GUIDE TO COMPUTER-ASSISTED INVESTMENT ANALYSIS

William B. Riley, Jr.
Austin H. Montgomery, Jr.

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To Cheryl, Erin, and Kerry;
Muriel, Bruce, Debi, and Janet

PREFACE

Recent texts on investments are substantially different from the very descriptive material presented in the textbooks of a decade ago. Advances in areas such as portfolio theory require quantification of many things which were previously discussed only in general terms. The language of computers and statistics has, by necessity, become an integral part of the vocabulary of the modern student of investments.

This move toward quantification has created some pedagogical problems in various courses in investments, security analysis, and portfolio management. The purpose of this text is to help resolve some of these problems.

It has been our experience that while students may have a keen interest in the material presented in these courses, they tend to get bogged down in the number crunching that is necessary to analyze many aspects of the subject matter. Certainly students must understand the basic concepts, and this usually requires some exposure to the hand calculations which result in problem solutions. For example, in order to gain a conceptual understanding of the Markowitz covariance model or the Sharpe index model, a student may need to go through the computations of risk and return for a small number of securities. Once this has been done, little learning is gained from time-consuming iterations of this process for a more realistic, significantly larger number of securities. The Markowitz model requires a minimum of nine calculations for a three-security portfolio and at least 135 calculations for a 15-stock portfolio. Obviously, no instructor would ordinarily assign a problem of the latter scope to a class. However, with an interactive computer program for portfolio analysis, the problem is not unreasonable.

Without computer assistance, the tradeoff often becomes a matter of simplifying the problem to reduce it to manageable proportions for student solution and thus sacrificing realism, or making the problem realistic and thus requiring students to perform many hours of laborious and repetitive calculations. We feel that the use of interactive computer programs can help resolve this dilemma. Some users may wish to completely replace hand calculations with these programs. Others may choose to have students solve simple problems by hand calculations and more complex problems with the interactive programs. Certainly a canned program can be executed with virtually no understanding of the underlying relationships. This type of "black box" approach to problem solving is a mistake. We must stress our belief that the programs should be used to supplement and *not* to replace an understanding of the basic relationships underlying each program. With this in mind, we strongly feel that these programs offer the student of investments an additional tool to apply knowledge in a more realistic and thorough manner.

In the past, several authors have responded to this problem by including copies of computer programs in the appendixes of their texts. While this may provide a partial solution, we believe that interactive computer programs offer many advantages over computer programs which require batch processing. They require no programming knowledge. They allow the user to input data, execute the program, alter the inputs, and reexecute the program without the long turnaround time of batch processing. This is especially useful in evaluating many option strategies. For example, the user may wish to value a call option by using the Black and Scholes valuation model. The data are entered and a value received. This is helpful information, but the user may wish to change one of the data items (assumptions) to examine how sensitive the solution is to a change in these parameters. This type of sensitivity analysis is quick and easy in the interactive mode but could require significant amounts of elapsed time in batch processing. An additional benefit is the lack of interruption that the student experiences with interactive programs. The user can sit at a terminal for long intervals communicating only with the computer. For this type of problem analysis, the continuous contact with the material seems to offer many advantages over batch processing. Student interest and motivation appear to be at a much higher level with this hands-on use of the computer.

ORGANIZATION

This text consists of eight chapters supplemented by 25 interactive computer programs. Each chapter contains a description of the topic area; a brief examination of the theoretical constructs; a description and explanation of the relevant computer program; and examples, hand solutions, and computer runs.

The material covered by the programs conforms to the format of most recent texts in investments. This allows the text and programs to easily supplement any of the popular texts in the investment area. This includes such courses as portfolio management, security analysis, and bank management, in addition to the Principles of Investment course. Many case courses can also be vastly improved by supplementing the case approach with the interactive computer programs provided here.

The text should prove to be an invaluable reference guide for the professional security analyst, portfolio manager, and stockbroker, as well as for the serious student of investments. This book can also serve as a basis for a short course or seminar for practitioners.

The eight chapters are listed below with a brief description of the relevant computer programs which are included in each chapter.

Chapter 1: Risk and Return

The computer program contains a brief statistical package which computes the arithmetic and geometric means, standard deviation, and variance for a series of data. The program also contains an ordinary least-squares regression option which provides the user with characteristic-line information.

Chapter 2: Transaction Costs and Margins

Four computer programs are included in this chapter. A commission program computes stock and option commissions based on a typical commission schedule. Two margin programs provide the user with margin information on long and short transactions. A tax program provides information on the tax impact of security transactions on ordinary income.

Chapter 3: Stock Valuation

Two stock valuation models are included which arrive at an intrinsic value estimate by either capitalizing expected future earnings or dividends. A growth-rate program uses three different approaches to estimate an expected future growth rate for a series of data.

