

PRINCIPLES *of* QUANTITATIVE EQUITY INVESTING

A COMPLETE GUIDE TO CREATING,
EVALUATING, AND IMPLEMENTING
TRADING STRATEGIES



SUGATA RAY

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**A Complete Guide to Creating,
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Trading Strategies**

Sugata Ray, PhD

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To my family.

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ACCESS COLOR FIGURES

If you would like to study the figures in this book more closely, color versions are available from the book's Web site, www.ftpress.com/title/9780134192796. Click the Downloads tab to access them.

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About the Author

Sugata Ray teaches and conducts research at the University of Florida. Ray's research has been published in a number of peer-reviewed journals, including the *Journal of Investment Management* and the *Journal of Financial Markets*. Ray's work has been presented to regulators, including those at the SEC and the Fed; academics at conferences such as the American Finance Association and European Finance Association; and industry participants. Ray's research has been covered in CNN, *The Economist*, the *Financial Times*, NPR, and *The Wall Street Journal*, among numerous other trade and popular press outlets. In addition to his academic pursuits, Ray also develops and manages quantitative investment strategies for Fundamental Global Investors, an investment company, and Capital Wealth Advisors, a wealth management company. Previously, Ray worked in various capacities in a number of financial services firms and asset managers, including Legg Mason, Oliver Wyman, and Lehman Brothers. He received his Doctorate, Master's, and Bachelor's degrees from the Wharton School at the University of Pennsylvania. You can read more about the author at his website: www.sugata.in.

Preface

What This Book Is About (and Not About) and Who It Is For (and Not For)

This book is about investing in U.S. equities using quantitative strategies. It is not about investing in most other things. For example, it is not about investing in bonds, mutual funds, CDs, or real estate. It is not about investing in other countries.¹

This book is not about *trading* U.S. equities. Although trading is a part of investing in U.S. equities, it is a small part. Strategies discussed in this book are largely of the buy-and-hold nature, with occasional trades in the portfolio. If you are looking for a book on trading in and out of stocks multiple times within a day (also called *day trading*), this book is not for you.

This book is for (1) investors with money to invest who are learning how to invest using quantitative techniques, (2) professional financial advisors who manage money for clients and are looking to introduce quantitative techniques in their management processes, and (3) students who are interested in learning quantitative investing.

This book is not for speculators or “investors” who buy stocks based on recent headlines. Most quantitative strategies pick no-name stocks and hold them for long periods of time (quarters or years). It’s not as exciting as owning Facebook or Apple over an earnings announcement, but historically, this strategy has performed just fine.

Additionally, this book is tailored to the level of a lay audience. If you are interested in a book with advanced mathematical concepts applied to finance, this is probably not the book for you. Similarly, if you are a hard core coder, looking to apply your coding skills to the financial markets, this is probably not the book for you.

The tool used most often in this book is a piece of software called Equities Lab. All legal, new purchases of this book include a 20-week trial subscription to Equities Lab (see the “Getting an Equities Lab Account and Logging In” section in Chapter 2, “What You Need to Start Investing Using Quantitative Techniques,” for details on how to download and install Equities Lab). The second most common tool used in this book is Microsoft Excel. Any spreadsheet software (including free ones, such as Google Docs) should work fine.

Throughout the book, screenshots and techniques are shown using Equities Lab and Excel. These are simple, easy-to-use software packages that can deliver commercial-level analysis. The hope is that you will be able to follow along by repeating the analysis shown in the book (and experimenting with screens of your own). Finally, if you are interested in moving on beyond Equities Lab (or if your trial subscription has ended), check out Chapter 15, “Alternative Tools for Quantitative Investing,” which covers alternate tools you can use.

Concrete Scenarios of Readers Who Would Find This Book Useful

If you are convinced this is the right book for you and are ready to read on, I suggest you skip ahead to Chapter 1, “Overview of Quantitative Investing.” If you are still debating whether this is the right book, I will outline a few concrete scenarios where this book may be helpful to make your decision easier. As a reader of this book, you likely fall into one of several categories, as follows:

- Investors with money to invest who are learning how to invest using quantitative techniques
- Professional financial advisors who manage money for clients and are looking to introduce quantitative techniques in their management processes
- Students who are interested in learning quantitative investing

The following sections cover a few more explicit scenarios and how this book could potentially work for each of these types of investors.

