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The evolution of option valuation theory and its application in practice

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Abstract: Options are an important tool in financial markets for managing and transmitting risk, while also providing investors with the opportunity to earn returns. This paper first introduces the basic concepts and characteristics of options, including the definition of an option, buyer and seller, strike price, and expiration date. Next, the differences between European and American options, and the characteristics of Asian and Brazilian options are discussed. Then, the development and extension of option valuation models, as well as their applicability and limitations, are discussed. In addition, the application and role of options in the financial markets are analyzed, as well as option trading strategies and practical examples. The risks and challenges of options trading are further discussed, as well as the concepts of speculation and arbitrage. Finally, suggestions and outlooks for options trading and risk management are presented, as well as an analysis of the current state of research and future trends in options valuation theory and applications.

1. Introduction

Options trading has become an important part of modern finance with its flexibility and versatility. Option pricing models are important tools for options trading, and the Black-Scholes model is one of the most widely used models. However, the limitations of the Black-Scholes model have led to the development of many alternative models, such as the binomial model and the Monte Carlo simulation model. Despite the improvements, these models still have their own advantages and limitations. Options are widely used in financial markets, providing investors with a range of trading strategies such as speculation and hedging. However, options trading comes with risks and challenges, such as the risk of market volatility and the complexity of options trading strategies. Therefore, it is important for investors to fully understand the features and applications of options and the risks involved in options trading. In this paper, we review the basic concepts and characteristics of options, the development and promotion of option pricing models, the application and role of options in financial markets, and the risks and challenges of options trading. Finally, we provide some suggestions and outlooks on options trading and risk management.

2. Basic concepts and characteristics of options

2.1. Defining options and their essence

An option is a financial derivative that is the right to buy or sell a specific commodity within an agreed time period. An option contract generally includes elements such as the underlying, type of option, exercise price, and expiration date [1]. The essence of an option is that it is a financial instrument that exists to achieve risk management and asset allocation for a portfolio. The two parties to an option transaction are the buyer and the seller, and the transaction is carried out by paying or receiving a certain option fee. Another essence of an option is that it has a leverage effect, where a small amount of capital can control a larger amount of assets, thereby multiplying returns. The buyer can realize gains from market fluctuations, while the seller takes the risk of potentially large losses. An understanding of options is important to investors for asset allocation and risk management.

2.2. Explain the basic features of options, such as buyer, seller, strike price, etc

An option is a financial instrument whose basic characteristics include a buyer, a seller, and an exercise price. The buyer is the party who buys the option contract and acquires the rights but not the obligations; the seller is the party who sells the option contract and assumes the obligations but does not acquire the rights. The option contract also includes the exercise price, which is the price at which the underlying asset will be bought or sold at the agreed expiration date. In an option transaction, the buyer and seller trade by paying or receiving a certain option fee. There are two types of options, which are call options and put options. A call option is the buyer's right to purchase the underlying asset at an agreed price within an agreed period; a put option is the buyer's right to sell the underlying asset at an agreed price within an agreed period. The expiration date of an option refers to the expiration date of the contract, after which the contract automatically expires [2]. The basic characteristics of options determine that they are a flexible and diverse investment tool that can be used for risk management and asset allocation, as well as for speculation and arbitrage.

3. Classification and types of options

3.1. The difference between European and American options

European options and American options are the two most common types of options in the options market, and the biggest difference between them is the difference in the timing of the exercise. Specifically, European-style options can only be exercised on the expiration date, while American-style options can be exercised at any time prior to the expiration date.

The exercise time of a European option is fixed, and once the option is purchased, the buyer can only exercise it on the expiration date [3]. As a result, European options allow the seller to better control the risk of the option before the expiration date. In a European option, the buyer does not have a flexible exercise time and therefore needs to have a more accurate forecast of the market trend.

European-style options and American-style options have their own advantages and disadvantages, and investors need to choose based on their needs and risk tolerance. Generally speaking, European-style options are suitable for those who have a more accurate forecast of market trends, while American-style options are suitable for those investors who need more flexibility and reduced risk.

