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MATHEMATICS AND FINANCE INTERACTION: CHALLENGES AND OPPORTUNITIES IN THE UNDERSTANDING AND APPLICATION OF FINANCIAL CONCEPTS

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ABSTRACT

This research article addresses the close relationship between mathematics and finance, highlighting its importance in understanding and applying financial concepts. It was recognized that financial knowledge is crucial in daily life and the business world. However, the need for a renewal in the teaching of financial mathematics has been raised due to the global financial crisis. The complexity of mathematical models in finance was highlighted, and the importance of higher-order thinking skills in this field was underlined. In addition, the dependence of financial mathematics on disciplines such as statistics and computer science is evident, and exploring areas such as psychology and neuroscience was suggested to obtain a better understanding of the complex aspects of finance. In summary, this article emphasizes the intimate relationship between mathematics and finance. It highlights the opportunities for development and the need for a multidisciplinary perspective in mathematical finance.

Keywords: Financial Mathematics, Mathematics and Finance Relationship, Models and Financial Complexity

1. INTRODUCTION

Over the years, lectures on mathematics and statistics and research on student learning have provided university professors with some insight into the difficulties faced by students, both those entering university and those in later years, when learning mathematics Thomas et al. (2012). Engaging in the arduous duty of instructing freshman students and overseeing doctoral candidates across diverse fields provides faculty members with an opportunity to acquire a more profound

comprehension of students' learning processes, as well as their grasp of the methodologies and principles specific to their respective areas of study Ergün (2018).

Interaction with a broad group of students allows mathematics teachers to observe different learning styles, as many students find mathematics difficult. Some consider it useless and not applicable to their daily lives or future careers Ernest (2018). The "mathematics difficulty feature" allows teachers to investigate students' previous experiences with mathematics, their understanding of concepts, and their personal beliefs Rafael (2018).

Supervising graduate students in finance, including those earning a Ph.D. in mathematical finance, has provided significant opportunities to observe students' learning process throughout their academic trajectory until reaching their maximum education Capiński & Zastawniak (2003). Graduated students have obtained a deeper understanding of the mathematical needs of finance students in terms of their abilities and the gaps or misconceptions they present in their learning and understanding Bueno (2006). This research paper was based on a thoughtful analysis of an extensive database of research experiences, which may provide possible strategies for closing the gaps in student learning and financial discipline so that students can understand and apply various financial tools based on mathematics.

Instead of routinely teaching mathematics in finance, students must understand it Wang & Xu (2015). Although some workers in the field highlight the importance of this approach, pointing out that the current way of teaching is not conducive to the development of higher-order thinking skills (HOTS), which are essential in financial thinking, especially in times of global crises Torben & Andersen (1997).

This document uses mathematical procedures in finance to show the nature and levels of thinking skills that students must acquire to deal with financial learning and decision-making in financial studies Thomas (2012).

2. MATERIALS AND METHODS

The methodology based on a particular scientific orientation is adopted, which implies the need to investigate a specific situation accurately and coherently. According to Barón, the methodology is "the previous steps selected by the researcher to obtain favorable results that help him to propose new ideas." Baron (2006) In this context, the research development focuses on coordinating actions that involve a bibliographic review to complement previous ideas related to the importance of mathematical thinking in teaching finance at a higher level to generate general considerations that broaden the proposed interest.

In all research, methodological actions were required that allows knowing and projecting the possible events that determine it and the characteristics that turn the scientific act into an interactive process adjusted to an interpretable reality. In this sense, the present investigation corresponds to the documentary type, according to the definition by Taherdoost, who points out that this type of investigation deals with the study of problems posed at a theoretical level, where the information necessary to address them is found mainly in materials Taherdoost (2016). Printed, audiovisual, and electronic.

In line with this definition, the methodological orientation of this research allowed for carrying out a series of activities inherent to the review and reading of various documents, where explicit ideas related to the themes that identify each

characteristic included in the study were found. Therefore, continuous interpretations were carried out to review the appreciations or investigations proposed by different researchers concerning the topic of interest, to argue later the approaches based on the needs found in the inquiry.

The analysis of the selected subject's predominant characteristics requires using different documentary sources that provide the necessary support and allow the evaluation of the facts to generate new criteria that serve as a reference for other investigations. According to Xiao (2019), documentary sources in documentary or bibliographic research represent the sum of systematic materials that are rigorously and thoroughly reviewed to analyze the phenomenon Xiao (2019). Therefore, a previous and selective reading was carried out to find those aspects closely related to the theme in order to explain the general appreciation of importance through adequate development.

