More Praise for
Modern Investment Management

“This book is likely to become the bible of quantitative investment management.”
—Philippe Jorion
Professor of Finance
Graduate School of Management
University of California—Irvine

“A readable book, aimed at the serious investor. It is a comprehensive guide that takes the reader from the theoretical and conceptual all the way through practical application. Our company has been researching and evaluating investment managers for more than 30 years, and yet I am eager to incorporate the insights found in this book into our work. New additions to our staff will be reading it on day one.”
—Paul R. Greenwood
Director of US Equity
Frank Russell Company

“Building on the Nobel Prize-winning work of William Sharpe, and on that of their late colleague Fischer Black, Bob Litterman and his colleagues at Goldman Sachs Asset Management have taken the familiar and appealing concept of capital market equilibrium and reshaped it into an approach to asset management. They then extend their reach into many other related topics. Practically all investment managers, plan sponsors, brokers, and other financial professionals will find something of value in this encyclopedic work.”
—Larry Siegel
Director, Investment Policy Research
The Ford Foundation

“Equilibrium theory is fundamental to virtually every aspect of modern investment practice. In this book, the team from Goldman Sachs Asset Management provides not only a highly-readable review of the academic theory, but also a very practical guide to applying it to most of the important problems faced by today’s institutional investors. Perhaps most impressive is the breadth of this work. From asset allocation, to risk budgeting, to manager selection, to performance attribution, this book touches on the key aspects of professional investment management. This would be a wonderful text to build an applied investment finance course around.”
—Gregory C. Allen
Executive Vice President
Manager of Specialty Consulting, Callan Associates
“An elegant, well-written book, which gives the reader a better understanding of the workings of interrelated markets; it explains counterintuitive outcomes in a lucid way. Highly recommendable reading.”
—Jean Frijns
Chief Investment Officer
ABP Investments

“Modern Investment Management outlines a comprehensive, coherent, and up-to-date road map of the key strategic and implementation issues that institutional investors need to face. This book is destined to become required reading for institutional investors and their advisors.”
—Bill Muysken
Global Head of Research
Mercer Investment Consulting

“I found the book to be a valuable A to Z compendium of investment management theory and practice that would be an excellent reference for the experienced investor as well as an educational tool for the less knowledgeable. The book provides a clear and complete guide to both the important technical details and the more practical ‘real-world’ aspects of portfolio management from 30,000 feet and from ground level. This is certainly another in a long line of high-quality contributions to the investment management industry knowledge base made by Bob Litterman and colleagues at Goldman Sachs Asset Management.”
—Tim Barron
Managing Director, Director of Research
CRA RogersCasey

“Early applications of portfolio theory, based on analysts’ rate of return forecasts, required arbitrary constraints on portfolio weights to avoid plunging. The path-breaking Black-Litterman equilibrium approach changes focus to the rate of return threshold necessary for a portfolio shift to improve the investor’s risk return position. An excellent portfolio theory text based on the Black-Litterman model is long overdue. This book should be required reading for portfolio managers and asset allocators.”
—Bob Litzenberger
Emeritus Professor, Wharton
Retired Partner, Goldman, Sachs & Co.
MODERN INVESTMENT MANAGEMENT
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MODERN INVESTMENT MANAGEMENT

AN EQUILIBRIUM APPROACH

Bob Litterman and the Quantitative Resources Group
Goldman Sachs Asset Management

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A potential reader of this book with a cynical bent might well ask an obvious question: “If those folks at Goldman Sachs who wrote this book really knew anything worthwhile about investing, why would they put it together in a book where all of their competitors could find it?”

