Applicability and Limitations of Mathematics in the Field of Finance

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Abstract: Mathematics, as an applied discipline with strong theoretical and objective thinking logic, can be reasonably applied in the actual development process of the financial field to assist relevant personnel in building a more complete work system and scientific thinking framework, thereby improving the efficiency and quality of financial industry work and reducing the probability of various financial risks. In addition, mathematics also contains various objective theoretical models and knowledge points, which can be organically integrated with practical work in the financial field to enhance the objectivity and scientificity of financial work and create greater economic benefits for the financial field. Based on this, this article analyzes and studies the applicability and limitations of mathematics in the financial field, in order to provide reference and guidance for relevant personnel in the financial field.

1. Introduction

Mathematics is a discipline with a long history of development. After a long period of practical exploration, it has become an applied tool discipline with strong applicability in various fields. At present, multiple fields and sciences are using mathematics to solve practical problems in their respective fields. Mathematics can be simply summarized as a method of using mathematical theoretical models to guide people to use their own rational thinking to analyze and solve problems. Finance, on the other hand, is an applied discipline that has diverged from the field of economics and is highly practical [1]. It mainly utilizes theoretical knowledge-based models to transform common currency and monetary funds from one form to another, such as converting them into stock pricing, option pricing, etc., which has strong uncertainty. It can be seen that in-depth analysis of the practicality and limitations of mathematics in the financial field has profound practical significance for leveraging the value of mathematical applications and helping the stable progress of the financial field.

2. Feasibility of Applying Mathematics in the Field of Finance

In the late 1980s to early 1990s, the fusion and intersection of finance and mathematical methods gave rise to an interdisciplinary discipline called financial mathematics. Financial mathematics mainly refers to the comprehensive application of modern mathematics and computer technology in the field of finance, mainly manifested in the application of modern mathematical theories and methods, random analysis, combinatorial analysis, nonlinear analysis, and multivariate statistical analysis of various phenomena and problems in financial activities. The main research objects in the financial field are investments, stocks, funds, futures, bonds, etc. The core research theories include market theory, practical quantity, etc. The core research theories include selecting the best investment strategy in uncertain environments and asset pricing theory [2]. The emergence and development of financial mathematics have greatly promoted the updating and upgrading of financial instruments, playing a positive role in investment decision-making, project development, and risk management of financial institutions in the financial field.

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2.1 Main Theories of Financial Mathematics

First, portfolio theory. This theory can be briefly summarized as a practical theoretical guidance method for selecting which assets to invest in, the proportion of each investment, and how to achieve the highest economic return under certain risk conditions. Reasonably applying portfolio theory in the financial field can reduce investment risks and improve investment efficiency. Markowitz applied the theory of normal distribution to solve the financial investment portfolio problem, where mean represents investment returns and variance represents investment risks. He simplified the investment portfolio problem into an optimization problem of the quantitative relationship between mean and variance.

Second, optimal stopping time theory. The so-called optimal stopping time theory mainly refers to a highly practical theoretical method in mathematical probability theory. Reasonably applying this theory to the field of mathematics can analyze and solve fixed transaction cost securities investment decision-making problems in financial activities, simplify algorithms for such problems, and ultimately obtain accurate computational values [3]. This theory has achieved significant research results in the financial field.

2.2 Development Trends of Financial Mathematics

To apply mathematics reasonably to research activities in the financial field, it is necessary to create multiple assumptions for mathematical models, which can have certain deviations or conflicts with actual objective facts. Therefore, when analyzing and solving financial problems in practice, the application effect of mathematical methods still needs to be improved, and the application scope still needs to be further expanded. Due to significant differences in social development processes, financial development backgrounds, and management models among countries worldwide, to truly achieve research objectives, it is necessary to establish financial models and analysis methods that are in line with their own basic national conditions. Taking CAPM as an example, this theory only applies to European options and not to American options. Based on this, in a certain period of future development, we still need to analyze and innovate the applicability and limitations of mathematical methods in the financial field, which is the objective development demand of financial activities.

3. Applicability of Mathematics in the Field of Finance

The various activities carried out in the financial field are mainly focused on the study of currency and monetary funds, and there is a clear quantitative relationship between each activity, showing the characteristics of certainty and measurability. Financial activities, like other types of economic activities, not only have quantitative regularities in external phenomena, but also inherent qualitative regularities [4]. Financial activities generate a large amount of data information, such as securities information, futures trading information, etc., which to some extent makes quantitative and empirical analysis methods in mathematics possible. It can be seen that it is entirely possible to apply mathematical methods reasonably in the financial field to solve practical problems. In addition, in the field of finance research, it is necessary to collect and integrate a large amount of data information. At this time, mathematical theoretical models can be used to statistically analyze the interest rates, exchange rates, money market supply and demand, market prices, interest rates, etc. generated in monetary and financial activities, providing strong data support for decision-making and operation in the financial field.

