EQUITY VALUATION AND PORTFOLIO MANAGEMENT

FRANK J. FABOZZI • HARRY M. MARKOWITZ, EDITORS
Equity Valuation and Portfolio Management
Preface xiii
About the Editors xxiii
Contributing Authors xxv

CHAPTER 1
An Introduction to Quantitative Equity Investing 1
Paul Bukowski
   Equity Investing 1
   Fundamental vs. Quantitative Investor 2
   The Quantitative Stock Selection Model 7
   The Overall Quantitative Investment Process 9
   Research 9
   Portfolio Construction 18
   Monitoring 21
   Current Trends 22
   Key Points 23
   Questions 24

CHAPTER 2
Equity Analysis Using Traditional and Value-Based Metrics 25
James L. Grant and Frank J. Fabozzi
   Overview of Traditional Metrics 25
   Price Multiples 32
   Fundamental Stock Return 36
   Traditional Caveats 38
   Overview of Value-Based Metrics 39
   Key Points 58
   Appendix: Case Study 60
   Questions 69
Chapter 3: A Franchise Factor Approach to Modeling P/E Orbits

Stanley Kogelman and Martin L. Leibowitz

Background 72
Historical Data Observations 75
Formulation of the Basic Model 81
P/E Myopia: The Fallacy of a Stable P/E 85
Two-Phase P/E Orbits 91
Franchise Valuation under Q-Type Competition 96
Franchise Labor 97
Key Points 101
Questions 102

Chapter 4: Relative Valuation Methods for Equity Analysis

Glen A. Larsen Jr., Frank J. Fabozzi, and Chris Gowlland

Basic Principles of Relative Valuation 106
Hypothetical Example 115
Key Points 123
Questions 124

Chapter 5: Valuation over the Cycle and the Distribution of Returns

Anders Ersbak Bang Nielsen and Peter C. Oppenheimer

The Link Between Earnings and Returns 126
The Phases Can Be Interpreted in Relationship to the Economy 132
Asset Class Performance Varies across the Phases 137
Incorporating Cyclicality into Valuations 139
Appendix: Dates and Returns of the Phases 142
Key Points 146
Questions 146

Chapter 6: An Architecture for Equity Portfolio Management

Bruce I. Jacobs and Kenneth N. Levy

Architectural Building Blocks 148
Traditional Active Management 151
Passive Management 156
Engineered Management 157
**CHAPTER 10**  
*Tracking Error and Common Stock Portfolio Management*  
*Raman Vardharaj, Frank J. Fabozzi, and Frank J. Jones*

- Definition of Tracking Error  
- Components of Tracking Error  
- Forward-Looking vs. Backward-Looking Tracking Error  
- Information Ratio  
- Determinants of Tracking Error  
- Marginal Contribution to Tracking Error  
- Key Points  
- Questions

**CHAPTER 11**  
*Factor-Based Equity Portfolio Construction and Analysis*  
*Petter N. Kolm, Joseph A. Cerniglia, and Frank J. Fabozzi*

- Factor-Based Trading  
- Developing Factor-Based Trading Strategies  
- Risk to Trading Strategies  
- Desirable Properties of Factors  
- Sources for Factors  
- Building Factors from Company Characteristics  
- Working with Data  
- Analysis of Factor Data  
- Key Points  
- Questions

**CHAPTER 12**  
*Cross-Sectional Factor-Based Models and Trading Strategies*  
*Joseph A. Cerniglia, Petter N. Kolm, and Frank J. Fabozzi*

- Cross-Sectional Methods for Evaluation of Factor Premiums  
- Factor Models  
- Performance Evaluation of Factors  
- Model Construction Methodologies for a Factor-based Trading Strategy  
- Backtesting  
- Backtesting Our Factor Trading Strategy  
- Key Points  
- Appendix: The Compustat Point-in-Time, IBES Consensus Databases and Factor Definitions  
- Questions
CHAPTER 13
Multifactor Equity Risk Models and Their Applications 339
Anthony Lazanas, António Baldaque da Silva, Arne D. Staal, and Cenk Ural
Motivation 340
Equity Risk Factor Models 342
Applications of Equity Risk Models 350
Key Points 370
Questions 371

CHAPTER 14
Dynamic Factor Approaches to Equity Portfolio Management 373
Dorsey D. Farr
Methods of Active Management 376
Modeling 385
Implementation 392
Key Points 395
Questions 395