It’s a good question, because it leads naturally to the kind of thought process this book is really all about. The question might be rephrased in a way that makes our motivation for writing the book a little more clear: “Why, in equilibrium, would a successful investment manager write a book about investment management?” By “in equilibrium” we mean in an investment world that is largely efficient and in which investors are fairly compensated for risks and opportunities understood and well taken. Suppose there is wealth to be created from careful and diligent pursuit of certain rules of investing. Suppose further that one were to write those rules down and publish them for everyone to follow. In equilibrium, wouldn’t those sources of success disappear? Somehow it doesn’t seem to make sense for good investment managers to write books about their craft. Indeed, many sources of investment success, in particular those with limited capacity, would eventually disappear with increased competition. What we have tried to do in this book is to focus on other types of phenomena, those with a capacity consistent with the equilibrium demand for them. In equilibrium these types of phenomena would remain.

Consider an example of a phenomenon with limited capacity. Suppose it were the case that looking at publicly available information one could easily identify certain stocks (for example, those with small capitalization) that would regularly outperform other stocks to a degree not consistent with their risk characteristics. We would expect that if such a strategy were published and widely recognized, then the prices of such stocks would be bid up to the point where the costs of implementing such a strategy just about offset any remaining excess returns. In other words, we would expect such a phenomenon to disappear.

Now consider a phenomenon in the equilibrium camp. Suppose a rule of portfolio construction, for example a rule suggesting increased global diversification, were published that allows an investor to achieve a higher level of return for the same level of portfolio risk. The actions of investors following this suggestion will increase their expected wealth, but their implementation does not in any way reduce the strategy’s effectiveness. Even though other investors might implement the change (in equilibrium all investors will), it will nonetheless remain a rule that makes sense for each investor individually. In this book we write about the latter class of phenomena, not the former. In equilibrium this is what a reader should expect us to do.

Despite this equilibrium approach, our view is that the world is clearly not perfectly efficient, whatever that might mean. There might be a little bit of extra
reward for those armed with the most thorough, efficient, and disciplined investment processes, even though competition will certainly quickly eliminate most such opportunities. In equilibrium, markets will be relatively efficient, and to the extent that there are limited opportunities left to create excess returns, why would any profit-seeking investor put such proprietary insights into print? The answer is, of course, that in truth they would not. Let’s be honest: To the best of our ability we have tried not to include any proprietary information; there are no secret insights buried in this book about how to beat the market, and no descriptions of the exact factors that enter our quantitative return generating models. Clearly some of the anomalies we rely on to actively manage assets are not equilibrium phenomena, and the process of inviting too many competitors to fish in our pond would diminish our ability to create excess returns in the future.

We do believe, though, that the material we have written here is worthwhile. What we have tried to do is to describe what happens when markets are in equilibrium, and how investors, trying to maximize their investment return, should behave. We also address the question of how investors might, as we do, try to identify and look to take advantage of deviations from equilibrium.

Enough about equilibrium theory. The authors of this book are all market professionals and what we have written is designed to be a practical guide. Although we spend a few chapters in the beginning developing a simple, one-period version of a global equilibrium model, the main body of the text is concerned with what it takes to be a serious investor in the world today. The basics of being a smart investor involve understanding risk management, asset allocation, the principles of portfolio construction, and capital asset pricing. The latter refers to being able to identify the return premiums that are justified by the risk characteristics of different securities, and therefore understanding the basis for being able to identify opportunities.

We have chapters focused on the traditional equity and fixed income asset classes as well as on alternative assets such as hedge funds and private equities. We believe that active management can be productive, and we discuss how to build a portfolio of active managers. We understand, though, that not everyone can outperform the average and that in equilibrium it has to be extremely difficult for a portfolio manager to be consistently successful at the active management game. We have a core focus on the problems faced by institutional funds, but also several chapters on the special issues faced by taxable investors. We hope the book fills a gap by tying together the academic theories developed over the past 50 years with the practicalities of investment management in the twenty-first century.

Finally, we provide here a few words on who we are, and a few words of thanks to those to whom we are indebted. We are the Quantitative Resources Group, a part of Goldman Sachs Asset Management (GSAM). Our group has a number of functions. We manage money using quantitative models, we build financial and risk models, we act as fiduciaries and advisors to institutional funds, and we produce research and market outlooks.

