The Formation and Development of Options and Pricing Models

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Abstract: Option, BSM and mean-variance pricing model have always been hot topics in financial statistics, as well as basic concepts to master when learning financial knowledge and engaging in the financial industry. With the increasingly mature theoretical research on financial risk control, many pricing models related to risk control have been established based on BSM model and mean-variance model. Therefore, this paper mainly studies BSM model and mean-variance model. So, this paper mainly discusses the learning achievements of option contract, BSM model and mean-variance model. Firstly, this paper introduces the basic concept of option contract, explains what option contract is, the components of option contract, and the formation history and development process of option and option contract. Secondly, the formation and development process of BSM model and mean-variance model are explained respectively in the work, and related concepts are described and explained rationally. From the historical and realistic point of view, this paper explains the risk avoidance effect of option contract, BSM model and mean-variance model on financial transactions.

Keywords: finance，option contract, BSM model, mean-variance model

1. Introduction

In the study of financial derivatives, the model and method of option pricing is the most important, the most widely used and the most difficult to study. In 1973, the BSM option pricing model was formally proposed, which was hailed as "the second revolution of Wall Street". BSM model has become the cornerstone of modern option pricing theory research, marking the development of financial derivatives ushered in a key turning point. After nearly 50 years of development and research, the application of option pricing theory and model is increasingly mature, and a variety of pricing models have been studied, but the BSM model is still the most basic part of option pricing theory. With the development of economic globalization, the competition in the financial market becomes more and more fierce, and stock investment is constantly promoted and popularized around the world. While bringing huge benefits to economic subjects, it also produces a lot of potential risks. The stable operation of the financial market in the global scope is related to the economic security of each country. At present, more and more market economic subjects choose to use the mean-variance model to scientifically evaluate the returns and risks of stock investment decisions, so as to achieve the investment program that can maximize the returns and minimize the risks. Western capitalist countries apply the stock portfolio theory to the actual investment

operation, and the data shows that 7/10 countries will adopt the mean-variance model to control the investment risk.

The most important use of option contract and pricing model lies in the management of financial risks. In order to effectively manage and control financial risks, the first thing to be done is to reasonably and correctly evaluate options, fully consider all factors, and try to exclude uncontrollable influences, so as to achieve a scientific evaluation of option pricing. The generation and development of BSM model and mean-variance model provide a powerful theoretical and practical basis for the theoretical research of global option pricing, and play a huge role in promoting the development of option market. The basic principles and methods of BSM option pricing model and mean-variance model have been widely used in macro and micro economic and management analysis and decision-making, the most concentrated reflected in the financial application and practice, at the same time in investment decision-making and other aspects have been widely used.

The emergence of mean variance model is of great significance to the research of option pricing theory, but it has many shortcomings and problems to be solved because of its too strict assumptions. First of all, there is a rational man hypothesis in the mean-variance model, which sets the investor as a completely rational man. This hypothesis is not consistent with the real investor behavior. People have very large irrational factors, so it is impossible to look at any investment in a completely rational way. When the potential benefits are greater than the estimated risks, most investors tend to have a fluke mentality and turn a blind eye to the visible risks, resulting in huge losses. In reality, investors tend to be limited rationality rather than completely rational. Because investors have different perceptions and perspectives on investment, they tend to make different investment choices. Second, the hypothesis of mean-variance model is that investors have negative views on risks. It assumes that all investors have the same attitude towards risks and believe that investors will be risk averse. However, in reality, some investors buy both insurance and stocks, and both risk preference and risk aversion will be presented to the same investor. Thirdly, this model has certain limitations in measuring risks. Mean-variance model uses standard deviation to measure risks. This method is feasible to some extent, but it also has some problems. Standard deviation measures price fluctuation, which mainly includes two aspects: one is risk caused by falling price, the other is profit caused by rising price. In the market, investors' understanding of risk lies in the risk caused by the damage to their assets caused by the price decline. Therefore, it is somewhat narrow to replace risk only with the standard deviation generated by the price fluctuation. Due to certain blind spots and loopholes in the supervision of financial market, when financial companies operate stock prices without authorization, they can not only use price fluctuations to measure the risks of the company, which is contrary to the reality. The above three points are the deficiencies of mean-variance model in practical application. For these problems, the academic circle has not worked out corresponding countermeasures.