3.2. Introduction to sub-style options and Brazilian options

A sub-style option is a special type of option where the strike price is the average of the asset price

over a period of time. There are two types: average-price sub-style options and sub-style floating options. The exercise price of an average price sub-style option is the average of the asset prices over the option period, while the exercise price of a sub-style floating option is the highest or lowest value of the asset prices over the option period. Compared to European and American options, sub-style options are better suited for risk management dealing with average asset price fluctuations and slow market price changes.

The Brazilian option is a type of option similar to the European option, where the strike price is related to the time between expiration dates. In Brazilian options, the strike price decreases over time until the expiration date [4]. Unlike European options, the strike price of Brazilian options is calculated by a market formula rather than negotiated between buyers and sellers. Brazilian options are commonly used for risk management and hedging, and there is a relationship between their price and the price of the underlying asset, the strike price and the time to expiration.

4. Option valuation theory

4.1 Basic principles and formulas of the Black-Scholes option pricing model

The Black-Scholes Option Pricing Model (BOPM) is a mathematical model used to calculate European-style option prices. Its basic principle is to build a partial differential equation model based on factors such as option price, strike price, maturity date, risk-free interest rate, underlying asset price and volatility, etc. By solving this equation, the theoretical price of European options is derived [5].

The core formula of the Black-Scholes model is (1):

$$C = SN(d1) - Xe^{(-rt)}*N(d2) \quad (1)$$

Where C denotes the option price, S denotes the underlying asset price, X denotes the strike price, r denotes the risk-free rate, t denotes the time interval between the expiration date and the current date, N denotes the standard normal distribution function, and d1 and d2 are (2):

$$d1 = [\ln(S/X) + (r + 0.5\sigma^2)t]/(\sigma\sqrt{t})$$

$$d2 = d1 - \sigma\sqrt{t} \quad (2)$$

Where σ is the volatility of the underlying asset. The values in these two equations can be mathematically calculated. The calculation of N (d1) and N(d2) can be performed using standard normal distribution tables or computer programs.

With the Black-Scholes option pricing model, investors can calculate the theoretical price of European-style options and thus compare and analyze the actual prices in the market. The model also provides a theory-based pricing method for option trading, which makes the market price more closely resemble the theoretical price and improves the effectiveness and fairness of the market.

4.2. Development and extension of option valuation models

Option valuation models are an important tool in the financial field to measure and estimate the price and value of options. Traditional option valuation models are mainly based on the Black-Scholes model, but this model also has its limitations, such as problems such as higher sensitivity to market volatility. Therefore, to address these problems, scholars have proposed a series of improved and extended models based on the Black-Scholes model [6], such as extended models that take into account factors such as dividends, volatility, and risk-free interest rates. Meanwhile, some new option valuation models based on different ideas have also been proposed, such as option pricing models based on risk-neutral probabilities and option pricing models based on simulation methods. The

development and extension of these models have greatly improved the accuracy and practicality of option valuation, which is of great importance to the financial market and practical applications.

4.3. Applicability and limitations of option valuation models

While option valuation models are an important tool for measuring the value of options, their applicability and limitations need to be noted. In actual application, the assumptions of the model may not fully match the actual situation, resulting in errors in the valuation results. Moreover, the application of the model needs to be appropriately adjusted according to different market environments and trading objects to ensure the accuracy of the results. At the same time, the calculation of the option valuation model also requires consideration of certain costs and time, which also affects the effectiveness of the actual application. Therefore, the option valuation model needs to consider various factors in its practical application to ensure its applicability and accuracy.

5. Application of options

5.1. The application and role of options in the financial market

Options have a wide range of applications and roles in financial markets. It is not only used for speculation and arbitrage, but also as a risk management tool. Options can be traded in a variety of flexible ways, both in the over-the-counter market and in the over-the-counter market. Through options trading, investors can gain in a market with fluctuating prices, while also being able to manage price fluctuations effectively. Options are widely used in financial markets such as stocks, bonds, commodities, and foreign exchange, and have become one of the essential tools for all types of traders. At the same time, options trading also promotes the liquidity and price discovery functions of financial markets, providing an important means to achieve economic efficiency and risk control.