Individual Investors Who Are Relatively New to Investing

Perhaps you are a busy professional with no brokerage account. You have never bought stocks or participated in the financial markets outside of your 401k, where you’ve invested in the default option.

Before investing the time and effort into learning quantitative investing strategies, you should convince yourself that they are worth learning. The easiest way to do this is to run a small cap value screen, or any other screen that is known to work (see Chapter 10, “Some Powerful Screens”), and write down the results. Make a list of the stocks the screen picks that the model suggests should outperform the market. While you track the progress of the picks to see if they do truly outperform, learn about investing in general (and read this book). If the stocks you picked using the screen did beat the market

handily over a month or so (as they are statistically likely to do), you might be hooked and ready to take the plunge into quantitative investing in earnest.² When ready, deposit a small amount of money into a brokerage account (you really must be able to lose this money, or it will add too much stress to your life), and consider yourself a busy professional with a brokerage account (that is, the investor described later).

Individual Investors Who Have Invested in Equities Before But Are Not Professionals or Semiprofessionals at Investing

This category covers a large number of readers. You are likely to have had a bit of experience investing in equities directly and have an online brokerage already set up. The key here is experimenting with quantitative techniques, learning with small amounts of money, and growing that amount as your confidence increases.

You could start by paper trading: not trading for real money but keeping track of what “buys” and “sells” are suggested by your chosen quantitative trading model and simulating a profit and loss statement using those trades. However, you should be sure to switch over to a real money account at some point. You don’t need to have 50 positions in quantitative strategies right off the bat; a small handful is fine as a start. You can’t learn how to manage risk until you take some. By the same token, stick to money you can easily afford to lose. You are extremely unlikely to lose it all, but keeping the amount small prevents the roller-coaster ride of emotions that can make it hard to think. If you’re stressed about it while at work, you need to worry less or reduce the amount you have invested.

You’ll want to pick a couple of screens that have performed well historically and suit your investment style. Pick a few stocks from the screen output to invest in, and now you’re a quantitative investor. Your first few tries might be somewhat rocky. This book will hopefully help you avoid some of the more obvious mistakes, but many less obvious ones remain. But as they say, practice makes perfect—and there is no substitute for learning by doing.

Involuntary Investors Who Receive a Cash Windfall

You’ve just inherited money, earned a massive bonus at work, or otherwise come into a lot of money. You’ve never invested before and have no idea what you’re doing. The first thing you should do is probably consult a broader resource on investing in general. The next thing you should do is invest in index funds (S&P 500 or some other index) with your money. This will prevent you from missing out on market returns while you figure out what to do.³ You will gradually sell these index funds as you develop strategies,

but tracking the market will put you ahead of 80% of the people out there. This type of investment is tax efficient, easy, and good enough to start with.

Having done this, start with one of the other scenarios (perhaps “Individual Investors Who Are Relatively New to Investing”), and begin investing. Investing well will make your nest egg last a lot longer than investing poorly, and developing good investing habits right off the bat will go a long way toward your prosperity. One thing to keep in mind is that you’ll be a bit more risk averse than others, at least to start with, because unlike investors investing money saved up from a salary, you most likely can’t reproduce the circumstances that caused the windfall.

That’s OK. As you learn more, you’ll become comfortable taking on more risk. Because you didn’t have the money before the windfall event, you obviously aren’t dependent on it. This should help reduce your stress. Also, depending on the sum of the windfall, consider hiring a CPA and other advisors to help you with your affairs and taxes, at least for a year or two. There are a number of ways to optimize taxes and financial setups for windfalls, and doing things right from the start could save a lot of money and headache later on.

Investors and Investment Advisors Who Invest Mainly in Mutual Funds and ETFs

There are likely to be both investors and financial advisors who invest large chunks of their portfolios in funds. This has been the commonly dispensed advice by financial gurus: Invest in cheap passive index funds or exchange traded funds (ETFs). These investors are familiar with the mechanics of buying financial instruments through a brokerage, but have possibly never thought about individual stocks.

This book actually fits very well with this advice. The only difference is that rather than being constrained to the ETF/index funds out there, quantitative tools allow these investors to create a custom basket of securities that basically acts like a fund. Furthermore, many ETFs/index funds have holdings that don’t accurately match up to their names. So while you might think that XYZ Bank’s Value ETF actually holds value stocks, you might open the prospectus and examine the holdings and find value has been loosely defined to include speculative biotech companies!