In the work, this paper gives a brief introduction to options, and points out that the emergence and development of options have a good restraint effect on the credit and potential risks in market transactions. As for the model of option pricing, this paper mainly discusses the generation background of BSM model and mean-variance model, as well as the effect implemented in the early stage of the research. This paper not only studies the feasibility of option pricing model at the theoretical level, but also focuses on the practical effects produced by the market players in the past 50 years when they use option and option pricing model, including benefits and damages, to understand the significance of option and option pricing model and its future development from both theoretical and practical perspectives.

2. History of Option Contracts

Option contract is a financial derivative product. Option contract originated in the Chicago Board Options Exchange in 1973. It is a trading contract with financial derivatives as the exercise variety. The right to buy or sell a quantity of a commodity at a specified price within a specified period of time. The buyer or holder of a contract owns the rights by paying the margin, or option premium; The seller or issuer of the contract receives an option fee and must fulfill the obligation when the buyer wishes to exercise the option. The price that the buyer of an option contract pays the seller for the right is called the premium. Option contracts are contracts for the right to buy or sell a particular commodity at a certain price at a certain time in the future [1]. The underlying assets of options include: stocks, stock indexes, foreign exchange, debt instruments, commodities and futures contracts. There are two basic types of options, call options and put options, also known as call and put options. The holder of a call option has the right to buy the underlying asset at a certain price at a certain time. The holder of a put option has the right to sell the underlying asset at a certain price at a certain time. The price in an option contract is called the strike price. The date in the contract is the expiration date, execution date or expiration date. American options can be exercised at any time during the life of the option. European options can only be exercised on the expiration date. Most options traded on the exchange are American options. However, European options are generally easier to analyze than American options, and some properties of American options can always be deduced from those of European options.

Options trading began in American and European markets in the late 1700s. The development of option trading has been restrained because of the unsound system and other factors. In the early 1920s, put/call traders were professional options traders who did not make a continuous bid over the course of a trade, but only made a bid when the price moved significantly in their favor. Such options trading is not universal, not easy to transfer, the market liquidity is greatly restricted, the trading system is thus frustrated. The blame for the early trading regime does not stop there. In the case of an XYZ option trade, it is entirely possible to have a situation where only one trader is making the market, causing the bid-ask spread to become too large and thus "price discovery" -- the process of reaching an agreed price -- to be blocked. Clients often ask, "How do I know my order is being sold at the best price?" Concerns about fairness prevent markets from attracting more participants quickly. The problem was not solved until April 26, 1973, when the Chicago Board Options Exchange (CBOE) opened to standardize and buy and sell options contracts. The terms of the option contract, including the amount of the contract, the expiration date, the pricing, etc., are gradually standardized. At first, just 16 calls were written on stocks. Soon, that number doubled, and put options soon began trading on more than 2,500 stocks and 60 stock indexes on all U.S. exchanges. Later, the Commodity Futures Trading Commission relaxed the restrictions on option trading and consciously launched commodity option trading and financial option trading. Due to the standardization of option contracts, option contracts can be conveniently transferred to a third party in the exchange, and the transaction process is very simple, and the final performance of the contract is guaranteed by the exchange, which not only improves the transaction efficiency, but also reduces the transaction cost. In January 1983, the Chicago Mercantile Exchange proposed the S&P 500 stock index options, and the New York Board of Trade also launched the New York Stock Exchange stock index futures and options trading. With the success of the stock index futures and options trading, various exchanges quickly expanded the option trading to other financial futures. At present, options exchanges are now spread all over the world, among which the Chicago Board Options Exchange is the largest in the world. The over-the-counter, or over-the-counter, options market also saw significant growth in the 1980s and 1990s. Over-the-counter options are options traded off an exchange. The seller of options is usually the bank, and the buyer of options is usually

the bank's customer. Banks design related varieties according to the needs of customers, so the varieties traded over the counter have greater flexibility in terms of maturity, strike price and number of contracts [2, 3]. Foreign exchange options came later. Today the leading currency options exchange is the Philadelphia Stock Exchange (PHLX), which offers European and American options contracts in the Australian dollar, British pound, Canadian dollar, euro, Japanese yen and Swiss franc. At present, most of the foreign exchange options transactions are over the counter transactions. "Optionsbao" business, which has been set up by some branches of Bank of China, adopts the way of over-the-counter trading of options.

Option is widely used because of its own advantages in market transactions. Its advantages mainly lie in its small trading risk, which can hedge market risks, lock profits and increase returns, and improve the efficiency of fund use.