CHAPTER 15
A Factor Competition Approach to Stock Selection 397
Joseph Mezrich and Junbo Feng
The Problem 397
The Solution 403
Which Factors Get Picked? 407
Does the Alpha Repair Process Work? 408
Key Points 411
Questions 412

CHAPTER 16
Avoiding Unintended Country Bets in Global Equity Portfolios 413
Michele Aghassi, Cliff Asness, Oktay Kurbanov, and Lars N. Nielsen
Country Membership and Individual Stock Returns 414
Ways to Build Active Global Portfolios 416
Studying the Naive Portfolio 419
Empirical Results 420
Why Does the Naive Stock Selection Portfolio Make Country Noise Bets? 422
Key Points 423
Questions 424
### CHAPTER 17
**Modeling Market Impact Costs**

*Petter N. Kolm and Frank J. Fabozzi*

- Market Impact Costs 426
- Liquidity and Transaction Costs 427
- Market Impact Measurements and Empirical Findings 430
- Forecasting and Modeling Market Impact 433
- Key Points 439
- Questions 440

### CHAPTER 18
**Equity Portfolio Selection in Practice**

*Dessislava A. Pachamanova and Frank J. Fabozzi*

- Portfolio Constraints Commonly Used in Practice 442
- Benchmark Exposure and Tracking Error Minimization 450
- Incorporating Transaction Costs 454
- Incorporating Taxes 460
- Multi-Account Optimization 465
- Robust Parameter Estimation 469
- Portfolio Resampling 471
- Robust Portfolio Optimization 474
- Key Points 480
- Questions 481

### CHAPTER 19
**Portfolio Construction and Extreme Risk**

*Jennifer Bender, Jyh-Huei Lee, and Dan Stefek*

- Measures of Extreme Loss 484
- Constraining Shortfall 485
- Performance 485
- Imposing Benchmark Neutrality 487
- Analysis 489
- Key Points 493
- Appendix: Constructing Out-of-Sample Shortfall Betas 494
- Questions 495

### CHAPTER 20
**Working with High-Frequency Data**

*Irene Aldridge*

- What is High-Frequency Data? 497
In an editorial in the Winter 2011 issue of the *Journal of Portfolio Management*, Mark Kritzman notes the following regarding what is popularly referred to as *Markowitz portfolio theory*: “Mean-variance optimization is about to begin its 60th year and by all accounts it has aged extremely well.” He goes on to say, “As with many innovations, however, practitioners of the old technology resisted change and defended their resistance with a variety of excuses, which persist even today.” There are several reasons why practitioners were reluctant or slow to adopt a more quantitative approach such as that offered by the mean-variance framework. The computing power needed to manipulate the databases used to obtain the required inputs for mean-variance analysis and then efficiently solve for the optimal portfolios was very limited in the years that followed its introduction in 1952. Major advances in computing power have taken care of this obstacle, as well as the availability of commercial software for solving large complex optimization problems.

A second reason for the reluctance or inability to adopt a more quantitative approach was simply practitioners’ lack of the mathematical skill set necessary to appreciate the advantages of a quantitative approach. Since the late 1970s, however, university finance programs have armed their graduates with the mathematical and statistical skills needed to deal with quantitative models. In fact, over the past decade, a good number of universities have augmented their degree offerings beyond the traditional MBA with a specialization in finance to degree programs that bear titles such as “computational finance,” “quantitative finance,” “mathematical finance,” and “financial engineering,” in recognition of the need to equip students with strong quantitative skills.

Finally, the classical mean-variance model required refinements and extensions to deal with real-world institutional constraints and market frictions and allow it to be effectively implemented in the real world. In this book, the contributors provide the state-of-the-art methods for implementing equity valuation models, trading models, and portfolio management strategies. Both traditional equity management and quantitative equity management are covered. All of the contributors to this book have had experience as equity portfolio managers or equity strategists.
In the first chapter, Paul Bukowski reviews the fundamentals of quantitative equity investing, the core steps in the quantitative equity investment process, and the most common techniques used by quantitative equity managers. He contrasts quantitative equity investing with the traditional approaches and explains how the quantitative and traditional approaches differ in their creation of a repeatable process that utilizes several key criteria to find the most attractive companies—the stock selection model.