Investors and Investment Advisors Who Invest in Individual Stock Picks

There are also investors and advisors among you who have invested in individual securities. Whether this is after doing a thorough valuation of a stock or after reading a couple of news articles, you are familiar with how to buy individual stocks. The main difference is that quantitative strategies will have you buying stocks based on different metrics than before. Instead of basing purchases off deep fundamental valuations, or meticulous reading of the news, quantitative strategies will use numbers reported by the company (and all other companies) to determine which stocks are most suitable for your portfolio.

To fit quantitative investing into your existing investment style, you'll want to use it as a source of ideas at first. Find a screen that gives you companies that you understand, and that performs well, and use it to find a new stock you like. Do your normal research on it, and invest in that stock as you normally would. Repeat the process several times in the coming weeks, and see how those stocks perform relative to your regular ones. If they outperform, consider automating more of your process. That is, cutting out the step of deep research into each of the names produced by the screen, and simply investing equally in all names produced by the screen. You can then spend the time saved refining the screen to make it perform better or creating other screens that capture other attributes you look for.

Investors and Investment Advisors Who Already Have a Quantitative Strategy in Place

If you already have a quantitative strategy in place, you've already implemented a system. You can make another one easily. Or improve the current one. Or test any assumptions you've made empirically; for example, are low price to earning (PE) ratio companies really good investments? If you test every testable assumption of your system, you may be shocked at what does (and doesn't) matter. You may find your strategy is really driven by one or two key criteria in your screens and the rest are not that useful.

Finally, a Note for Investors Who Have a Legacy Account

Maybe you have just inherited your grand aunt's stock portfolio. Maybe you've just bought an investment advisory business from a friend. Whatever the reason, you don't know what half of the things in your portfolio are.

Before embarking on any asset reallocation plans, the first question for you is how long ago were these positions bought, and what is their cost basis? If the cost basis is small, think really hard before selling. Make sure you have a better investment lined up. You'll pay significant taxes on gains if you sell, and that taxed money could have stayed in your account, compounding returns, if you held on to the position longer. If you believe you have positions that are going to underperform the market long term, you should go ahead and take your medicine, as directed by any tax advisor you might be using. Otherwise, just trim away at them by replacing them with better investments, until you have only the ones you like. One other consideration: If you have a concentrated position (for example, in tech), you'll need to adjust your strategies to not buy any more of that sector or industry. That way, you can use new money deployed to contribute toward diversification.

As with any cash windfall, strongly consider hiring a CPA for a couple of years after getting the brokerage account, as reconciling the cost basis of your positions is best done by a professional.

Student Scenarios

Finally, for students looking to learn about quantitative investing, a few words of wisdom from someone who was once in your shoes.

The Finance Student

You're a student, either in a finance course or business major, and want to see what quantitative investing is all about. Perhaps your professor has recommended or required this book for a class. You've got a bit of time and (probably) very little money to invest. This is no problem. However, you've actually got two problems to solve. One is learning how to invest, and the other one is determining if you like investing. If you end up deciding you like investing and you learn how to invest well (using quantitative techniques or otherwise), you potentially have a pretty lucrative career ahead of you.

Even if you don't end up choosing investing professionally as a career, you will always be tasked with investing your own money. As a student, your time horizon is at least 50 years (probably much longer), and your lack of money is not an issue at all. You can easily afford to lose what discretionary money you have (not including money used for tuition or rent) because you have high future labor income to replenish your savings. This gives you more risk tolerance than you will ever have in the future. You'll want to explore various strategies, and find screens that outperform. Try creating some basic

screens. If you have a bit of disposable capital, implement screens that suit your temperament. The time you spend experimenting with the market will be well rewarded, as you'll find out what sorts of screens and systems you like, and whether you like investing at all. In addition, your lack of money is likely very temporary, so learning to invest now is a good idea. Very soon, you'll be joining the ranks of one of the investor categories described earlier. Trained in quantitative techniques, you'll be able to earn hefty returns on your newly earned capital.

The Technical Student

You are an engineering or computer science student interested in quantitative investing because you have heard tales of fabulous riches from financial investing. Maybe you're taking a course in the business school that covers quantitative investing. This book won't help you with your engineering coursework, but virtually everything else holds true from the previous "The Finance Student" section.

