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Applied Mathematics and Modelling in Finance, Marketing and Economics

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Abstract- The integration of advanced mathematical methods into commercial disciplines has redefined the boundaries of possibility for modern decision-making. This paper provides a conceptual review of the edited volume Applied Mathematics and Modelling in Finance, Marketing and Economics (Melliani, Castillo, and Hajaji, Springer, 2024), a landmark collection of research that bridges the gap between applied mathematical theory and its real-world applications in finance, marketing, and economics. By examining the backgrounds of the volume's editors, surveying its thematic structure, and exploring representative chapters, this study offers a clear, non-technical overview of how contemporary mathematical modelling is driving progress in areas such as derivative pricing, fuzzy optimisation, and market simulation. The paper concludes by highlighting the critical role such interdisciplinary research plays in an increasingly data-driven and uncertain commercial world.

Keywords- Financial Mathematics, Quantitative Finance, Stochastic Processes, Option Pricing Models, Risk Management, Portfolio Optimization, Asset Pricing

I. INTRODUCTION

In the modern era, the boundaries between pure mathematical theory and its practical commercial applications have become increasingly porous. Nowhere is this more evident than at the intersection of applied mathematics, finance, marketing, and economics. The edited volume Applied Mathematics and Modelling in Finance, Marketing and Economics, published by Springer in 2024 and edited by Said Melliani, Oscar Castillo, and Abdelmajid El Hajaji, captures the latest developments in this fertile interdisciplinary space. The book serves as both a collection of cutting-edge research and a testament to the growing importance of mathematical modelling in solving complex real-world problems in commerce and society.

The chapters in this volume bring together diverse ideas—from pricing financial derivatives and optimising marketing strategies to simulating market behaviour—and demonstrate how methods such as fuzzy logic, fractional calculus, and numerical analysis can be harnessed to tackle issues of uncertainty, complexity, and risk. This research paper provides a conceptual, equation-free overview of the book, explaining its core themes, the contributions of its editors, and a selection of its most representative chapters. The aim is to show how applied mathematics serves as an indispensable toolkit for modern finance, marketing, and economics.

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II. THE EDITORS AND THEIR SCHOLARLY BACKGROUNDS:

The credibility of any edited volume rests heavily on the expertise of its editors. The three scholars behind this collection bring complementary strengths that span pure and applied mathematics, fuzzy systems, and computational intelligence.

Said Melliani is affiliated with the Laboratory of Applied Mathematics and Scientific Computing at Sultan Moulay Slimane University in Beni-Mellal, Morocco. His research focuses on applied mathematics, mathematical modelling, simulation, and statistics and probability, with significant contributions to fuzzy systems and optimisation. Melliani's work provides the rigorous mathematical foundation for the volume, ensuring that the models discussed are both theoretically sound and computationally viable.

Oscar Castillo is a Professor of Computer Science at the Tijuana Institute of Technology in Mexico and an Adjunct Professor at San Diego State University in the USA. He is a world-renowned expert in fuzzy logic and computational intelligence, with over 300 journal publications to his name. Castillo's research explores the design of intelligent systems that combine fuzzy logic, neural networks, and genetic algorithms—tools particularly well-suited to handling the uncertainty and imprecision inherent in financial markets and consumer behaviour.

Abdelmajid El Hajaji is based at the National School of Trade and Management, part of Chouaib Doukkali University in El Jadida, Morocco. El Hajaji's expertise lies in the practical application of mathematical methods to commercial and economic problems, ensuring that the volume's theoretical contributions are rooted in real-world relevance.

Together, these three scholars provide a seamless bridge between abstract mathematical theory and practical commercial application, making the volume uniquely positioned to advance the state of the art.

Key Themes of the Volume:
The book is structured around three broad thematic areas, each reflecting a major domain of applied mathematical research.

Mathematical Modelling in Finance:
Financial markets are inherently dynamic, uncertain, and often incomplete. Mathematical models offer a systematic way to price assets, manage risk, and design hedging strategies. The volume covers a range of financial topics, including the modelling of interest rates and asset prices, market behaviour analysis, modelling of market imperfections, and the pricing of financial derivative securities.

Mathematical Modelling in Marketing:
Marketing decisions—such as pricing strategies, customer segmentation, and brand positioning—increasingly rely on data-driven mathematical models. These models help companies understand consumer preferences, predict market responses, and allocate resources optimally. The volume explores how mathematical tools can be applied to these challenges, fostering better decision-making in competitive environments.