Chapters 2 and 3 cover relatively new and improved approaches for what would be classified as “traditional” approaches to equity selection. Fundamentals and valuation metrics are used in traditional and value-based approaches to equity valuation. James Grant and Frank Fabozzi explain and illustrate both approaches in Chapter 2 with the goal of showing their joint role in the valuation process. Liquidity, activity, debt (leverage), and profitability measures are used in the traditional approach, with growth rates and profitability measures often combined with relative valuation measures (“multiples”) to assess the attractiveness or unattractiveness of a firm’s common stock. Value-based metrics are financial measures that concentrate on metrics for discerning whether a company is pointing in the direction of wealth creation or wealth destruction. In this relatively new approach, the focus is on identifying firms that can consistently earn a return on capital that exceeds their weighted average cost of capital. A financial metric takes on a value-based metric character when there is an explicit recognition of and accounting for the overall cost of capital or the cost of equity. Hence, the most distinctive feature of the value-based metric analysis in contrast to traditional analysis is the formal recognition of the investor’s required rate of return (cost of equity) and the overall cost of capital. The most often used value-based metrics—residual income, economic value added (EVA®), market value added (MVA), and cash flow return on investment (CFROI®)—are explained in the chapter. In the end, the objective of both the traditional and value-based approaches is to determine a target valuation for a company leading to a potential buy (or “overweight” relative to reference index), sell (“underweight” relative to index) or hold decision (benchmark weight) on a company’s stock. After reviewing the relevant metrics, Grant and Fabozzi illustrate the benefits of using a synthesized approach to assess potential buy and sell (short) opportunities.

As Stanley Kogelman and Martin Leibowitz note in Chapter 3, although the standard dividend discount model is still often used as an equity valuation model, the model often masks the extreme variations in growth expectations, return on equity, and sustainable earnings that drive the change in valuations and move markets. These limitations of the dividend discount model are overcome by the franchise factor model developed by Kogelman and Leibowitz. This model offers greater clarity on how corporate and
economic events impact the key components of a firm’s value while still maintaining one of the major appeals of the dividend discount model—simplicity and intuitive appeal.

Relative valuation methods are a traditional approach for comparing several companies by using multiples or ratios (such as price–earnings, price–book, and price–free cash flow), implicitly assuming that the firms being analyzed are similar in their investment attributes and, therefore, on average, likely to trade at similar multiples. If so, relative valuation methods can be used by portfolio managers to identify companies that look “cheap” or “expensive” relative to their peers and thereby provide another tool for equity portfolio selection in long-only and long-short strategies. Relative valuation methods for equity analysis are covered in Chapter 4 by Glen Larsen Jr., Frank Fabozzi, and Chris Gowlland.

Empirical studies have found what intuition would suggest about stock behavior: Valuation is a good predictor of returns over the long run. Although today’s valuations offer investors a good deal of information about future expected returns, they are silent regarding how these returns should be distributed over time. For example, investors would like to know whether future expected returns are evenly distributed over several years or whether returns cluster into short time periods. Moreover, investors want to know whether there is a process that determines how future expected returns are generated. In Chapter 5, Anders Erskbak Bang Nielsen and Peter Oppenheimer address this issue. As they point out, the empirical evidence based on historical observations suggests that there is a relationship between valuation, earnings, and the economic cycle that provides guidance to future expected returns. The practical implication of their findings that valuations and returns shift over the economic cycle is that valuation models should be adjusted to take into account this important relationship.

In Chapter 6, Bruce Jacobs and Kenneth Levy provide an architecture for equity portfolio management, outlining the fundamental relationships between stocks (the raw investment material), investment approaches (portfolio construction techniques), potential rewards, and possible risks. The basic building blocks for constructing portfolios is the equity core and its constituent style subsets that are comprised of stocks with similar price behaviors—large-cap growth, large-cap value, and small-cap stocks. Investors must also decide among possible investment approaches—traditional, passive, and engineered (quantitative) active—each of which can be characterized by an underlying investment philosophy and a general level of risk. Because investment performance reflects breadth of inquiry (the sheer number of investment opportunities) and depth of analysis (the strength of investment insights), the three investment approaches can be distinguished on that basis. Although the traditional management approach provides
depth, it is characterized by a lack of breadth, susceptibility to cognitive errors, and lack of portfolio integrity. In contrast, there is no depth at all provided by the passive management approach but it does offer breadth, freedom from cognitive errors, and portfolio integrity. The advantage of the engineered management approach compared to the other two approaches is that it is capable of allowing a manager to construct portfolios that benefit from both breadth and depth of analysis, are free of cognitive errors, and have structural integrity. Breadth can be expanded with the use of short selling, either in market neutral long-short or 130-30 enhanced active long-short strategies.