You might feel uncomfortable because you don't have a finance degree, but it might not occur to you that your other skills could be incredibly useful. For instance, people who can program or work in technical fields can often handle more complexity than those who do not. They may very likely find it easier to create screens that exactly describe what they are looking for.

Bon Voyage

As you dive into the rest of the book, and hopefully into the exciting and profitable world of quantitative investing, I wish you all the best and look forward to hearing about your exploits. Please feel free to send me war stories and comments about the book. You can e-mail me at sugata.ray@gmail.com. If you want to join an online community of quantitative investors and exchange information about quantitative investing techniques, Equities Lab maintains a forum at their Web site www.equitieslab.com.

Endnotes

1. That being said, a lot of the lessons from quantitative U.S. equity investing are applicable in these other contexts. If you have data for these other markets and can readily trade in them, you should feel free to start a quantitative investing agenda in your preferred market.

2. If the stocks picked by the screen did not outperform the market, then you may well lose interest, but it's probably worth trying again. Quantitative investing *does* work. Generally, over a month, it will probably work, but like any investing, aberrations occur, leading to underperformance in some fraction of months.
3. The overall market generally outperforms cash (or other risk-free, liquid investments) handily by about 6% a year. It is true that in a given day, week, month, or even year, the market may do worse, but over the long run, you are generally better off with your investable money in the stock market rather than in cash.

Overview of Quantitative Investing

Quantitative investing is generally defined as the use of a rigorous set of rules based on easily observable criteria to guide investment decisions. It encompasses a wide variety of strategies, from longer-term equity strategies where equities are bought and held for periods up to or longer than a year, to very short-term strategies trading in and out of securities multiple times during the course of a day. Of course, these shorter-term strategies do not really “invest” in the securities. Regardless of the exact type of strategy employed, there are several common steps in all types of quantitative investing: (1) screens, (2) backtests, and (3) implementation. This general process is graphically represented in Figure 1.1.

Screens

A screen is a formula for deciding what to buy and sell at any given time. A simple screen might be: Buy all stocks that have positive returns over the last year.¹ This is an example of a stock screen, which divides the universe of stocks into those the system will pick to buy and those it will not. A more complicated stock screen could have multiple criteria, such as “buy all stocks that have positive returns over the last year AND price to earnings (PE) ratios between 5 and 15.”

As opposed to stock screens, you can also implement timing screens. *Timing screens* are screens that use some measure of the overall economy to decide whether it is a good time to buy or sell. An example of a timing screen could be “Move all assets to SPY if unemployment has fallen two months in a row. Otherwise, keep all assets in cash.” SPY is the ticker for a security that mirrors the S&P 500 index. Thus, the screen basically keeps money in the broad equity markets if the economy is stable and in cash if unemployment is rising.

