ONE

INTRODUCTION

1.1. The Subject of This Book

THIS IS A BOOK about the effects of investors interacting in capital markets and the implications for those who advise individuals concerning savings and investment decisions. The subjects are often considered separately under titles such as portfolio choice and asset pricing.

Portfolio choice refers to the ways in which investors do or should make decisions concerning savings and investments. Applications that are intended to describe what investors do are examples of positive economics. Far more common, however, are normative applications, designed to prescribe what investors should do.

Asset pricing refers to the process by which the prices of financial assets are determined and the resulting relationships between expected returns and the risks associated with those returns in capital markets. Asset pricing theories or models are examples of positive or descriptive economics, since they attempt to describe relationships in the real world. In this book we take the view that these subjects cannot be adequately understood in isolation, for they are inextricably intertwined. As will be shown, asset prices are determined as part of the process through which investors make portfolio choices. Moreover, the appropriate portfolio choice for an individual depends crucially on available expected returns and risks associated with different investment strategies, and these depend on the manner in which asset prices are set. Our goal is to approach these issues more as one subject than as two. Accordingly, the book is intended for those who are interested in descriptions of the opportunities available in capital markets, those who make savings and investment decisions for themselves, and those who provide such services or advice to others.

Academic researchers will find here a series of analyses of capital market conditions that go well beyond simple models that imply portfolio choices clearly inconsistent with observed behavior. A major focus throughout is on the effects on asset pricing when more realistic assumptions are made concerning investors' situations and behavior.

Investment advisors and investment managers will find a set of possible frameworks for making logical decisions, whether or not they believe that asset prices well reflect future prospects. It is crucial that investment professionals

differentiate between *investing* and *betting*. We show that a well thought out model of asset pricing is an essential ingredient for sound investment practice. Without one, it is impossible to even know the extent and nature of bets incorporated in investment advice or management, let alone ensure that they are well founded.

1.2. Methods

This book departs from much of the previous literature in the area in two important ways. First, the underlying view of the uncertain future is not based on the *mean/variance* approach advocated for portfolio choice by Markowitz (1952) and used as the basis for the original Capital Asset Pricing Model (CAPM) of Sharpe (1964), Lintner (1965), Mossin (1966), and Treynor (1999). Instead, we base our analyses on a straightforward version of the *state/preference* approach to uncertainty developed by Arrow (1953) extending the work of Arrow (1951) and Debreu (1951).

Second, we rely extensively on the use of a program that simulates the process by which equilibrium can be reached in a capital market and provides extensive analysis of the resulting relationships between asset prices and future prospects.

1.2.1. The State/Preference Approach

We utilize a state/preference approach with a discrete-time, discrete-outcome setting. Simply put, uncertainty is captured by assigning probabilities to alternative future *scenarios* or *states of the world*, each of which provides a different set of investment outcomes. This rules out explicit reliance on continuous-time formulations and continuous distributions (such as normal or log-normal), although one can use discrete approximations of such distributions.

Discrete formulations make the mathematics much simpler. Many standard results in financial economics can be obtained almost trivially in such a setting. At least as important, discrete formulations can make the underlying economics of a situation more obvious. At the end of the day, the goal of the (social) science of financial economics is to describe the results obtained when individuals interact with one another. The goal of financial economics as a prescriptive tool is to help individuals make better decisions. In each case, the better we understand the economics of an analysis, the better equipped we are to evaluate its usefulness. The term *state/preference* indicates both that discrete states and times are involved, and that individuals' preferences for consumption play a key role. Also included are other aspects, such as securities representing production outputs.

1.2.2. Simulation

Simulation makes it possible to substitute computation for derivation. Instead of formulating complex algebraic models, then manipulating the resulting equations to obtain a closed-form solution equation, one can build a computer model of a marketplace populated by individuals, have them trade with one another until they do not wish to trade any more, then examine the characteristics of the resulting portfolios and asset prices.

Simulations of this type have both advantages and disadvantages. They can be relatively easy to understand. They can also reflect more complex situations than must often be assumed if algebraic models are to be used. On the other hand, the relationship between the inputs and the outputs may be difficult to fully comprehend. Worse yet, it is hard if not impossible to *prove* a relationship via simulation, although it is possible to disprove one.