Bruce Jacobs and Kenneth Levy describe in Chapter 7 their approach to investing and its application to the stock selection, portfolio construction, and performance evaluation problems in a complex system such as the equity market. They discuss the advantages and disadvantages of portfolio managers trying to cover the broadest possible range of stocks or realizing better analytical insights by allocating their limited resources so as to concentrate on a particular subset of the market or a limited number of stocks. They explain how combining the two may offer the best avenue for identifying investment opportunities. They also discuss what Harry Markowitz in his foreword to the 2000 Jacobs-Levy book (Quantitative Analysis for Stock Selection) has termed their “seminal work” on disentangling return-predictor relationships. This involves multivariate analysis of numerous individual stock fundamental and behavioral variables, industry affiliations, and macroeconomic conditions, to forecast “pure” returns to each predictor, independent of the effects of other factors. Disentangling return-predictor relationships can reveal hidden opportunities and distinguish real from spurious effects; the resulting return predictions are also additive and generally more persistent than “naive” predictions obtained from simpler analyses using only one or a few factors at a time.

The balance of the book deals primarily with quantitative equity management. A review of three studies based on surveys and interviews of market participants about their use and experience with quantitative equity techniques is the subject of Chapter 8 coauthored by Frank Fabozzi, Sergio Focardi, and Caroline Jonas. They report that the primary methodology of financial modeling in investment management is factor models, which are used to forecast returns and to compute exposure to risk factors. Quantitative techniques that are also widely used are momentum and reversal models, cash flow–based models, and behavioral models. There is increased use of adaptive models capable of dealing with different market conditions and robust optimization models for portfolio optimization along with robust techniques for estimating inputs. It is expected that in the future there will see greater use of models for dealing with nonlinearities and fat-tailed
distributions, the use of risk measures suitable for nonlinear distributions, and methods to measure the complexity of the financial system.

In the quantitative process, the identification of any persistent pattern in the data is sought and must then be converted into implementable and profitable investment strategies. As explained by Frank Fabozzi, Sergio Focardi, and K. C. Ma in Chapter 9, how this is done requires the development of underlying economic theories, an explanation of actual returns, estimation of expected returns, and construction of corresponding portfolios. In evaluating models for potential implementation of investment strategies, two guiding principles are model simplicity and out-of-sample validation. A portfolio manager can place a higher level of confidence on a simple model validated on data different from those on which it has been built. The selection of a methodology for estimating a model should satisfy the same quality tests as developing economic theories and selecting samples. In the absence of strong intuition, the methodology that needs the least amount of human inputs should be employed for estimating a model. Even if the expected return is modeled properly at the individual stock level, the bottom line of implementable investment strategies is evaluated by an acceptable level of risk-adjusted portfolio excess returns. Because most institutional portfolios are benchmarked, the objective is to minimize tracking error given some level of portfolio excess return. For this purpose, risk control becomes technically much more complex than the conventional efficient portfolio concept.

The measure used to control equity portfolio risk relative to a specified benchmark, as well as for risk budgeting (i.e., allocation of risk) and assessing performance, is tracking error. This metric, also referred to as tracking error risk, is the dispersion of a portfolio’s active returns (where the active return is the difference between a portfolio’s return and a benchmark’s return). In Chapter 10, Raman Vardharaj, Frank Fabozzi, and Frank Jones review the concepts of backward-looking and forward-looking tracking error and identify the major factors that affect tracking error.

In Chapters 11 and 12, companion chapters coauthored by Petter Kolm, Joseph Cerniglia, and Frank Fabozzi, a demonstration of how to employ factors to build equity forecasting models is provided. These models, also referred to as alpha or stock selection models, serve as mathematical representations of trading strategies. The eight main steps in the development of a factor-based trading strategy are defining a trading idea or investment strategy, developing factors, acquiring and processing data, analyzing the factors, building the strategy, evaluating the strategy, backtesting the strategy, and implementing the strategy. The authors describe and illustrate with real-world examples these steps. In Chapter 11, the development of trading strategies based on factors constructed from common (cross-sectional)
characteristics of stocks is provided. After providing a definition of factors, they examine the major sources of risk associated with trading strategies and demonstrate how factors are constructed from company characteristics and market data. Because the quality of the data used in this process is critical, several data scrubbing and adjustment techniques to deal with the problems arising from backfilling and restatements of data, missing data, inconsistently reported data, as well as survivorship and look-ahead biases are explained. Finally, they discuss the analysis of the statistical properties of factors. Basic statistical measures include the time-series and cross-sectional averages of the mean, standard deviations, and key percentiles.