Our debts are many, though clearly our deepest is to Fischer Black, our intellectual leader, a cherished colleague, and the first head of quantitative research in GSAM. Fischer was a great believer in the practical value of the insights provided by equilibrium modeling and he inspired our pursuit of this approach. We also wish to thank our clients whose challenges and questions have sponsored all of the activ-
ities we sometimes call “work.” Next in line are our colleagues, those in the firm, in our industry, and in academia, who have shared their ideas, suggestions, and feedback freely and are clearly reflected on many of these pages. Many thanks to Goldman Sachs, which supported this project throughout and whose culture of teamwork and putting clients’ interests first is embraced by us all. Thanks to Bill Falloon, our editor at Wiley, who suggested we write this book, then waited patiently for several years as the ideas gelled, and finally managed to cajole us into putting thoughts on paper.

And finally, a huge thank-you to our families who most of the time live with the short end of the “balance” that Goldman Sachs affectionately promotes between work and family—and who have contributed even further patience in putting up with our efforts to produce this book. Our domestic accounts are, as usual, hopelessly overdrawn.

ROBERT LITTERMAN

New York, New York
June 2003
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PART One

Theory
There are many approaches to investing. Ours at Goldman Sachs is an equilibrium approach. In any dynamic system, equilibrium is an idealized point where forces are perfectly balanced. In economics, equilibrium refers to a state of the world where supply equals demand. But it should be obvious even to the most casual observer that equilibrium never really exists in actual financial markets. Investors, speculators, and traders are constantly buying and selling. Prices are constantly adjusting. What then do we find attractive about an equilibrium approach to investing?

There are several attractions. First, in economic systems there are natural forces that come into play to eliminate obvious deviations from equilibrium. When prices are too low, demand will, at least over time, increase. When prices are too high, suppliers will enter the market, attracted by the profitable opportunity. There are lots of interesting, and sometimes uninteresting, reasons why such adjustments take time. Frictions, uncertain information, noise in the system, lack of liquidity, concerns about credit or legal status, or questions about enforceability of contracts all can impede adjustment, and sometimes deviations can be quite large. But financial markets, in particular, tend to have fewer frictions than other markets, and financial markets attract smart investors with resources to exploit profitable opportunities. Thus, deviations from equilibrium tend to adjust relatively rapidly in financial markets.

We need not assume that markets are always in equilibrium to find an equilibrium approach useful. Rather, we view the world as a complex, highly random system in which there is a constant barrage of new data and shocks to existing valuations that as often as not knock the system away from equilibrium. However, although we anticipate that these shocks constantly create deviations from equilibrium in financial markets, and we recognize that frictions prevent those deviations from disappearing immediately, we also assume that these deviations represent opportunities. Wise investors attempting to take advantage of these opportunities take actions that create the forces which continuously push the system back toward equilibrium. Thus, we view the financial markets as having a center of gravity that is defined by the equilibrium between supply and demand.
Understanding the nature of that equilibrium helps us to understand financial markets as they constantly are shocked around and then pushed back toward that equilibrium.

The second reason we take an equilibrium approach is that we believe this provides the appropriate frame of reference from which we can identify and take advantage of deviations. While no financial theory can ever capture even a small fraction of the detail and complexities of real financial markets, equilibrium theory does provide guidance about general principles of investing. Financial theory has the most to say about markets that are behaving in a somewhat rational manner. If we start by assuming that markets are simply irrational, then we have little more to say. Perhaps we could find some patterns in the irrationality, but why should they persist? However, if we are willing, for example, to make an assumption that there are no arbitrage opportunities in markets, which is to assume that there are no ways for investors to make risk-free profits, then we can look for guidance to a huge amount of literature that has been written about what should or should not happen. If we go further and add the assumption that markets will, over time, move toward a rational equilibrium, then we can take advantage of another elaborate and beautiful financial theory that has been developed over the past 50 years. This theory not only makes predictions about how markets will behave, but also tells investors how to structure their portfolios, how to minimize risk while earning a market equilibrium expected return. For more active investors, the theory suggests how to take maximum advantage of deviations from equilibrium.