Chapter 4: Bond Analysis

Six computer programs supplement the material in this chapter. One program determines before- and after-tax yield to maturity and yield to first call for a corporate or municipal bond. A second program calculates bond prices for a selected issue across time at various market rates of interest. Bond value is determined on an accrued interest basis in a third program. The fourth program computes realized yield on a bond with a holding period less than the remaining life. The reinvestment-rate assumption is explored in program five, and bond duration is computed in program six.

Chapter 5: Convertible Securities and Warrants

A convertible security program computes yield to estimated forced conversion and yield to first possible forced conversion. A second program utilizes the Sheldon valuation model to estimate a warrant value.

Chapter 6: Listed Stock Options

This chapter evaluates strategies of writing or buying calls and puts. The programs provide the user with information on the investment required, upside or downside breakeven, and profit or loss information for a range of stock price movements for each strategy. A fifth program uses the Black and Scholes model to value an option.

Chapter 7: Advanced Option Strategies

Six option programs allow the user to examine strategies of writing or buying straddles and spreads as well as long and short variable hedges. The investment required for each strategy is determined along with profit or loss information for a range of price movements.

Chapter 8: Portfolio Analysis

A portfolio program computes portfolio return and risk by either the Markowitz or Sharpe method. The program will also generate a series of corner portfolios forming the efficient frontier from a given set of inputs.

ACKNOWLEDGMENTS

We wish to thank the Amos Tuck Graduate School and Kewit Computational Center at Dartmouth College for furnishing a portion of the portfolio program discussed in Chapter 8. We would also like to express our thanks for the many useful comments and suggestions provided by colleagues who reviewed this text during the course of its development, especially to Oswald Bowlin, Texas Tech University; Eugene Drzycimski, University of Wisconsin; Preston W. Estep, Salomon Brothers; Crumpton Farrell, Saint Cloud State University; Jack Francis, City University of New York–Baruch College; Raymond Hartl, Indiana State University; and Melvin Williams, College of Saint Thomas.

SOFTWARE

The investment software package is designed to permit easy adaption to a wide variety of BASIC dialects. This is achieved by avoiding sophisticated features common only to a few compilers.

The programs are listed in Appendix D and are written in IBM VS BASIC. For those interested in "turnkey" ease of adoption, an inventory of "floppy" ($5\frac{1}{2}$-in.) disks and magnetic tapes containing versions of the programs in the more popular dialects of BASIC will be available. The programs are available for micros, minis, and mainframes. See Appendix D for a description of the available versions.

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CONTENTS

CHAPTER
ONE

RISK AND RETURN

Program	Description
STATPACK	This program has the following options: 1. Generates characteristic-line coefficients for a series of data (beta, alpha, R^2). 2. Computes holding-period yields, standard deviation, variance, and arithmetic and geometric means for a series of data.

This text is concerned with the use of the computer to assist in the analysis and selection of securities which can best achieve a defined objective. The investment objective is assumed to be an increase in wealth resulting from the purchase of financial assets. The wealth maximization goal is assumed to hold for both individual and institutional investors. It is also assumed that investors have an aversion to risk and therefore would prefer, other things being equal, to have a high return and no risk. Unfortunately, it is very difficult to simultaneously achieve high returns and low risk.[1] Indeed, one of the major tenets of finance is the direct relationship between risk and return. Figure 1-1 depicts this tradeoff between risk and return.

[1] Ibbotson, Roger G., and Rex A. Sinquefield, "Stocks, Bonds, Bills, and Inflation," *Journal of Business*, January 1976; Soldofsky, Robert M., and Dale F. Max, *Holding Period Yields and Risk Premium Curves for Long-Term Marketable Securities: 1910–1976*, Monograph Series in Finance and Economics, 1978-2, New York University; Fisher, Lawrence, and James H. Lorie, "Rates of Return on Investments in Common Stock: The Year-by-Year Record, 1926–65," *Journal of Business*, July 1968.

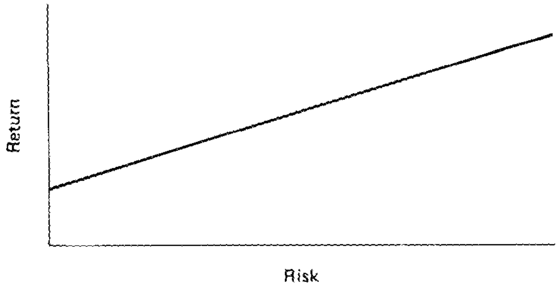

Figure 1-1 Risk-return tradeoff.

Given this general relationship, the objective of investment is the maximization of wealth or return at a given level of risk or, conversely, the minimization of risk at a given level of return. This is really the most one can hope to achieve. In this context, it is necessary that one understand the concepts and measurements of risk and return. This chapter discusses arithmetic and geometric holding-period yields as measures of return. The standard deviation or variance of return as well as beta coefficients are discussed as measures of risk. A list of the symbols used in Chapter 1 is presented in Table 1-1.