Carrying out documentary research requires the application of specific actions to select techniques that fit the characteristics of the study. Morentin points out that these techniques "help the selection procedures of primary and secondary ideas." In this sense, underlining, summaries, and signing were essential to the review and selection of documents containing theoretical content. These techniques made it possible to collect information during the bibliographic review of various elements related to the orientation of the research. In addition, information analysis techniques were used to process the data obtained. In the same way, these techniques "offer the researcher the vision or the steps that he must follow during his exercise, and each of them must correspond with the level to be used." This implies that the processing of the data collected, using techniques such as summary sheets and textual and descriptive records, must be adjusted to the level selected in the study Morentin (2015).

3. RESULTS AND DISCUSSIONS

The importance of financial knowledge in everyday life and its application in business and accounting is indisputable. According to Won Kim et al. (2016), "The most useful major a young person can choose today for a future career is a degree in finance. A finance degree will give people the necessary knowledge to control their finances effectively, provide ample employment opportunities and contribute to individual and economic well-being".

Some might argue that this statement has changed due to the global financial crisis (GFC). However, we must consider crises as turning points where revolutions occur, and new ways of thinking are adopted. In this sense, finance students could make critical decisions about market actions, mortgages, and investment opportunities. The financial knowledge and tools acquired in universities will help apply real-life examples in the work environment, making work more efficient.

Financial specialties have a crucial role in real life when allowed to guide individuals and companies in making investment decisions to achieve maximum wealth generation. The recent financial crisis has been a boost and an opportunity for finance departments to redesign their teaching, ensuring that students leave college with the best tools in finance. Students need to develop a new way of thinking about mathematical finance and prepare to face the current and future challenges of the financial world.

The teaching of mathematics and the implication of finances

Undoubtedly, financial mathematics has undergone significant changes in mathematical research and teaching mathematics in general Andrés-Sánchez & Sánchez (2015). Nowadays, it is not easy to find mathematics faculties that do not conduct research in finance and economics worldwide.

Financial applications include examples of mathematics related to finance. Mathematical concepts in new algebra and calculus texts demonstrate how finance research and teaching have significantly influenced mathematics research and teaching Prichett & Feinstein (1999). This integrated nature provides a deeper understanding of both related fields. It is not simply a "greater" causality in one sense between finance and mathematics. However, the practice of finance has influenced mathematics teaching and research in two directions.

Modern finance cannot do without mathematics, but the debate about whether mathematics has changed financial research is moot. However, one can understand how mathematics has influenced economic research through a recent statement on research topics.

Mathematical ideas in finance

Simple ideas in the field of finance can often lead to complex mathematical problems that are not easily understood by finance personnel. It is interesting to note that simple ideas in finance can be easily translated into mathematical terms, but solving the resulting mathematical problems can be challenging without certain simplifications or assumptions.

An illustrative example is the development of the equivalent mathematical problem for asset pricing and its evolution over time. To Geary, it took them approximately six months to develop the corresponding math problem and another three years to solve it mathematically successfully. It highlights the complexity that can arise when translating financial ideas into precise and working mathematical models Geary (2018).

A typical example concerns a simple problem that can result in complex math and require higher-order math skills to solve. For example, we now have a large amount of data in the stock market, including the lowest, highest, and closing prices for shares over several years. However, obtaining a price estimate from these statistical data and applying maximum likelihood methods may be enough to present a simplified mathematical model.

$$\frac{\partial l\left(p^{*},\sigma\right)}{\partial p^{*}}=\frac{1}{\sigma}\sum_{i=1}^{3}y_{i}\left(p^{*},\sigma\right)-\frac{n-1}{\sqrt{2\pi}\sigma}\sum_{i=1}^{2}\frac{(-1)^{i}}{1-Q_{i}\left(p^{*},\sigma\right)}e^{\frac{1}{2}y_{i}^{2}\left(p^{*},\sigma\right)}$$

Equation 1

Although Equation 1 may seem challenging to solve in its original form, the simplified version suggests that the best estimate is simply the average of the highest and lowest prices. However, financial ideas can lead to more complex mathematical propositions that require a more advanced mathematical approach.

