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Applications of Financial Mathematics : Challenges and future

Mrs. Ashwini Suresh Salunkhe
D.P. Bhosale College Koregaon

Abstract

Financial Mathematics is a branch of Mathematics that focuses on analyzing data, solving problems and modeling financial markets. It i useful in many industries and roles and there are many potential applications in financial mathematics including Economics, Statistics, Probability . This paper analyzes the basic connotation of financial mathematics,Financial mathematics through research development, control theory and discusses important applications of mathematics in the financial field.

Keywords : Mathematics, Financial Mathematics, statistics , Economics Asset Pricing Asset Pricing, Stochastic Optimal Control Theory

Introduction:

In general, there exist two separate branches of finance that require advanced quantitative techniques: derivatives pricing on the one hand, and risk and profolio management. Mathematical finance overlaps heavily with the fields of computational Finance and financial engineering and focus on applications and modeling, often by help of stochastic asset models, while the former focuses, in addition to analysis, on building tools of implementation for the models. A

French mathematician Louis Bachelier's doctoral thesis, defended in 1900, is considered the first scholarly work on mathematical finance. But mathematical finance emerged as a discipline in the 1970s, following the work of Fischer Black, Myron Scholes and Robert Merton on option pricing theory theory. Mathematical investing originated from the research of mathematician Edward Thorp who used statistical methods to first invent card counting in blackjack and then applied its principles to modern systematic investing.

Financial Mathematics is the application of mathematical methods to financial problems. It draws on tools from

probability, statistics, stochastic processes, and economic theory. Financial mathematics focuses on applying mathematical formulas and equations to financial problems, market modeling and data analysis. With this strategy, financial professionals can better understand business performance, including profitability and growth potential. If you're interested in applying mathematical strategies to business decision-making, learning more about this topic can help you develop the skills necessary to succeed in various careers.

objectives :

●The main objective is to motivate participants, to use their knowledge in probability and statistics, to study the theory of financial markets.

●To understand how to construct the best investment strategies that minimizes risks in the real world.

Applications :

The use of mathematics and statistics within the field of finance has been increasing substantially in the past, and such a trend is expected to continue. Various types of organizations and financial service providers utilize financial mathematics as part of their core operations, such as:

- Investment banks
- Retail and commercial banks
- Hedge funds
- Investment management companies
- Corporate treasuries
- Regulatory bodies

In addition, financial mathematics is applied considerably to solve problems, such as:

- Derivative security pricing and valuation
- Portfolio creation and structuring
- Quantitative investing strategies
- Risk management

Mainly there are three main Applications :

●Stochastic Optimal Control Theory

●The Basic Connotation of Financial Mathematics :

●Differential Game method

●Capital Asset Pricing Model

Stochastic Optimal Control Theory

Another important application field is the use of mathematics to solve the stochastic problems in financial problems.

The theory of stochastic optimal control is an important method and means to solve the financial problems with mathematical theory.

Stochastic optimal control is advanced in the development of the control theory gradually developed, through the application of Behrman principle in combination optimization, measure theory and functional analysis method of stochastic problem analysis. This method was formed in the late 60s of the last century, and became mature gradually in the early 70s. From the application of stochastic optimal control theory, the response of financial experts in this field is very rapid. At the beginning of 70s, the finance research field which appeared a few articles related to economics papers, including Merton (Merton) are discussed using the method of continuous time consumption and portfolio, the portfolio analysis between them is more consistent with the actual situation; and Brock (Brock) and Millman (Mirman) in random changes, using discrete time method of optimal economic growth are discussed. Subsequently, the stochastic optimal control method has been applied in most financial fields.

This article, from the construction of differential game application, option pricing and investment decision in the capital asset pricing model and stochastic optimization theory to explore three aspects of the important application of mathematics in the field of finance, reflects the important role of mathematics in modern financial analysis.

The Basic Connotation of Financial Mathematics :

Financial mathematics, also called analytical finance and mathematical finance, is an interdisciplinary subject of mathematics and finance that arose in the late 1980s and early 90s. Financial mathematics mainly uses the modern mathematical theory and method (such as stochastic analysis, stochastic optimal control, portfolio analysis, nonlinear analysis, multivariate statistical analysis, mathematical programming, modern computational methods etc.) of financial (including banking, investment, bonds, funds, stocks, futures, options and other financial instruments and markets) analysis the number of theory and practice. The core problem is the selection theory of the optimal investment strategy and the asset pricing theory under the uncertain condition. Financial mathematics not only have a direct effect on the innovation of financial instruments and financial markets operate efficiently, but also for the company's investment decision-making and evaluation of project research and development (such as real options) and risk management in financial institutions has been widely used [1] .

From a broad point of view, financial mathematics is a new discipline which applies mathematical theories and methods to the operation of Finance and economy. From the narrow perspective, mathematical problems in the financial field is mainly on the stock selection and portfolio analysis of asset pricing theory combined under conditions of uncertainty, which is the optimal arbitrage, and equilibrium theory the three most important basic concepts.