5.2. Options trading strategies and practical examples

Options trading strategy refers to the investor's goal of making profits in the options market by selecting different options contracts to trade and developing different investment strategies based on market conditions and risk appetite. Common option trading strategies include buying call options, buying put options, selling call options and selling put options.

The buy call option strategy is used in bullish markets, where the investor believes that the price of the underlying asset will rise. Buy put option strategies are used in bearish markets, where the investor believes that the price of the underlying asset will fall. The sell call option strategy is applicable to a flat or call market, where the investor believes that the price of the underlying asset will remain stable or rise, while the sell put option strategy is applicable to a flat or put market [7], where the investor believes that the price of the underlying asset will remain stable or fall.

Examples of options trading strategies in practice include the famous "Black Swan" incident and the "Wal-Mart Arbitrage" incident, during the 2008 financial crisis, some investors used the wrong options trading strategy due to incorrect market expectations, causing them to suffer During the financial crisis in 2008, some investors used the wrong options trading strategy due to wrong market expectations, which caused them to suffer huge losses. The "Wal-Mart Arbitrage" was a market arbitrage operation in which investors bought Wal-Mart stock and sold call options at the same time.

The selection of an option trading strategy requires comprehensive consideration based on the investor's risk appetite, market expectations and investment time. In practice, investors should follow scientific investment principles for risk management and asset allocation in order to achieve the goal of maximizing investment returns.

6. Risks and challenges of options

6.1. Risks and challenges of options trading

Although option trading has leverage and risk control, it also has certain risks and challenges. First, changes in option prices are affected by a variety of factors such as market factors, interest rate movements, and fluctuations in the price of the underlying asset, and market changes are difficult to predict, and investors need to have sufficient market analysis and judgment skills [8]. Second, once the expiration date of an option contract has passed, the contract expires, and if the option is not exercised or closed in time before the expiration date, it may cause irreparable losses. In addition, options trading suffers from transaction costs and illiquidity, which may limit investors' options and room for maneuver. Taken together, although options trading has various risks and challenges, with reasonable risk control and operational strategies, options trading is still an attractive financial instrument that can bring investors more investment opportunities and returns.

6.2. Speculation and Arbitrage in Options Trading

Options speculation usually follows two strategies: call options and put options. Call option speculators anticipate that asset prices will rise and purchase call options for profit. Conversely, put speculators anticipate that asset prices will fall and purchase puts to take advantage. Speculators can also use various combination strategies, such as option vertical and horizontal arbitrage, to realize gains.

Arbitrage is usually accomplished by comparing price differences between two or more assets, such as between stocks and options, or between options with different expiration dates. These arbitrage strategies are designed to take advantage of the price inconsistencies that exist in the market and thus yield less risky profits.

In practice, speculation and arbitrage are important strategies in options trading. However, they are not suitable for all investors, as they may require a high degree of risk tolerance and sophisticated trading skills. Therefore, investors should gain an in-depth understanding of the characteristics and risks of the options market before using these strategies and choose them carefully based on their own circumstances.

7. Conclusion

7.1 Summarize the basic concepts and characteristics of options

To summarize the basic concepts and characteristics of options, it is necessary to first clarify that an option is a financial derivative, the essence of which is a right, i.e., the holder has the right to buy or sell the underlying asset at an agreed price within a certain period of time. The basic features of an option include the buyer, seller, exercise price, expiration date, underlying asset, contract unit, etc. There are two types of options, European-style options and American-style options. European-style options can only be exercised on the day of expiration, while American-style options can be exercised at any time before the expiration date. In addition, there are other types such as Asian options and Brazilian options.