3.1. HIGHER ORDER THINKING SKILLS (HOTS) AND MATHEMATICS LEARNING AND TRAINING

Indeed, there is a close relationship between finance and mathematics in financial and economic disciplines, where financial mathematics is based on the underlying theory of these areas. Professionals in financial mathematics tend to derive and extend aspects of theoretical models and applications in the economic

field. However, financial mathematics also depends on other areas, such as statistics and computer science, complementing its approach Won Kim et al. (2016).

For example, a financial economist may study structural aspects to determine the price of a particular stock. In contrast, a financial mathematician will use his knowledge of pure and applied mathematics to calculate the fair value of a derivative based on an underlying asset. Many of the mathematical processes involved require using higher-order thinking skills (HOTS), such as creativity, logical reasoning, deduction, and metacognitive analysis, during the applied problem-solving process Tularam (2013).

Such problem-solving exercises can take time, as previously mentioned by Black and Scholes (2013), who indicated it took six months to develop the Black-Scholes equations and another three years to solve the model successfully. Solving mathematical models can take considerable time, sometimes even years. However, it also shows that mathematicians are highly trained to pursue their goals using higher-order thinking skills, including affective traits such as persistence and motivation. Although solutions may take time, mathematicians could seek and develop logical approaches using their problem-solving skills and lateral thinking to create solution opportunities in most cases Won Kim et al. (2016).

3.2. DEVELOPMENT OF FINANCIAL MODELS USING HIGHER-ORDER MATHEMATICAL THINKING.

Options trading is an essential practice within the finance industry, where individuals engage in contracts known as options. These agreements grant the buyer the privilege to purchase or sell an underlying asset, such as stocks or bonds, at a predetermined price on a specific expiration date. This option type is similar to an insurance contract, in which the option holder is protected from possible changes in the underlying asset's price. Various financial agents have raised whether there is a theoretical price for any derivative or option in a given economy Ruíz & Stephens (2011).

In an ideal situation, the theoretical model predicts that an option's price will equal the initial amount of money invested in the portfolio replica simulating the option and will be paid precisely on the option's expiration date. However, this formula requires taking into account several assumptions. The model provides an opportunity to develop higher-order rules and refine the understanding of option pricing in the financial context Blanchet-Scalliet et al. (2005).

3.3. THE FUTURE OF MATHEMATICS IN FINANCE

The complexity of financial transactions in the fundamental securities markets and the industry, in general, should not be underestimated. The world is full of complexities, and to understand the nature of the world, human beings must study the relationships between various systems, no matter how complex. Much of finance's physical laws and chemical aspects have become more clearly understood over time, thanks to research. However, there are still areas that require further investigation. The historical analysis reveals that the incorporation of mathematics in finance is a relatively recent phenomenon, which may be the reason for the lack of understanding of the most complex aspects compared to areas such as physics and chemistry, which have had centuries of mathematical participation Tularam (2013).

However, we can be sure that the growth of knowledge and revolutions in thinking based on new ideas continue to emerge, indicating that the opportunities for idea development and advancement in mathematical finance are increasing.

However, it is also clear that more work is needed to address the extensive effects of noise in financial analyses. Other aspects must be explored, such as the assumption that participants act rationally and seek to maximize processes. Work in neural psychology and behavioural finance can offer significant insights and advances in economic thinking. It is true that if all of the elements mentioned above were incorporated into the modelling process, a higher level of mathematics would be required to address aspects such as the inclusion of "real" market participants, the consideration of random walks, market interdependencies, correlations, among others NE (2015).

4. CONCLUSIONS & RECOMMENDATIONS

In conclusion, this article highlights the close relationship between mathematics and finance and its importance in the financial field. It has been highlighted that financial knowledge is essential in daily life and in the business world, offering job opportunities and contributing to the economy. However, the need for a renewal in the teaching of financial mathematics has been recognized due to the global financial crisis and its new challenges. The complexity of mathematical models in finance and the importance of higher-order thinking skills in this field have been emphasized. In addition, the dependence of financial mathematics on disciplines such as statistics and computer science has been highlighted. Exploring areas such as psychology and neuroscience have been suggested to gain a greater understanding of the complex aspects of finance. In summary, the responses obtained in this chat have underlined the relevance of mathematics in finance and highlighted the opportunities for development and the need for a multidisciplinary approach in mathematical finance.

CONFLICT OF INTERESTS

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