Mathematical Modelling in Economics:
Economics is fundamentally a quantitative social science, and mathematical modelling has long been central to its methodology. The volume addresses economic fundamentals such as interest rate determination, asset price dynamics, and the simulation of market imperfections. It also examines broader questions of how markets behave under different regulatory and structural conditions.

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III. HIGHLIGHTS FROM REPRESENTATIVE CHAPTERS:

While the volume contains 19 chapters, a few stand out for their clarity and conceptual richness. Below are three examples that illustrate the book's breadth.

1. High-Precision Method for Space-Time-Fractional Klein-Gordon Equation:
Although the title sounds abstract, this chapter, authored by A. Habjia, A. El Hajaji, J. El Ghordaf, K. Hilal, and A. Charhabil, introduces a powerful mathematical method known as fractional calculus. Fractional calculus extends traditional calculus to fractional orders, providing a more flexible tool for modelling physical and financial systems that exhibit long-range dependencies or memory effects. The authors apply this method to the Klein-Gordon equation—a partial differential equation that originally emerged in quantum physics to describe the Higgs boson and the propagation of bosons in a vacuum. By developing a high-precision numerical method for solving this equation, the chapter provides computational techniques that could one day be adapted to model financial systems characterised by sudden jumps or long-term memory, such as volatility clustering in asset returns.

2. Solving Fuzzy Linear Programming Using the Parametric Form:
Marketing and economics are replete with decisions that must be made under conditions of uncertainty: future demand, customer preferences, or competitor actions are rarely known with precision. Traditional linear programming assumes all input data are known exactly, which is often unrealistic. In this chapter, Abdellatif Semmouri and Mostafa Jourhmane address this shortcoming by developing a method for solving linear programming problems in which the data are expressed as triangular fuzzy numbers—a way of encoding expert judgments as intervals rather than exact numbers. The authors show how to transform such a "fuzzy" problem into a parametric form that can be solved using conventional optimisation techniques, then validate their approach with practical examples. This work has direct applications in supply chain planning, budget allocation, and portfolio selection under uncertainty.

3. Valuing a European Option Under the Heston Model with Interest Rate:
One of the most practically relevant chapters in the book is by Siham Bayad, Khalid Hilal, and Abdelmajid El Hajaji, who derive a closed-form pricing formula for European options—a type of financial derivative—under the well-known Heston model. The Heston model is widely used because it captures the fact that asset prices exhibit volatility that itself fluctuates over time (a phenomenon known as stochastic volatility). This study extends the model by incorporating a stochastic (i.e., randomly varying) interest rate alongside stochastic volatility, creating a more realistic two-factor description of financial markets. The authors obtain an analytical solution, meaning that option prices can be computed quickly and accurately without relying on computationally intensive simulations. Such formulas are essential tools for risk managers, traders, and central banks, as they enable rapid valuation and hedging of options even in volatile market conditions.

The Role of Conferences and Collaboration:
It is worth noting that this volume is not an arbitrary collection of papers; rather, it features selected contributions from the first International Conference in Applied Mathematics to Finance, Marketing and Economics, held at the National School of Commerce and Management in El Jadida, Morocco, on 26–27 November 2020. This origin is significant because it emphasises the collaborative, international, and peer-reviewed nature of the research presented. By drawing together mathematicians, economists, and marketing scientists from around the world, the conference—and the resulting volume—fosters precisely the kind of cross-disciplinary dialogue needed to advance both theory and practice.

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IV. CONCLUSIONS

Applied Mathematics and Modelling in Finance, Marketing and Economics (Melliani, Castillo, and Hajaji, Springer, 2024) is a timely and important contribution to the literature on quantitative methods in commerce. Through its 19 carefully selected chapters, the volume demonstrates how applied mathematics—including fractional calculus, fuzzy optimisation, and advanced option pricing theory—can be harnessed to address the complex, uncertain, and dynamic challenges that characterise modern finance, marketing, and economics.

For researchers, the book offers a roadmap of current frontiers. For practitioners, it provides a glimpse into the mathematical tools that increasingly underpin high-stakes decisions in banking, asset management, and corporate strategy. And for students, it serves as an accessible entry point into a field that is only set to grow in importance as data availability and computational power continue to expand.

In an era of economic volatility, algorithmic trading, and data-driven marketing, the ability to think mathematically about commercial problems is no longer a luxury—it is a necessity. Volumes such as this one play a crucial role in equipping the next generation of scholars and professionals with the intellectual tools they need to navigate an uncertain world.

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