In Chapter 12, Kolm, Cerniglia, and Fabozzi extend the analysis to include multiple factors with the goal of developing a dynamic multifactor trading strategy that incorporates a number of common institutional constraints, such as turnover, transaction costs, sector allocation, and tracking error. After reviewing several approaches for the evaluation of return premiums and risk characteristics to factors (the four most common being portfolio sorts, factor models, factor portfolios, and information coefficients), they describe four approaches (data driven, factor model, heuristic, and optimization) used to combine several factors into a single model—a trading strategy. To understand the performance and risk characteristics of a factor-based trading strategy, it is imperative to perform out-of-sample backtests. An out-of-sample methodology is a backtesting methodology where the researcher uses a subset of the sample to specify a model and then evaluates the forecasting ability of the model on a different subset of data. The authors explain the two approaches for implementing an out-of-sample methodology: the split-sample approach and the recursive out-of-sample test.

While Chapters 11 and 12 describe how to build and test factor–based models so that they can be used as the basis for trading strategies, in Chapter 13, Anthony Lazanas, António Baldaque da Silva, Arne Staal, and Cenk Ural present an actual equity factor model—the Barclays Capital Global Risk Model—and demonstrate its applications to portfolio risk management, portfolio construction, portfolio rebalancing, scenario analysis, and performance attribution. Although the authors describe the structure of multifactor equity risk models, types of factors used in these models, and estimation techniques as in the prior two chapters, the applications are the focal point. In particular, they explain how an equity factor model provides portfolio managers with insight into the major sources of portfolio risk so that managers can control a portfolio’s risk exposures and understand the contributions of different portfolio components to total risk. They also show how a factor model can be used in performance attribution analysis so as to (1) provide ex post insight into how the portfolio manager’s views and corresponding investments can be translated into actual returns and (2)
provide portfolio managers with a powerful tool to perform stress testing of portfolio positions and gain insight into the impact of specific market events on portfolio performance.

Portfolio managers use factor models to construct portfolios based on tactical exposure to factors such as equity style, industry, or geographic location, macroeconomic factors, or microeconomic factors while attempting to eliminate sources of security-specific risk. Dynamic factor approaches to portfolio management, the subject of Chapter 14, authored by Dorsey Farr, describes portfolio strategies based on dynamic factor methods, explores a variety of the modeling approaches used to govern the implementation of these strategies, reviews the increasing number of tools available for implementation of these strategies, and highlights how security selection is no longer necessary for an efficient implementation in many cases.

A dilemma facing managers employing factor models for stock selection is deciding when to abandon a factor that seems to have lost efficacy, and when to introduce one that appears to have become important. Joseph Mezrich and Junbo Feng describe an approach in Chapter 15, which they refer to as the “Alpha Repair” strategy, which deals with this issue. The objective of the proposed approach is to provide a systematic framework that removes failed strategies from the factor model until they prove worthy, while providing an opportunity for new strategies to be introduced into the factor model. They cast the problem as one of asset allocation for factors, with the important twist that a large set of factors always compete for a place in a small set of factors that are used for stock selection. The history of a factor return, volatility, and correlation with other factor returns in a given month is the criterion used to determine whether a factor remains in the model.

Although a good number of studies have analyzed the relative importance of stock-specific risk, sector risk, and country risk for global portfolios and find that country risk is a key driver of individual stock returns, there has been less focus on the impact of country membership on actively managed stock portfolios. For example, there is a question as to whether ignoring country membership in constructing global portfolios can hamper accurate risk allocation. This issue is addressed by Michele Aghassi, Cliff Asness, Oktay Kurbanov, and Lars Nielsen in Chapter 16, where they demonstrate that ignoring country membership in stock portfolio construction can yield sizeable country bets, which may in fact be dominated by unintended tilts. They show that these issues are especially pronounced in the context of emerging market countries. They then explain how a stock selection manager can (within a quantitative or qualitative process) adjust for country membership in order to achieve accurate risk allocation and thereby reduce the likelihood of “noise pollution” of alpha signals.
The transaction costs associated with trading adversely impact portfolio return. Therefore, efficient equity portfolio management requires a systematic integration of trading costs management, trading execution, and portfolio management. Petter Kolm and Frank Fabozzi address equity transaction costs in Chapter 17, first defining the different types of costs—explicit costs (which include brokerage and taxes) and implicit costs (which include market impact costs, price movement risk, and opportunity cost)—and then introducing several approaches for the modeling of transaction costs, in particular market impact costs. Typical forecasting models for market impact costs are based on a statistical factor approach.