INVESTMENT RETURN

Throughout this text it is assumed that an increase in wealth as a result of the purchase of financial assets is the overriding goal of investments. The return on investment is a measure of the change in wealth resulting from the purchase of

Table 1-1 Symbols and definitions used in Chapter 1

HPY_i	= holding-period yield (%) for security i
WR_i	= wealth relative for security i
GM_i	= geometric mean yield (%) for security i
σ_i^2	= variance for security i
σ_i	= standard deviation for security i
α_i	= alpha coefficient for security i
β_i	= beta coefficient for security i
r_m	= market return
r_i	= return for security i
R^2	= coefficient of determination
SEE	= standard error of the estimate
Σ	= summation
EV_j	= expected value for j
X_j	= possible outcome j
P_j	= probability of outcome j occurring
K	= discount rate

a financial asset. This return can be expressed in a number of ways. Return is generally expressed as a wealth relative WR or a holding-period yield HPY.

$$WR = \frac{\text{ending wealth}}{\text{beginning wealth}}$$

$$HPY = \frac{\text{ending wealth} - \text{beginning wealth}}{\text{beginning wealth}}$$

The purchase of an asset for \$80 and the subsequent sale of the asset for \$100 results in a \$20 gain over the holding period. This can be expressed as a 1.25 wealth relative or a 25 percent holding-period yield.

$$\frac{100}{80} = 1.25 = WR$$

$$\frac{100 - 80}{80} = .25 \qquad \text{or} \qquad 25\% = HPY$$

The 25 percent holding-period yield is easily interpreted as a 25 percent yield on the investment. This yield may turn out to be positive or negative. The 1.25 wealth relative can be interpreted as a \$1.25 return per \$1 invested. It has the advantage over the holding-period yield in that it will never be a negative value. A loss of \$20 on an investment of \$80 will be reflected in a WR of .75 ($\frac{60}{80}$), or a return of \$0.75 per \$1.00 invested. This represents a negative HPY of 25 percent $(-\frac{20}{80}) = -.25$). The absence of negative values facilitates computations which involve logs and square roots.

Many financial assets generate a series of cash payments over the holding period which must also enter into the return calculations. Bonds generate interest payments over the holding period or life of the bond. Stocks generally pay cash dividends over the holding period of the stock. When cash payments are present, both measures of return must be adjusted to reflect these payments.

$$WR = \frac{\text{ending wealth} + \text{cash payments}}{\text{beginning wealth}}$$

$$HPY = \frac{\text{ending wealth} - \text{beginning wealth} + \text{cash payments}}{\text{beginning wealth}}$$

In the previous example, if the asset paid a \$4 dividend over the holding period, the return figures would now be

$$WR = \frac{100 + 4}{80} = 1.30$$

$$HPY = \frac{100 - 80 + 4}{80} = .30$$

Note the relationship between the holding-period yield and the wealth relative. The wealth relative return equals the holding-period yield plus 1 (WR = HPY + 1).

The quarterly holding-period yield is calculated for the Standard & Poor's Composite Stock Index in Table 1-2. This computed yield includes both a dividends and a capital gains component.

We are primarily concerned with predicting future returns from the investment in a security. No one can state precisely what these future returns will be. At best we can state the most likely expected outcome. This value is the expected value of a probability distribution of possible outcomes. For example we may feel there is a 20 percent probability of a 5 percent return, a 60 percent probability of a 10 percent return, and a 20 percent probability of a 20 percent return. The expected value EV of a subjective probability distribution is the summation of the product of the possible outcome and their associated probabilities $\left(\sum_{j=1}^{N} X_j P_j\right)$.

Yield X_j	Probability P	$\sum X_j P_j$
5%	.2	1.0
10%	.6	6.0
20%	.2	4.0
	EV =	11.0

The expected value of this probability distribution is 11.0 percent. It represents a best-guess estimate of the return that is likely to occur over some period of time.

Historical data may also be used to predict expected future returns under the assumption that the factors affecting past returns will continue to be present in the future. Returns generated from past data can, at best, provide only a rough estimate of expected future returns. The operating environment of the company as well as the economy change over time. These changes can be expected to alter expected future returns. Nevertheless, these historical returns can provide a starting point for predicting future returns. The mean $\bar{X}$ of a historical probability distribution of returns is equal to $(1/N) \sum_{t=1}^{N} X_t$. This mean is computed on the basis of an objective rather than a subjective probability distribution.

Arithmetic Mean versus Geometric Mean

It is one thing to measure the holding-period yield or return over a single holding period and quite another to describe a series of yields over time. Consider the data presented in Table 1-3 for stocks A and B. The mean wealth relative WR equals 1.078 or a 7.8 percent yield for stock A and 1.056 for stock B. How does one interpret an average yield of 7.8 percent? Does this figure accurately describe what one would have actually earned on an investment in stock A?