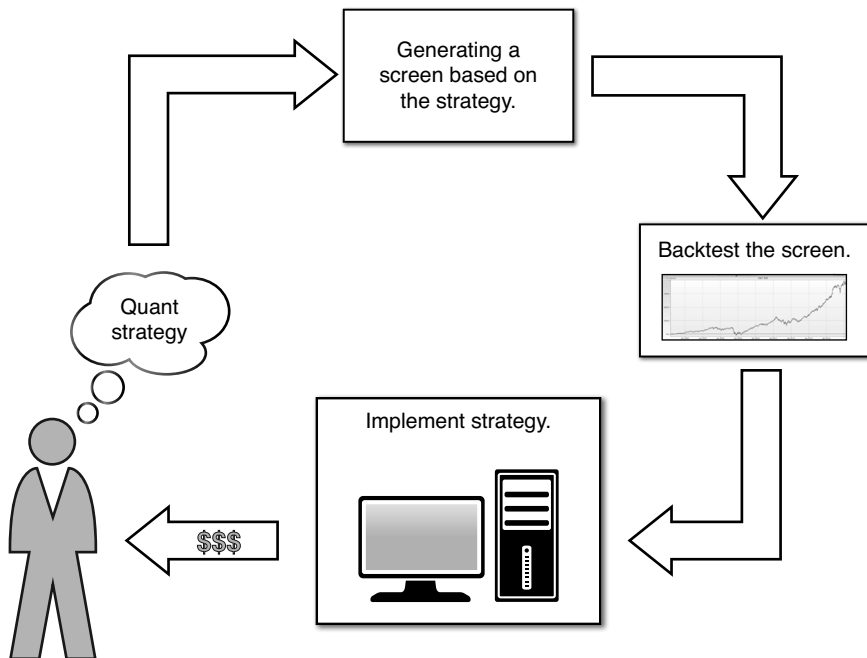


Figure 1.1 Life cycle of a quant investment

The difference between timing screens and stock screens can be subtle, and a number of screens will have flavors of both types. “Buy all stocks if unemployment has fallen two months in a row, and buy only stocks with PE ratios between 5 and 15 if not” is a screen that combines timing and stock screen elements. This book generally keeps them separate, but it is important to remember that they could be used together, if desired.

A screen generally returns a list of stocks and then a decision must be made. For example, the screen “Buy all tech stocks with PE ratios less than 10 that are profitable and pay a dividend” might return a list of about 15 stocks. The next step is to decide what to do with these lists. Generally, the easiest (and most popular) strategy among quantitative investors is to invest capital equally in all stocks that pass through a screen. So if 15 stocks pass through the screen, you divide the money you are investing equally into the 15 stocks and that will be your portfolio. There are other ways to weight the list: For example, you can weight by market capitalization or by dividends. Alternatively, you could do deeper fundamental analysis on the company names generated by the screen and pick individual securities to invest in, rather than simply dividing your capital equally among the companies that pass through the screens.

You should feel free to use screens to support deeper analysis of individual companies. Chapter 4, “For the Deeper Divers among Us: How to Use Quantitative Strategies to Enhance Fundamental Valuations,” explores two case studies that do just that. However, this book does not cover techniques to do deep analysis into individual companies.²

Horizons (or Rebalancing Frequency)

A key part of any quantitative investing screen is the horizon of the strategy. If the screen provides information that determines what the trade will be, the horizon provides the duration over which the information in the screen is valid. After the horizon is reached, the old positions are closed out, and if desired, the screen can be run again and new positions chosen. This process of closing out old positions and choosing new ones is known as *rebalancing*. The horizon of your strategy is, thus, also known as the *rebalancing period*. Rebalancing is a very important part of quantitative investing and Chapter 8, “Rebalancing—Why, How, and How Often,” is dedicated to this concept.

Many times, the measures used in the screen dictate the horizon. So, for example, in the screen discussed earlier that was based on unemployment, the strategy must have a horizon of at least one month because unemployment numbers are released monthly. Put a different way, horizons cannot be shorter than the frequency at which information is released (if they were, the stocks in the screen would remain the same until new information came out). The screens based on PE ratios can have a much shorter horizon because the price of a stock is constantly changing and, thus, PE ratios are constantly changing.

If the trading horizon is longer than the information frequency, you risk that the information previously used to generate the portfolio has gone stale in between rebalances. For example, you sort on PE ratios today and buy all stocks with PE between 0 and 10. Tomorrow, one of the stocks you bought spikes, its PE is more than 10 and no longer passes through your screen. If your horizon is longer than a day, you will hold this stock despite the fact that the stock no longer passes through your screen. Thus, the shorter the horizon, the less likely stocks that are in your portfolio that do not pass through your screen, and the less likely that your portfolio excludes stocks that have evolved to pass through your screen.

The other main factor driving strategy horizon is transaction costs. The shorter the horizon of your strategy, the more times you will have to trade out of old positions and into new ones. Trading generally incurs transactions costs, both in terms of commissions, price impact when trading, and time and headache spent executing your trades.

This is the main tension in choosing the ideal strategy horizon. Too long and you're holding stocks based on old information; too short and your returns are being eroded

by transaction costs. In the financial industry, trading horizons can range from the extremely long (a year or even longer) to the very, very short (microseconds or even nanoseconds). High-frequency trading is the form of quantitative “investing” that deals with these very short holding periods. However, high-frequency trading really is not “investing” because positions are rarely held overnight and rarely is the intention of such trades to actually invest in companies. This book, for most strategies, runs a quarterly rebalance. Equities Lab (the tool that most of the analysis in this book uses) has a default rebalancing period of a week, although that can be easily changed.