Quantitative formulations of portfolio allocation problems used in equity portfolio management are presented in Chapters 18 and 19. As noted earlier, a quantitative equity portfolio selection often involves extending the classical mean-variance framework formulated by Harry Markowitz or modifying the framework to incorporate more advanced tail-risk portfolio allocation frameworks so as to include different constraints that take specific investment guidelines and institutional features into account. In Chapter 18, Dessislava Pachamanova and Frank Fabozzi discuss extensions—such as index tracking formulations, the incorporation of transaction costs, optimization of trades across multiple client accounts, and tax-aware strategies—and review methods for incorporating robustness into quantitative portfolio allocation procedures by applying robust statistics, simulation, and robust optimization techniques. In Chapter 19, Jennifer Bender, Jyh-Huei Lee, and Dan Stefek adapt mean-variance analysis so as to construct active equity portfolios with less exposure to extreme losses compared to normal optimized portfolio. They do so by introducing a measure of the sensitivity of a portfolio to periods of extreme stress that they refer to as shortfall beta and then constrain this measure in the optimization process. Their empirical evidence demonstrates the potential benefits of constraining shortfall beta.

The idiosyncrasies, opportunities, and pitfalls in equity portfolio management arising from the use of high-frequency data (i.e., bid and ask quotes, sizes and latest trade characteristics that are recorded sequentially at irregular time intervals) are covered in Chapter 20 by Irene Alridge. She explains how and when the traditional methods of data analyses employed when low-frequency data (such as daily data) are used by equity managers must to be modified to deal with the unique nature of high-frequency data.

Statistical arbitrage strategies seek to identify mispriced stocks using quantitative models of historical prices and then exploit the mispricings that have been identified. Investors employing such strategies are subject to a myriad of risks. The major risk is model risk, which is the risk that the quantitative model of the price process of stocks employed in the strategy to identify mispricing may not be valid. In Chapter 21, Brian Jacobsen explains
two simple models of statistical arbitrage—pairs trading and correlation trading—and then presents a more general method based on modeling the long-run relationships and short-run dynamics of the pricing processes.

Frank J. Fabozzi
Harry M. Markowitz
May 2011
Frank J. Fabozzi is Professor of Finance at EDHEC Business School and a member of the EDHEC-Risk Institute. Prior to joining EDHEC in August 2011, he held various professorial positions in finance at Yale University’s School of Management from 1994 to 2011 and from 1986 to 1992 was a visiting professor of finance and accounting at MIT’s Sloan School of Management. Professor Fabozzi is the editor of the Journal of Portfolio Management, as well as an associate editor of the Journal of Fixed Income and on the editorial boards of the Journal of Asset Management, Journal of Structured Finance, Quantitative Finance, and Review of Futures Markets. He earned a doctorate in economics from the City University of New York in 1972. He is a trustee for the BlackRock family of closed-end funds. In 2002, he was inducted into the Fixed Income Analysts Society’s Hall of Fame and is the 2007 recipient of the C. Stewart Sheppard Award given by the CFA Institute. He earned the designation of Chartered Financial Analyst and Certified Public Accountant. He has authored and edited numerous books in finance.