Consider, for example, an assertion that when people have preferences of type A and securities of type B are available, equilibrium asset prices have characteristics of type C; that is, $A + B \Rightarrow C$. One can run a simulation with some people of type A and securities of type B and observe that the equilibrium asset prices are of type C. But this does not prove that such will always be the case. One can repeat the experiment with different people and securities, but always with people of type A and securities of type B. If in one or more cases the equilibrium is not of type C, the proposition $(A + B \Rightarrow C)$ is disproven. But even if every simulation conforms with the proposition, it is not proven. The best that can be said is that if many simulations give the same result, one's confidence in the truth of the proposition is increased. Simulation is thus at best a brute force way to derive propositions that may hold most or all of the time.

But equilibrium simulation can be a powerful device. It can produce examples of considerable complexity and help people think deeply about the determinants of asset prices and portfolio choice. It can also be a powerful ally in bringing asset pricing analysis to more people.

1.2.3. The APSIM Program

The simulation program used for all the examples in this book is called APSIM, which stands for *A*sset Pricing and *P*ortfolio Choice *Sim*ulator. It is available without charge at the author's Web site: www.wsharpe.com, along with workbooks for each of the cases covered. The program, associated workbooks, instructions, and source code can all be downloaded. Although the author has made every attempt to create a fast and reliable simulation program, no warranty can be given that the program is without error.

Although reading C++ programming code for a complex program is not recommended for most readers, the APSIM source code does provide documentation for the results described here. In a simulation context, this can serve a

function similar to that of formal proofs of results obtained with traditional algebraic models.

1.3. Pedagogy

If you were to attend an MBA finance class at a modern university you would learn about subjects such as portfolio optimization, asset allocation analysis, the Capital Asset Pricing Model, risk-adjusted performance analysis, alpha and beta values, Sharpe Ratios, and index funds. All this material was built from Harry Markowitz's view that an investor should focus on the expected return and risk of his or her overall portfolio and from the original Capital Asset Pricing Model that assumed that investors followed Markowitz's advice. Such *mean/variance analysis* provides the foundation for many of the quantitative methods used by those who manage investment portfolios or assist individuals with savings and investment decisions. If you were to attend a Ph.D. finance class at the same university you would learn about no-arbitrage pricing, state claim prices, complete markets, spanning, asset pricing kernels, stochastic discount factors, and risk-neutral probabilities. All these subjects build on the view developed by Kenneth Arrow that an investor should consider alternative outcomes and the amount of consumption obtained in each possible situation. Techniques based on this type of analysis are used frequently by financial engineers, but far less often by investment managers and financial advisors.

Much of the author's published work is in the first category, starting with "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk" (1964). The monograph *Portfolio Theory and Capital Markets* (1970) followed resolutely in the mean/variance tradition, although it did cover a few ideas from state/preference theory in one chapter. The textbook *Investments* (Sharpe 1978) was predominantly in the mean/variance tradition, although it did use some aspects of a state/preference approach when discussing option valuation. The most recent edition (Sharpe, Alexander, and Bailey 1999) has evolved significantly, but still rests on a mean/variance foundation.

This is not an entirely happy state of affairs. There are strong arguments for viewing mean/variance analysis as a special case of a more general asset pricing theory (albeit a special case with many practical advantages). This suggests that it could be preferable to teach MBA students, investment managers, and financial advisors both general asset pricing and the special case of mean/variance analysis. A major goal of this book is to show how this might be accomplished. It is thus addressed in part to those who could undertake such a task (teachers, broadly construed). It is also addressed to those who would like to understand more of the material now taught in the Ph.D. classroom but who lack some of the background to do so easily (students, broadly construed).

1.4. Peeling the Onion

Capital markets are complex. We deal with stylized versions that lack many important features such as taxes, transactions costs, and so on. This is equivalent to introducing some of the principles of physics by assuming away the influences of friction. The justification is that one cannot hope to understand real capital markets without considering their behavior in simpler settings.

While our simulated capital markets are far simpler than real ones, their features are not simple to fully understand. To deal with this we introduce material in a sequential manner, starting with key aspects of a very simple case, while glossing over many important ingredients. Then we slowly peel back layers of the onion, revealing more of the inner workings and moving to more complex cases. This approach can lead to a certain amount of frustration on the part of both author and reader. But in due course, most mysteries are resolved, seemingly unrelated paths converge, and the patient reader is rewarded.