Options trading is risky and challenging and requires investors to have in-depth market analysis and trading strategies. Speculation and arbitrage are the two main strategies in options trading, where speculation refers to buying or selling options to make a profit, while arbitrage is risk-free trading by taking advantage of price differences in the options market.

In summary, understanding the basic concepts and characteristics of options, as well as valuation

models, speculative and arbitrage strategies, risks and challenges in options trading, is important for investors to develop scientific trading strategies, conduct effective risk management and realize investment returns.

7.2. Analyze the current research status and future development trend of option valuation theory and application

Option valuation theory is an important research direction in the field of finance, and its research includes the theoretical construction and empirical testing of various option pricing models. Existing option pricing models have certain limitations in practical applications, and researchers are continuously trying to improve and innovate. For example, the Black-Scholes model based on risk-neutral estimation leads to large errors in practical applications because of the inadequacy of its underlying assumptions, so researchers have proposed a series of improved models, such as jump diffusion model, stochastic volatility model, stochastic risk premium model, etc., in order to adapt to more practical situations.

In addition, with the development of artificial intelligence and big data technologies, more and more scholars have started to apply these technologies to the field of option valuation to explore new pricing models and more accurate prediction methods. For example, machine learning-based option valuation methods can use a large amount of historical data to train more accurate models, thus improving the accuracy of option pricing. At the same time, with the emergence of new financial instruments such as cryptocurrencies, it also brings new challenges to option pricing theory.

In summary, the research on option valuation theory is still going deep and developing, and future research directions include, but are not limited to, improving and innovating option pricing models, applying artificial intelligence and big data technologies for option valuation, and studying option pricing of new financial instruments such as cryptocurrencies.

7.3. Provide suggestions and outlook on options trading and risk management

In the future, options trading and risk management will face many challenges and opportunities. With the continuous development of artificial intelligence technology and big data analysis technology, options trading and risk management will become more automated and intelligent. At the same time, it is also necessary to continue to study option valuation theory and application in depth, continuously improve the models and methods of option trading, and improve the efficiency and accuracy of option trading.

The future also requires more attention to risk management issues in options trading, especially in complex market conditions. This requires the establishment of more complete risk management systems and tools and the adoption of effective risk control strategies and instruments to protect the interests of investors and market stability. In addition, there is a need to strengthen the regulation and supervision of options trading to prevent the emergence of market risks and operational risks and to promote the healthy and orderly development of the options trading market.

In summary, options trading and risk management are an important part of the financial market, and an important means for investors to obtain profits and protect investment risks. In the future, it is necessary to continue in-depth research and development of the theory and practice of options trading and risk management, improve the efficiency and precision of options trading, strengthen the regulation and standardization of options trading, and ensure the healthy and orderly development of the market.

References

[1] Black F., & Scholes M. (1973). The pricing of options and corporate liabilities [J]. Journal of Political Economy, 81(3):637-654.
[2] Merton R. C. (1973). Theory of rational option pricing [J]. The Bell Journal of Economics and Management Science, 4(1):141-183.
[3] Li X. (2019). The valuation of American put option based on the method of fuzzy binomial tree [J]. Journal of Physics: Conference Series, 1238(1):012057.
[4] Mao C., & Shi J. (2019). Analysis on the risk management of options trading in China [J]. Journal of Physics: Conference Series, 1238(1):012012.
[5] Lu J., Wang W., & Yuan Q. (2020). Option pricing under the generalized hyperbolic distribution [J]. Physica A: Statistical Mechanics and its Applications, 540, 123197.
[6] Wu Y., Sun, C., & Zhou Y. (2020). Research on option pricing model based on improved grey wolf optimization algorithm [J]. Journal of Physics: Conference Series, 1597(1):012007.
[7] Wu G. P. (2016). Research on option price evaluation method [J]. Science and Technology Innovation and Productivity, 290(13):143-144.
[8] Xu J., & Xie W. (2017). A study on option market and option trading strategy [J]. Science and Technology Wind, 17(6):102-103.