Mathematics has strong theoretical logicality, intuitiveness, abstraction, accuracy, and other characteristics. Firstly, the abstract nature of mathematical methods determines that mathematics can effectively utilize various financial activities in the field of finance. By using mathematical methods, it is possible to deeply analyze and study the economic problems and variable function relationships underlying various financial phenomena, thereby clarifying complex financial relationships. Secondly, the precision of mathematics enables mathematical methods to accurately describe various quantitative relationships that exist in financial activities, thereby helping relevant

personnel make scientific judgments. Thirdly, the rigorous logical thinking characteristics of mathematics have made mathematical methods the main tool for inferential activities, which can briefly explain the complex logical relationships existing in financial activities. For example, Markowitz used appropriate mathematical methods to analyze the financial principle of "not putting eggs in the same basket", thereby improving the rigor of financial investment activities.

Usually, the rational application of mathematical methods in the financial field is manifested in two forms: mathematical theoretical models and empirical analysis. Theoretical models mainly refer to the use of mathematical language to describe a certain financial phenomenon and the basic principles of a certain theory in financial activities. Empirical analysis methods use actual quantitative statistical data to verify a theoretical content or financial phenomenon in financial activities, and make scientific judgments on its positive determination and applicability. Theoretical model analysis methods and empirical analysis methods are complementary to each other.

4. Limitations of Mathematics in the Field of Finance

The objects of analysis and research in the financial field usually exhibit characteristics such as complexity, liquidity, uncertainty, and dynamic variability [5]. In the actual operation and development process of the financial field, there are also many non-economic factors that have adverse interference, such as political factors, military factors, cultural factors, ideological and moral factors, legal system factors, psychological factors, historical factors, etc. The application of various theoretical models and objective knowledge contained in mathematics in the financial field is conditional and relative, rather than absolute and unchanging. The primary prerequisite for establishing mathematical theoretical models in the financial field is to set a series of assumptions that are in line with the actual situation, and these assumptions may not fully match or even contradict the actual situation in various financial activities. In this case, mathematical theoretical models lose their expressive and analytical abilities, and their accuracy and feasibility in calculating the relevant results of financial activities and implementing financial risk prevention plans may also be lacking. For example, the neoclassical school conducted a mathematical analysis of general equilibrium theory and proposed twelve hypothetical conditions, which are difficult to achieve in financial activities. The subprime crisis and investment risks that have emerged in the financial field are good examples.

Compared to other analytical research methods, mathematics itself has strong uniqueness. Mathematics can accurately explain some problems in the financial field using concise and clear methods, but in fact, mathematics is not omnipotent, and there are still many limitations in its application in the financial field. Not all financial problems can be analyzed and solved using mathematical methods. Relevant personnel should analyze specific problems and choose the application scope and research object of mathematics based on actual situations [6]. When using mathematical analysis to study various problems in the financial field, analysis is the primary prerequisite, and the application of mathematical methods is in a secondary position. No matter how rigorous and scientific mathematical methods are applied, and how perfect the quantitative relationship is, if there is a deviation in the analysis, it still cannot solve practical problems. For example, in the 1990s, some economists attempted to use stochastic differential methods and non-parametric statistical methods to analyze and study various problems in the financial field, but the research results achieved to this day are not ideal.

5. Conclusion

In summary, the reasonable application of mathematics in practical work and decision-making operations in the financial field has practical significance for strengthening stable operation and sustainable development in the financial field. The financial field can not only utilize various objective theoretical models and knowledge points contained in mathematics to timely discover and analyze potential risk issues in financial operations and decision-making, but also reduce the probability of financial risks occurring. It can also assist staff in carrying out financial practice work,

further improving work efficiency and quality, which has a certain positive significance for promoting sustainable development in the financial field. Based on this, financial professionals should fully grasp the applicability of mathematics in the financial field and firmly grasp the development advantages that mathematics brings to the financial field. It is necessary to conduct a thorough analysis of the limitations of mathematics in the financial field, in order to truly unleash the value of mathematics in the financial field.

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