1.5. References

The material in this book builds on the work of many authors. Although some key works are referenced, most are not because of the enormity of the task. Fortunately, there is an excellent source for those interested in the history of the ideas that form the basis for much of this book: Mark Rubinstein's *A History of the Theory of Investments: My Annotated Bibliography* (Rubinstein 2006), which is highly recommended for anyone seriously interested in investment theory.

1.6. Chapters

A brief description of the contents of the remaining chapters follows.

1.6.1. Chapter 2: Equilibrium

Chapter 2 presents the fundamental ideas of asset pricing in a one-period (two-date) equilibrium setting in which investors agree on the probabilities of alternative future states of the world. The major focus is on the advice often given by financial economists to their friends and relatives: avoid non-market risk and take on a desired amount of market risk to obtain higher expected return. We show that under the conditions in the chapter, this is consistent with equilibrium portfolio choice.

1.6.2. Chapter 3: Preferences

Chapter 3 deals with investors' preferences. We cover alternative ways in which an individual may determine the amount of a security to be purchased or sold,

given its price. A key ingredient is the concept of marginal utility. There are direct relationships between investors' marginal utilities and their portfolio choices. We cover cases that are consistent with some traditional financial planning advice, others that are consistent with mean/variance analysis, and yet others that are consistent with some features of the experimental results obtained by cognitive psychologists.

1.6.3. Chapter 4: Prices

Chapter 4 analyzes the characteristics of equilibrium in a world in which investors agree on the probabilities of future states of the world, do not have sources of consumption outside the financial markets, and do not favor a given amount of consumption in one future state of the world over the same amount in another future state. The chapter also introduces the concept of a complete market, in which investors can trade atomistic securities termed state claims. Some of the key results of modern asset pricing theory are discussed, along with their preconditions and limitations. Implications for investors' portfolio choices are also explored. We show that in this setting the standard counsel that an investor should avoid non-market risk and take on an appropriate amount of market risk to obtain higher expected return is likely to be good advice as long as available securities offer sufficient diversity.

1.6.4. Chapter 5: Positions

Chapter 5 explores the characteristics of equilibrium and optimal portfolio choice when investors have diverse economic positions outside the financial markets or differ in their preferences for consumption in different possible states of the world. As in earlier chapters, we assume investors agree on the probabilities of alternative future outcomes.

1.6.5. Chapter 6: Predictions

Chapter 6 confronts situations in which people disagree about the likelihood of different future outcomes. Active and passive approaches to investment management are discussed. The arguments for index funds are reviewed, along with one of the earliest published examples of a case in which the average opinion of a number of people provided a better estimate of a future outcome than the opinion of all but a few. We also explore the impact of differential information across investors and the effects of both biased and unbiased predictions.

1.6.6. Chapter 7: Protection

Chapter 7 begins with a discussion of the type of investment product that offers "downside protection" and "upside potential." Such a "protected investment

product" is a derivative security because its return is based on the performance of a specified underlying asset or index. We show that a protected investment product based on a broad market index can play a useful role in a market in which some or all investors' preferences have some of the characteristics found in behavioral studies. We also discuss the role that can be played in such a setting by other derivative securities such as put and call options. To illustrate division of investment returns we introduce a simple trust fund that issues securities with different payoff patterns. Finally, we discuss the results from an experiment designed to elicit information about the marginal utilities of real people.

1.6.7. Chapter 8: Advice

The final chapter is based on the premise that most individual investors are best served through a division of labor, with investors assisted by investment professionals serving as advisors or portfolio managers. We review the demographic factors leading to an increased need for individuals to make savings and investment decisions and suggest the implications of the principle of comparative advantage for making such decisions efficiently. We then discuss the importance of understanding the differences between investing and betting and the need for investment advisors to have a logically consistent approach that takes into account the characteristics of equilibrium in financial markets. The chapter and the book conclude with a discussion of the key attributes of sound personal investment advice and an admonition that advisors and managers who make portfolio choices should have a clear view of the determination of asset prices.