Needless to say, not all of the predictions of the theory are valid, and in truth there is not one theory, but rather many variations on a theme, each with slightly different predictions. And while one could focus on the limitations of the theory, which are many, or one could focus on the many details of the different variations that arise from slight differences in assumptions, we prefer to focus on one of the simplest global versions of the theory and its insights into the practical business of building investment portfolios.

Finally, let us consider the consequences of being wrong. We know that any financial theory fails to take into account nearly all of the complexity of actual financial markets and therefore fails to explain much of what drives security prices. So in a sense we know that the equilibrium approach is wrong. It is an oversimplification. The only possibly interesting questions are where is it wrong, and what are the implications?

Nonetheless, suppose we go ahead and assume that this overly simple theory drives the returns on investments. One great benefit of the equilibrium approach to investing is that it is inherently conservative. As we will see, in the absence of any constraints or views about markets, it suggests that the investor should simply hold a portfolio proportional to the market capitalization weights. There may be some forgone opportunity, and there may be losses if the market goes down, but returns are guaranteed to be, in some fundamental sense, average.

Holding the market portfolio minimizes transactions costs. As an investor there are many ways to do poorly, through either mistakes or bad luck. And there are many ways to pay unnecessary fees. The equilibrium approach avoids these pitfalls. Moreover, no matter how well one has done, unfortunately there are al-
most always many examples of others who have done better. The equilibrium approach is likely to minimize regret. If an investor starts with an approach that assumes the markets are close to equilibrium, then he or she has realistic expectations of earning a fair return, and won’t be led to make costly mistakes or create unacceptable losses.

Suppose an investor ignores the lessons of equilibrium theory. There are lots of ways the markets can be out of equilibrium. If an investor makes a particular assumption about how that is the case and gets that approach wrong, he or she could easily be on a limb, and the consequences could be disastrous relative to expectations. The equilibrium approach may not be as exciting, but over long periods of time the overall market portfolio is likely to produce positive results.

Investors today have a lot more opportunity to invest intelligently than did previous generations. Tremendous progress has been made in both the theory and the practice of investment management. Our understanding of the science of market equilibrium and of portfolio theory has developed greatly over the past 50 years. We now have a much better understanding of the forces that drive markets toward equilibrium conditions, and of the unexpected factors that shock markets and create opportunities. In addition, the range of investment products, the number of service providers, and the ease of obtaining information and making investments have all increased dramatically, particularly in the past decade. At the same time, the costs of making investments have decreased dramatically in recent years. Today it is far easier than ever before for the investor to create a portfolio that will deliver consistent, high-quality returns. This book provides a guide to how that can be done.

We have divided the text into six parts. The first presents a simple, practical introduction to the theory of investments that has been developed in academic institutions over the past 50 years. Although academic in origin, this theory is a very practical guide to real-world investors and we take a very applied approach to this material. We try to provide examples to help motivate the theory and to illustrate where it has implications for investor portfolios. Our hope is to make this theory as clear, as intuitive, and as useful as possible. We try to keep the mathematics to a minimum, but it is there to some extent for readers who wish to pursue it. We also provide references to the important original source readings.

The second part is focused on the problems faced by the largest institutional portfolios. These funds are managed primarily on behalf of pensions, central banks, insurance companies, and foundations and endowments. The third part concerns various aspects of risk, such as defining a risk budget, estimating covariance matrices, managing fund risk, insuring proper valuations, and understanding performance attribution. The fourth part looks at traditional asset classes, equities and bonds. We look at the problem of manager selection, as well as managing global portfolios. The fifth part considers nontraditional investments such as currency and other overlay strategies, hedge funds, and private equity. Finally, the last part focuses on the particular problems of private investors such as tax considerations, estate planning, and so on. Paradoxically, the investment problems of private investors are typically much more complicated than those of most institutional portfolios simply because of the unfortunate necessity of private individuals to pay taxes. For example, even in the simplest equilibrium situation, buying and holding
a market capitalization portfolio is no longer optimal for a taxable investor. The simple buy-and-hold strategy, while it is generally very tax efficient, can nonetheless still usually be improved upon by selling individual securities when they have encountered short-term losses relative to their purchase prices. Such losses can then generally be used to reduce taxes.