Applying mathematics to the financial field is based on some financial or economic assumptions, and uses abstract mathematical methods to construct mathematical models of how the financial mechanism works. Financial mathematics mainly includes the basic concepts and methods of mathematics, the related natural science methods and so on. They are applied in various forms of entry theory. The use of mathematics is to express, reason, and prove the underlying principles of finance. From the nature of financial mathematics,

financial mathematics is an important branch of finance. Therefore, financial mathematics is completely based on the background and foundation of financial theory. The people who engage in financial mathematics through formal financial academic training will have more advantages in this context. Finance is used as a subdiscipline of economics of identity development, though it has a characteristic enough from the economic independence, but it still requires economic principle and economic technology related as background. At the same time, financial mathematics also needs financial knowledge, tax theory and accounting principles as the background of knowledge [2] .

The theoretical basis of financial mathematics also includes mathematical modeling and statistical theory, the first step is a mathematical or statistical modeling, which is from the complex financial environment were key factors to identify related factors and independent factors, and then from a series of assumptions to deduce various relations, finally obtains the conclusion to make the conclusion explain. This modeling activity is not only very useful and very important, because in finance a small error, an error is derived, a wrong conclusion, or a conclusion of error explanation may lead to a financial disaster. In addition, in the study of financial mathematics, the application of computer technology also has a very prominent position.

Differential Game method

Using differential game method to study option pricing problem and investment decision problem is an important direction of the development of modern financial theory, and some achievements have been achieved. When the financial market does not satisfy the steady-state assumption or abnormal fluctuations in stock prices, often do not obey the geometry Brown motion, then using the method of random dynamic model of securities investment decision problems both in theory, or in fact there is deviation from. Using the differential game method to study the financial decision problem can relax the hypothesis. The uncertainty disturbance is assumed to be a hostile one, and the optimal investment strategy with strong robustness can be obtained by optimizing the worst case. In addition, the Behrman equation for differential games is a first-order partial differential equation, which is much simpler than the two order partial differential equations for stochastic control problems. Therefore, the application of differential game method to the study of financial problems has broad application prospects.

Capital Asset Pricing Model :

Markowitz (Markowitz, 1952) the dispersion of investment portfolio theory and efficiency for the first time as a means of rigorous mathematical tools to show a method for risk averse investors how to construct the optimal portfolio of risky assets in many. It should be said that this theory has a strong sense of normative, which tells investors how to make investment choices. But the problem is that in 1950s, even with the help of computer was just born, in practice the application of Markowitz theory is still hard work a tedious and boring; or, with the investment of the real world apart too seriously, thus it is difficult to be completely by investors-the United States Baumol of the Princeton University (William Baumol) said in his 1966 paper Tobin Markowitz system in this paper, according to Markowitz theory, even with the simplified model, to choose efficient portfolios from 1500 securities, the time for each run by a computer will cost $150-300, but if you want to perform a complete Markovitz operation, the cost is at least 50 times the amount; and all of these must have a premise, is the analyst The expected return, risk, and correlation coefficients of the underlying securities must be sustained and accurate, otherwise the entire process will become meaningless.

It is because of this problem, from the beginning of 1960s, SHARP (W. Sharpe, 1964), Linter (J. Lintner, 1965) and mossim (J. Mossin, 1966) as the representative of some economists began from the empirical point of view,

to explore the reality of securities investment, namely Markowitz theory applied in reality can be if investors are using simplified? Markowitz portfolio theory to select the optimal portfolio, then the equilibrium prices of assets will be how to balance the return and risk in the form? Or, in the market equilibrium, asset price risk and how to determine?

The research of these scholars has directly led to the emergence of the capital asset pricing (CAPM) model. As one of the predictive model for risk assets based on expected profit equilibrium on the basis of CAPM, explains the formation of market equilibrium in investors by Markowitz's theory of investment management under the conditions of the theory of the relationship between the expected return and expected risk in a simple linear relationship between the expression of it, that there is a positive correlation the relationship between a beta scale an asset to the expected rate of return and measure the risk value of assets. It should be said that, as a kind of objective of risk asset equilibrium price decision theory, single index model, and based on CAPM not only simplifies the computation process of portfolio selection, the Markowitz portfolio selection theory in the real world a big step forward, but also makes the securities theory from the previous qualitative analysis to quantitative analysis, empirical turn from the normative, then the securities investment theory and practical operation, which has a great influence even to the development of financial theory and practice, has become the theoretical basis of modern finance.

Of course, in recent decades, as the focus of the capital market equilibrium model of attention, in the form of CAPM has been far beyond the traditional form, and put forward the SHARP Lintner Mossin, has made great progress, such as arbitrage pricing model, intertemporal capital asset pricing model, consumption capital asset pricing model, has formed a the system of capital market equilibrium theory [3] .

Black-Scholes-Merton Model

For example, the Black-Scholes-Merton (BSM) Model is a mathematical model that is used for pricing options. Options are a particular form of derivative, which is a financial asset that derives its value from the price of another underlying asset.

Before the Black-Scholes Merton model was developed, the pricing of options contracts was extremely difficult and limited. However, with the model, financial academics and professionals alike could accurately price the complicated derivative products.

It is one of the most important financial models ever developed and is still used today to price options. The three professors – Fischer Black, Myron Scholes, and Robert Merton – won a Nobel Prize for the development of the mode

Conclusion :

Mathematical finance is an interdisciplinary study of financial markets. It helps economist/trader to make decisions and frame policies to their advantage.

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