# Book Review

# Mathematical Finance

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With the widespread availability of online calculators and other tools that automate the mathematical computations of personal finance, it is possible for nearly anyone to perform the most common calculations related to compound interest, the cost of credit or finance charges, and average daily balances without an understanding of the underlying theories and concepts. Results of studies measuring consumers' financial knowledge and ability to implement financial recommendations suggest such an approach is not adequate for the average consumer. Members of AFCPE aspire to develop and maintain greater knowledge and a deeper understanding of how the theories and concepts of personal finance are operationalized mathematically.

In the preface to his recently published book, *Mathematical Finance*, M. J. Alhabeeb explains that over the course of many years of teaching economics and finance, he identified a need, even a desire, among his students to reverse the approach of standard math textbooks that focus on technical aspects of deriving equations and solving them while addressing finance and financial subjects on the side. Instead, Alhabeeb focuses on finance and financial problems using mathematical methods as the tools to solve them. In doing so, he aims to provide a foundation for readers to reinforce their understanding of basic finance and financial problems and to be able to analyze and interpret the solutions obtained.

The author, M. J. Alhabeeb, is well suited to this approach. As a professor of economics and finance at the University of Massachusetts - Amherst, he draws from his experience of teaching college finance for more than 30 years. His innovation and creativity in the classroom have been recognized by the Academy of Educational Leadership. His scholarship has been recognized internationally by the Academy of Marketing Studies and nationally by the American Council on Consumer Interests – Certified Financial Planner Board of Standards Outstanding Research Award.

Through eight units, each comprised of two or more chapters, *Mathematical Finance* leads readers through a variety of financial problems encountered in personal, corporate, entrepreneurial, and managerial finance. While the book is 536 pages long, each unit includes both a unit summary and a list of formulas in addition to numerous examples and several problems to be solved. Along with a reference list, there is an appendix that includes mathematical tables and a comprehensive index. Steps for solving the problems using a financial calculator or computer methods are not discussed.

Unit I, *Mathematical Introduction*, provides a concise review of such foundational mathematic concepts as numbers, exponents, and logarithms; mathematical progressions; and statistical measures. Through the use of simple examples, data tables, and figures, the first chapter in the unit starts with a discussion of the basic concepts of fractions, decimals, and percentages, then moves on through ratios, proportions, exponents, scientific notation and logarithms. The second chapter in Unit 1 discusses arithmetic, geometric, recursive, and infinite geometric progressions. It also discusses growth and decay curves (graphic representations of an exponential function of the form $Y = ab^x$). Finally, the third chapter in the unit discusses statistical measures and formulas for probability, variance, standard deviation, covariance, correlation, and the normal distribution function.

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While educators may hope that students come to class with a firm grasp of the concepts discussed in Unit I, experience suggests that this is not always the case. Taking class time to review this material not only brings all students to a minimum level of knowledge but, through the examples, students are exposed to real-world applications of what they are learning. Unit I will also be useful for practitioners wanting to refresh their understanding of basic mathematical and statistical concepts.

Unit II, *Mathematics of the Time Value of Money*, presents and discusses formulas for simple interest, bank discounts, compound interest, and annuities. Unlike other units, Unit II also includes an introduction. The author describes the time value of money as "a key theoretical concept and fundamental tool in finance" (p. 65) due to our tendency to value it more highly in the present than in the future. Alhabeeb explains this tendency as a result of inflation, consumer impatience, and life uncertainty. He then introduces the concept of interest as the reward attained by giving up the "immediate satisfaction brought about by spending the money" (p. 65) in the present rather than in the future.

The chapters in Unit II explain and illustrate how calculations of the time value of money involve solving for one of five key variables in terms of the others. The variables are the principal (also called current value or present value), the future value, the interest rate (or the discount rate, depending upon which direction the calculation is aimed – current value to future value or future value to present value), the time of maturity, and the periodic payment. Calculations are achieved using mathematical formulas and, in a few instances, table values.

*Mathematics of Debt and Leasing*, Unit III, includes chapters on credit and loans, mortgage debt, and leasing. In this Unit, Alhabeeb makes the argument that both businesses and consumers need to have an understanding of credit and how to manage it. Further, he asserts that credit is an important element in the health of the economy and a determinant of economic growth. While he argues that there is a place for credit in long-term saving and spending plans, he emphasizes the difference between a credit limit and a debt limit. As he uses the terms, a credit limit is defined as the "maximum level of credit that would be offered by a lender to borrowers on an open-ended credit account based on the lender's criteria" (p. 162). One of those criteria is likely to be the borrower's credit score. A debt limit is defined as the "maximum level of debt that a borrower would allow himself or herself based on affordability and the person's future capacity to meet the debt repayment obligations" (p. 162). Formulas for two indicators of whether or not a borrower can easily meet debt payment obligations or not are discussed: debt payment to disposable income ratio and debt to equity ratio. A third indicator, continuous debt measure or how long it would take to clear all debts, is also discussed. The amortization process is described in terms of mortgage debt. Formulas discussed include those for obtaining monthly payments of an amortized loan, the balance of an amortized loan, and the maturity of an amortized loan. Although not specifically related to mortgage debt, a discussion of the sinking fund method follows that of the amortization process since it is another way "to accumulate money in a systematic way for a specific purpose" (p. 182). Leasing is the final form of debt financing discussed in Unit III. The cost of buying on credit versus the cost of leasing is compared from the perspective of both the lessee and lessor.