3. BSM Model

The formation process of the option pricing model is introduced in detail in the documentary "Trillion Doller Bet", which is a documentary produced by the famous American television station PBS. The documentary mainly tells the story of Long-Term Capital Management from infinite glory to bankruptcy, reflecting the drawbacks and shortcomings of the excessive digitization of finance, and arousing people's reflection. In the financial world, scholars have been debating about whether financial investment is a natural science that emphasizes positivism or an empirical humanities science. Long-term Capital Management was a bold attempt to make financial investment completely scientific. Fortunately, this plan was very successful at the beginning, but as time went by, it failed miserably due to "black Swan" events. Among the founding partners of Long-Term Capital Management were Myron Scholes and Bob Merton, who won the Nobel Prize for inventing the Black-Scholes-Merton model. The Black-Scholes-Merton model was a financial sensation at the time and made the two academics rich and famous, but when they tried to apply the BSM model they had created to financial markets, it did not work well. In the financial market, capital flows frequently and changes rapidly. When scientivism is confident that it can rule the financial field, human beings, as the subject of financial market transactions, are an uncontrollable variable. Extreme and irrational events of human beings directly remove the basic assumptions and premises on which scientific conclusions are valid.

Since the dawn of capitalism, there has been a golden rule: if you want to make money, you have to take risks. The so-called high risk high yield, low risk low yield. There are two competing schools of thought on how to deal with risk. Some successful old-school traders believe that their success is due to their superior analysis, experience and even intuition, and that price movements can be predicted. Academic financial scientists, on the other hand, believe that a trader's success is just luck. Like flipping a coin, the price is completely random and unpredictable. The more people try to predict prices, the more unpredictable they become. In a number of related experiments, such as throwing darts at a blackboard full of ticker symbols while blindfolded, these stock portfolios outperformed the performance of top traders. Rigorous science hates uncertainty very much. They try to understand risks in a more quantitative way, and then help investors control risks [4]. Therefore, financial scientists have embarked on a great journey of quantifying risks one after another. In the early 20th century, an unknown French economics student, Louis Bachelier, had begun to study the random problem of prices, writing a doctoral thesis, "On Speculation". He thought that market prices were random and unpredictable, but he invented a way to control risk. This way was the option. An option is similar to insurance. If a person fears that the price will fall, he can buy an insurance policy that allows him to sell it at an agreed price when the price falls. This is called a put option. If a person thinks the price of an asset will rise, he can also buy insurance that allows him to buy the asset at a certain price if the price rises in the future. This is called a call

option. Louis Bachelier came up with the concept of options and tried to price them without success. The pricing of options involves the level of confidence of each market participant, and trying to quantify the subjective state of a person is a very difficult thing. Many financial scientists have tried unsuccessfully to solve this conundrum, and the question of how to price options has become the holy grail of financial scholarship, the economists Fischer Black and Myron Sholes, who have studied the issue specifically, have made a breakthrough on key elements. Two scholars found that when pricing option, stock price, volatility, strike price, contract term and other factors that can affect option price can be quantified, but only the risk of option itself is difficult to quantify, which is the difficulty of the problem and also the key breakthrough point. Through continuous research and exploration, two economists found that they believed that if the problem of quantifying risk could not be solved directly, it would be better to consider the solution from another Angle. Since it is difficult to quantify the risk of option, the scholar tried to find a way to make it irrelevant in pricing, so the method of "Delta hedging" was created. It has become one of the most important inventions in modern economics. Fischer Black and Myron Sholes found that if you combine a stock with a certain number of options, you can smooth out the volatility of the stock price, so that a "hedged" portfolio of options yields only a risk-free return. In this way, the value of the option can be replicated in the construction of a portfolio of stocks and risk-free capital. In this case, the option price is only related to the stock price, volatility, strike price, contract duration and risk-free interest rate, which successfully eliminates the variable of risk carried by the option itself [5].

Black-Scholes-Merton model can effectively manage risks, but it cannot accurately predict the future. Financial investment is a complex of natural sciences and humanities. In addition to the need for useful scientific tools, human experience, judgment and intuition are irreplaceable.

4. Mean-variance Model

Harry Markowitz was studying for his PhD in economics at the University of Chicago when he ran into a stockbroker outside his office door while waiting to discuss his dissertation with his advisor. The chance encounter was a turning point in his fortunes. A conversation with a stockbroker led to a change of direction, and Harry Markowitz became very interested in the stock market. Fortunately, his mentor also supported and encouraged him to carry out research in this field and recommended to him The most famous book of the then famous economist John Williams: The Theory of Investment Value.