Harry M. Markowitz has applied computer and mathematical techniques to various practical decision making areas. In finance, in an article in 1952 and a book in 1959, he presented what is now referred to as MPT, “modern portfolio theory.” This has become a standard topic in college courses and texts on investments and is widely used by institutional investors for tactical asset allocation, risk control, and attribution analysis. In other areas, Dr. Markowitz developed “sparse matrix” techniques for solving very large mathematical optimization problems. These techniques are now standard in production software for optimization programs. He also designed and supervised the development of the SIMSCRIPT programming language. SIMSCRIPT has been widely used for programming computer simulations of systems like factories, transportation systems, and communication networks. In 1989, Dr. Markowitz received the John von Neumann Award from the Operations Research Society of America for his work in portfolio theory, sparse matrix techniques, and SIMSCRIPT. In 1990, he shared the Nobel Prize in Economics for his work on portfolio theory.
Contributing Authors

Michele Aghassi  AQR Capital Management  
Irene Aldridge  ABLE Alpha Trading  
Cliff Asness  AQR Capital Management  
António Baldaque da Silva  Barclays Capital  
Jennifer Bender  MSCI  
Paul Bukowski  Hartford Investment Management  
Joseph A. Cerniglia  Courant Institute of Mathematical Sciences, New York University  
Frank J. Fabozzi  EDHEC School of Business  
Dorsey D. Farr  French Wolf & Farr  
Junbo Feng  Nomura Securities International, Inc.  
Sergio M. Focardi  EDHEC Business School and The Intertek Group  
Chris Gowlland  Delaware Investments  
James L. Grant  University of Massachusetts–Boston  
Bruce I. Jacobs  Jacobs Levy Equity Management  
Brian J. Jacobsen  Wells Fargo Funds Management and Wisconsin Lutheran College  
Caroline L. Jonas  The Intertek Group  
Frank J. Jones  San Jose State University  
Stanley Kogelman  Delft Strategic Advisors, LLC  
Petter N. Kolm  Courant Institute of Mathematical Sciences, New York University  
Oktay Kurbanov  AQR Capital Management  
Glen A. Larsen Jr.  Indiana University, Kelley School of Business–Indianapolis  
Anthony Lazanas  Barclays Capital  
Jyh-Huei Lee  MSCI  
Martin L. Leibowitz  Morgan Stanley & Co.
Kenneth N. Levy  Jacobs Levy Equity Management
K. C. Ma  KCM Asset Management, Inc. and Stetson University
Lars N. Nielsen  AQR Capital Management
Anders Ersbak Bang Nielsen  Goldman Sachs International
Peter C. Oppenheimer  Goldman Sachs International
Dessislava A. Pachamanova  Babson College
Arne D. Staal  Barclays Capital
Dan Stefek  MSCI
Cenk Ural  Barclays Capital
Raman Vardharaj  OppenheimerFunds
The goal of this chapter is to provide the reader a basic understanding of quantitative equity investing and to explain the quantitative investing process. We focus on the following three questions:

1. How do quantitative and fundamental equity investors differ?
2. What are the core steps in a quantitative equity investment process?
3. What are the basic building blocks used by quantitative equity investors?

In answering these questions, this chapter explores the quantitative equity investment process. We see how it is similar to many other approaches, all searching for the best stocks. Where it differs is in the creation of a repeatable process that uses several key criteria to find the most attractive companies—its stock selection model. Additionally, some of the most common techniques used by quantitative equity investors are covered.

It is important to understand that this chapter is dedicated to a traditional quantitative equity investing approach. There are many other types of investing that are quantitative in nature such as high-frequency trading, statistical arbitrage, and the like, however, these are not covered.

EQUITY INVESTING

Investing can take many forms, but it starts with an investor assigning a value to a security. Whether this value exceeds or is less than the current market price usually determines whether the investor will buy or sell the
security. In the case of equities, the investor often seeks to understand the specific company under consideration, the broader economic environment, and the interplay between the two. This encompasses a wide range of information for the investor to consider as displayed in Exhibit 1.1. How this information is used differentiates the quantitative from the fundamental investor.

**FUNDAMENTAL VS. QUANTITATIVE INVESTOR**

Let’s start with a basic question. How do portfolio managers select stocks from a broad universe of more than a thousand companies?

Fundamental managers start with a basic company screen. For instance, they may first look for companies that satisfy conditions such as a price-to-earnings (P/E) ratio that is less than 15, earnings growth greater than 10%, and profit margins in excess of 20%. Filtering by those characteristics may result in, say, 200 potential candidates. Next, portfolio managers in consultation with their group of stock analysts spend the majority of their time thoroughly reviewing each of the potential candidates to arrive at the best 50 to 100 stocks for their portfolio. A quantitative manager, in contrast, spends the bulk of their time determining the characteristics for the initial stock screen, their stock selection model. They will look for five or more unique characteristics that are good at identifying the most attractive 200...