Backtesting

Once you’ve decided how you want your strategy to look in terms of screens and horizons, you have to backtest it. To *backtest* a strategy is to see how it would have performed had it been implemented historically in the past.

For example, if your strategy were to buy stocks with PE ratios between 0 and 10, rebalancing every week, you would need to go back to each week historically, see what stocks would pass the screen, and hold them equally in your portfolio. At the end of the week, you would sell all the stocks and reinvest the proceeds into the new stocks that would pass your screen for the next week. Along the way, you would keep track of the cumulative returns to the strategy. The results of your backtest would look like Figure 1.2.



Figure 1.2 Backtest of 0 to 10 PE strategies

These are results from Equities Lab. The darker (lower) line is the return of the S&P 500; the lighter (upper) line is the return of your strategy. We discuss how to use Equities Lab to generate these types of backtests in Chapter 2, “What You Need to Start Investing Using Quantitative Techniques.” Before that, I want to point out a few things about the backtest results. In this particular case, I chose a ten-year time period over which

to backtest. At the beginning of each week, Equities Lab chooses all stocks with a PE of more than 0 and less than 10 and creates a portfolio, holding an equal amount of each stock. It holds this portfolio until the end of the week and then sells all holdings, reinvesting the proceeds equally into the stocks chosen by the screen for the following week.³

In this backtest, you are looking at the returns to a trading strategy following the screen compared with the returns to the S&P 500 index. Over the ten years, \$100 invested in this simple quantitative trading strategy would have returned about \$275 in profits.⁴ The same \$100 invested in the S&P 500 would have returned about \$110 in profits.

And just like that, you have your first quantitative equity investing strategy. You will invest in stocks that have between 0 and 10 PE ratios, rebalancing your portfolio each week. Doing this historically would have outperformed the market by a healthy amount over the last decade and if this pattern continues over the next ten years, you'd be rich! Richer, anyway.

Implementation

Implementation is the most important part of the whole process, but once you have a strategy, it is generally easy to do. For example, if you chose a strategy such that you are investing in stocks with PE ratios between 0 and 10, all you'd have to do is open a brokerage account and divide your money equally between the stocks returned by the screen.

In theory, it sounds easy, but in practice, myriad complexities would arise, most of which are specific to a given individual. For example, the screen might return 500 stocks, but you only have \$5,000 to invest, making it cost-inefficient to divide your capital evenly between the screened names.⁵ Some of the more common concerns (such as quantitative investing with limited capital) are addressed in Chapter 14, "How Do You Actually Make Money Now? A Brief Guide to Implementation."

So we've outlined the general steps for devising a quantitative investment strategy: screen, backtest, and implement. However, numerous specific questions remain. These could include the following:

1. How do I get started developing my own strategies?
2. Why did you choose stocks with PE between 0 and 10?
3. What if I look at other backtesting horizons (for example, five years instead of ten years)?
4. Why is the rebalancing period a week?

5. Why am I comparing my strategy against the S&P 500?
6. Can't I find a strategy that does better than this in backtesting?

These, and other, questions are what the rest of this book is about. Chapter 2 discusses the tools needed to help you start creating and backtesting your own quantitative strategies (Question 1) before the rest of the book fills in the answers to the other questions.

Endnotes

1. This is known in industry and academic circles as a *momentum* screen. The screen buys winners in the hope they continue to be winners (or the *momentum* continues). Narasimhan Jegadeesh and Sheridan Titman documented it in their 1993 article, “Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency” (Jegadeesh & Titman, 1993).
2. An excellent reference for this is *Security Analysis* (Graham & Dodd, 1934). There are many revised versions of this text and other similar texts available. However, even Graham himself admitted such deep fundamental analysis is unlikely to yield the same payoffs in the modern markets that it did at the time the book was written (Graham, 1976).
3. Equally weighting stocks that pass through the screen is a very common practice and is the only weighting scheme currently supported in Equities Lab backtests. However, there are other ways to weight stocks in the portfolio. Weighting is discussed in Chapter 9, “Weights—Equal or Otherwise.”
4. Of course, this is assuming zero transaction costs. In practice, weekly rebalancing would lead to many trades and high transactions costs, which, in turn, would eat into returns.
5. Often, tickers or companies are also referred to as *names*. If you use this terminology, not only will you have another synonym for ticker/company, but you'll also sound like you are in tune with the asset management industry.

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