.3621 | 21.8584 |
| | 4615 | 11.9845 | 15.3298 |
| | 4620 | 6.9854 | 1.9654 |
| | 4625 | 1.2654 | 5.6478 |
| | 4630 | 0 | 1.3657 |
| | 4635 | 0 | 0 |
| | 4640 | 0 | 0 |
| | 4645 | 0 | 0 |
| | 4650 | 0 | 0 |

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The values obtained by the A model are higher than the values of the B model. The results are consistent with the reality.

## 5 Suggestions for developing agricultural product options in China

### *5.1. Establish a sound risk control and monitoring system*

The government should introduce policies and regulations to prevent and control the risks of options trading. From the US futures trading risk management and control strategy point of view, the systems generally include margin system, price limit system and market maker system, etc. These systems, after decades of practice in the United States, are enough to be used as reference in the establishment of our country's risk control system. For example, the price limits set, helps to set the price fluctuations, can effectively control the market risk. Raise the option market access principle, monitor the market position risk of the market maker, assess the performance of the market maker's obligations, and establish a complete financial monitoring system. In an open, fair and impartial manner, efficient operation of the long hours, the development of risk response strategies, standardization of risk, market transactions monitoring.

### *5.2. Government support and guide farmers to use agricultural product options*

Encourage other commercial enterprises, banks, trust companies, insurance companies and other competent and willing to take the risk of institutional entities into the options market speculation, increase the number of agricultural options market players, to improve the liquidity of the options market. To guide farmers to buy the lowest target price put options, and the government can pay a certain amount of options for farmers to pay the right to give farmers a certain financial subsidies to reduce the government's financial burden and the agricultural market price signal fully reflects the actual relationship between supply and demand, Improve the farmers in the agricultural market environment in the survival and competitiveness. Speed up the introduction of the laws and regulations on the management of agricultural options market, the options market trading activities under the legal framework to run, improve the transparency of agricultural options market management, to ensure that the agricultural options trading policy stability and continuity.

### *5.3. Increase the personnel training*

Institutions of higher learning should actively introduce options trading courses, understand the rules of the options trading process, and participate in options trading through practice. Futures exchanges and Futures Company should strengthen the training of options for the delivery of more advanced talents for society. The government education department will increase the advocacy of the option, and can draw on the experience of the United States and use part of the agricultural subsidies in the main agricultural production areas for the pilot trading of options. At the same time, we should pay more attention to strengthening investor education, increase the awareness of the investors, especially the farmers, and make rational use of the option to give full play to the role of option trading in agricultural products.

## 6 Conclusion

The development of rural economy in China needs to rely on agriculture to pull, to emerging financial derivatives options, for example, confirmed the current rural financial product innovation needs. The rapid development of options since the emergence of the main reason is that the option itself has a unique advantage, such as small capital costs, simple and efficient. The option divides the risk and the return so that the trader retains the opportunity to obtain the benefit while avoiding the risk.

In 2017, the listing of two options for sugar and soybean meal in the field ended the history of China's commodity options blank, and provided new ideas for the implementation of China's agricultural support policy. It is recommended to draw lessons from foreign experience and combine with China's national conditions to study the feasibility and specific implementation path of agricultural subsidies to explore the use of agricultural products. The agricultural product options help farmers lock in the lowest sales income and enrich the agricultural support policy tools.

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The agricultural product options market has just been established in China, and the option products should be tested by the market and investors. The exchange should improve the contracts and keep up with the requirements of the market development.

To prepare and timely introduction of new varieties of agricultural options, such as corn options, wheat options, etc., not only can enrich the options system, but also better serve the important grain varieties of the purchasing and storage system reform and agricultural supply side structural reform.

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