Throughout this book the equilibrium theory is sometimes evident, and sometimes behind the scenes, but it infuses all of our discussions of what are appropriate investment decisions.
In order to be successful, an investor must understand and be comfortable with taking risks. Creating wealth is the object of making investments, and risk is the energy that in the long run drives investment returns.

Investor tolerance for taking risk is limited, though. Risk quantifies the likelihood and size of potential losses, and losses are painful. When a loss occurs it implies consumption must be postponed or denied, and even though returns are largely determined by random events over which the investor has no control, when a loss occurs it is natural to feel that a mistake was made and to feel regret about taking the risk. If a loss has too great an impact on an investor’s net worth, then the loss itself may force a reduction in the investor’s risk appetite, which could create a significant limitation on the investor’s ability to generate future investment returns. Thus, each investor can only tolerate losses up to a certain size. And even though risk is the energy that drives returns, since risk taking creates the opportunity for bad outcomes, it is something for which each investor has only a limited appetite.

But risk itself is not something to be avoided. As we shall discuss, wealth creation depends on taking risk, on allocating that risk across many assets (in order to minimize the potential pain), on being patient, and on being willing to accept short-term losses while focusing on long-term, real returns (after taking into account the effects of inflation and taxes). Thus, investment success depends on being prepared for and being willing to take risk.

Because investors have a limited capacity for taking risk it should be viewed as a scarce resource that needs to be used wisely. Risk should be budgeted, just like any other resource in limited supply. Successful investing requires positioning the risk one takes in order to create as much return as possible. And while investors have intuitively understood the connection between risk and return for many centuries, only in the past 50 years have academics quantified these concepts mathematically and worked out the sometimes surprising implications of trying to maximize expected return for a given level of risk. This body of work, known today as modern portfolio theory, provides some very useful insights for investors, which we will highlight in this chapter.
The interesting insights provided by modern portfolio theory arise from the interplay between the mathematics of return and risk. It is important at this juncture to review the different rules for adding risks or adding returns in a portfolio context. These issues are not particularly complex, but they are at the heart of modern portfolio theory. The mathematics on the return side of the investment equation is straightforward. Monetary returns on different investments at a point in time are additive. If one investment creates a $30,000 return and another creates a $40,000 return, then the total return is $70,000. The additive nature of investment returns at a point in time is illustrated in Figure 2.1.

Percentage returns compound over time. A 20 percent return one year followed by a 20 percent return the next year creates a 44 percent\(^1\) return on the original investment over the two-year horizon.

The risk side of the investment equation, however, is not so straightforward. Even at a point in time, portfolio risk is not additive. If one investment creates a volatility\(^2\) of $30,000 per year and another investment creates a volatility of $40,000 per year, then the total annual portfolio volatility could be anywhere between $10,000 and $70,000. How the risks of different investments combine depends on whether the returns they generate tend to move together, to move independently, or to offset. If the returns of the two investments in the preceding example are roughly independent, then the combined volatility is approximately\(^3\) $50,000; if they move together, the combined risk is higher; if they offset, lower. This degree to which returns move together is measured by a statistical quantity called *correlation*, which ranges in value from +1 for returns that move perfectly together to zero for independent returns, to −1 for returns that always move in oppo-

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\(^{1}\)The two-period return is \(z\), where the first period return is \(x\), the second period return is \(y\), and \((1 + z) = (1 + x)(1 + y)\).

\(^{2}\)Volatility is only one of many statistics that can be used to measure risk. Here “a volatility” refers to one standard deviation, which is a typical outcome in the distribution of returns.

\(^{3}\)In this calculation we rely on the fact that the variance (the square of volatility) of independent assets is additive.