According to John Williams, the price of a security reflects its "intrinsic value", and the value of a security is the discounted price of its future dividends. However, Harry Markowitz soon found that there was a defect in this theory, which was the lack of analysis of "risk" : although investors want to maximize expected discounted returns, they should also consider that the variance of returns is a bad thing. Investors should consider both aspects in the decision-making process, and should construct a portfolio as follows: Make a trade-off between "expected return" and "variance of return". So in 1952, at The age of 25, Harry Markowitz published a paper in The Journal of Finance, a top finance journal, called Portfolio Selection.

But Harry Markowitz's research turned out to be correct, and it caused quite a stir in the academic world. The status of Portfolio Selection is first-class, and the work is often compared to Newton's Principia Mathematica of Natural Philosophy. It's like proving "Don't Put all your eggs in one basket." It's the hardest thing to prove the simplest common sense mathematically, but Harry Markowitz has done it [6, 7]. At the same time, Harry Markowitz's theory was advanced and had trans-era significance. With the development of technology, his theory was finally verified by the securities market and recognized by professionals. In 1990, 40 years after the article was published, Harry Markowitz won the Nobel Prize in Economics for his work on portfolio selection theory.

Harry Markowitz first proposed the Modern Portfolio Theory, or MPT, in this essay published in 1952. This theory refers to the assumption that there are four kinds of ABCD assets in the market at present, such as stocks, bonds, futures and cash. These liquid assets have their own rates of return, but also their own risks. Given the coexistence of benefits and risks, should investors hold only one asset? Asset A, for example, or should I hold a portfolio with more than one asset? If so, what types of assets should be included in the portfolio? How should various assets be matched to minimize the total risk, but maximize the benefit? This is the central problem of modern portfolio theory.

To truly understand this theory, it is necessary to learn two important elements: mean-variance analysis and efficient frontier. Modern portfolio theory uses mean and variance to reflect the two key factors of return and risk. The average refers to the expected return of a portfolio. It is the weighted average of the expected return of a single security, with the weight of the corresponding investment proportion. Variance, on the other hand, refers to the variance of the return rate of the portfolio, which measures the deviation between the actual return rate and the mean value and mainly reflects the risk of the portfolio [8, 9].

To calculate the variance of a portfolio, you need to know the covariance between all the assets. Covariance is a measure of how the return on two assets changes. In short, it is a measure of whether the return on two assets changes in the same direction or in the opposite direction and how much. If the return on asset A goes up when the return on asset B goes up at the same time, then they're going in the same direction, and the covariance is positive; If the return on asset A goes up at the same time that the return on asset B goes down, then they're going in the opposite direction, and the covariance is going to be negative. The larger the value of covariance, the greater the degree of both changes in the same direction or in the opposite direction. And the correlation coefficient is just the covariance divided by the standard deviation of the asset, so you can also view it as a special kind of normalized covariance.

Harry Markowitz revealed the role of covariance. The variance of a portfolio not only depends on the variance of a single asset, but also depends on the covariance among various assets. With the increase of the number of securities in the portfolio, the role of covariance in determining portfolio variance is increasing, while the role of the variance of a single asset is decreasing, that is to say, The covariance is almost the determinant of the combination variance.

Harry Markowitz made two important contributions to this research: the first is that 1+1 does not equal 2. Harry Markowitz proposed that portfolio risk is not simply the sum of the risks of various assets, but the correlation between them should be considered, that is, 1+1 does not equal 2 in this case: The risk of a portfolio is not the risk of the asset itself, but the mutual influence of various risks. Therefore, by manipulating the correlation between assets, people can manipulate the risk of the portfolio, so as to achieve a desired return -- the risk portfolio. The second is risk diversification. The principle of risk diversification is considered the only "free lunch" in modern finance. Combining multiple assets together can wash away some of the risk without lowering the average expected return [10].

There is also a detailed presentation on Efficient Frontier by Harry Markowitz, and one can find the right portfolio at Efficient Frontier.In terms of specific application, assume that there are four kinds of assets ABCD in the market at present, and people know their annualized returns, annualized volatility and correlation coefficient. People can analyze these data with mean variance to find the efficient frontier, so as to maximize the returns and minimize the risks of own portfolio. The point on the efficient frontier is the best combination [11]. Through the analysis of the mean variance of assets, people can find an efficient frontier, and the point on this efficient frontier is the optimal portfolio. That is, the expected risk is minimized under a given level of expected return; Maximizing expected return for a given level of expected risk.

5.   Conclusion

Option contract is one of the most dynamic financial derivatives. BSM model and mean-variance model play an important role in risk avoidance, risk investment and value discovery, as the most basic knowledge of finance, they are very important for future study. In recent years, the theoretical and practical significance of the three has been more penetrated into the economic and non-economic fields, which is the essential knowledge for learning finance.

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