With their emphasis on business applications, Units IV and V are least likely to be of interest to AFCPE members. They are mentioned only briefly in this review. As their titles suggest, Unit IV, *Mathematics of Capital Budgeting and Depreciation* and Unit V, *Mathematics of the Break-Even Point and Leverage*, include formulas for calculating profitability, depreciation, and depletion as well as break-even analysis and types of leverage. These units describe techniques businesses use for assessing the potential worthiness of an investment (Unit IV) and the level of sales required for a business to cover full operating costs and assess profitability (Unit V). Professionals working with entrepreneurs, family businesses or small businesses will find these units useful.

*Mathematics of Investment*, Unit VI, discusses stocks, bonds, mutual funds, options, the cost of capital, and ratio analysis. Stocks, bonds, mutual funds, and options are presented by the author as fundamental investment choices. The costs of capital and ratio analysis are presented as integrating topics. In addition to definitions associated with these tools, formulas for calculating valuation, cost of new issues, and other methods for evaluating the soundness of an investment choice are detailed. Examples provided include: illustrate what happens when bonds are purchased between interest days and how yield rates are calculated; describe mutual fund evaluation, loads, and performance measures; and discuss choices available to an option holder as well as the dynamics of making a profit with options.

In Unit VII, *Mathematics of Return and Risk*, the relationship between financial risk and return on an investment, is explored. Financial risk is the chance that a loss of principal will occur. The return on an investment refers to a change in its value and can be a gain or a loss. According to Alhabeeb, “the only relevant risk is nondiversifiable risk because diversifiable risk can be greatly reduced, and even eliminated, by a sensible diversification of assets” (p. 422). The unit includes formulas related to measuring return and risk as well as the Capital Asset Pricing Model.

The final section, Unit VIII, is the *Mathematics of Insurance*. It includes discussions of life annuities, life insurance, and property and casualty insurance. Formulas discussed and worked through with examples include mortality table and commutation terms as well as pure endowments, whole life, and temporary life annuities, and whole life, term, and endowment insurance policies. Four approaches to estimating life insurance needs are explained. Terms introduced in the discussion of property and casualty insurance include actual cash value, replacement value, deductibles, co-insurance, and policy limits.

In my opinion, M. J. Alhabeeb succeeded in his goal of writing a text book that focuses on finance and financial problems using mathematical methods as the tools to solve them. With the explanations and solved examples throughout the text, he builds a foundation for readers to reinforce their understanding of basic finance and financial problems. As a result, readers gain insights needed to analyze and interpret the solutions obtained. Including financial problems encountered across the domains of personal, corporate, entrepreneurial, and managerial finance is a strength of the book.

This book will be appropriate for use in advanced undergraduate and graduate personal finance courses. It is also an excellent reference for educators and practitioners. The detailed index makes it easy to identify and locate specific concepts and formulas of interest. The author’s inclusion of descriptions and references describing the development and history of various financial innovations and products adds to the book’s value.

As a reader, I would have preferred that the chapters be numbered consecutively rather than within each unit. At times I found the organization within chapters to be confusing. Also, rather than numbering examples, tables, and figures within each section of the chapter, numbering consecutively throughout the chapter would be less cumbersome for readers to follow.

In my opinion, by its nature, a textbook focused on the mechanics of mathematics, solving problems, and interpreting their results must be held to a higher standard of accuracy, editing, and proofreading than other types of text books. If a student is struggling to learn the material and confidently apply it, even infrequent awkward phrases or incorrect mathematical notation and terms are problematic. While perhaps not a significant factor in the ultimate instructional value of the book, their frequency in this edition became frustrating as I progressed through the text. One of the strengths of *Mathematical Finance* as a text book is the Exercises at the end of each Unit. It is natural to assume that a solution guide is available to instructors Unfortunately a solution guide is not currently available. A complete table of contents is available at http://www.barnesandnoble.com/w/mathematical-finance-m-j-alhabeeb/1100750818. Recognizing that text books are not static publications, I urge the author and publishing team to address these issues in a second edition. Doing so will enhance usability and further build on the book’s contribution to financial counseling, planning and education.

Below are some examples of the types of mathematical finance problems contained within this book.

Compound Interest Rate, Example 3.4.1, p. 100: *If you want to buy a car for $15,485 in 5 years and you want to start investing what you have now, $7,700, what should the interest rate be?* Solution: 15%

Current Value of an Ordinary Annuity, Example 4.3.2, p. 115: *What is the current value of an annuity involving $3,750 payable at the end of each quarter for 7 years at an interest rate of 8% compounded quarterly?* Solution: $79,804.77

Monthly Payment of an Amortized Loan, Example 2.1.1, pp. 166-67: *Jimmy is interested in a two-bedroom townhouse, the asking price for which is $98,000. His mortgage officer told him that the best interest rate he could get would be 5% if he chooses the 15-year term. What would his monthly payment be?* Solution: $774.98

Expected Rate of Return, Example 1.2.1, p. 301: *Gill purchases 50 shares of stock in a local firm at $75.00 per share. He expects to get a dividend of $4.00 per share at the end of the year. He also expects to sell his shares at $80.00 each. What is his expected rate of return (r)?* Solution: 12%