CHAPTER 1

An Introduction to Quantitative Equity Investing

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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?

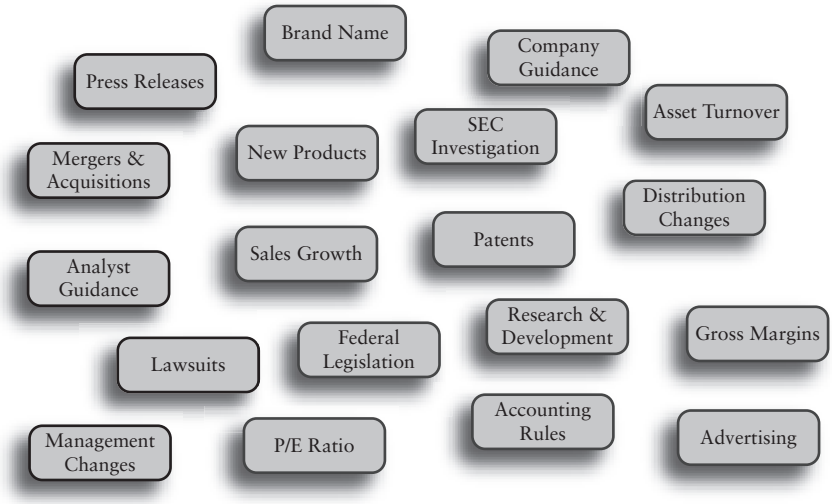
In answering these questions, this chapter explores the quantitative equity investment process. We see how it is similar to many other approaches, all searching for the best stocks. Where it differs is in the creation of a repeatable process that uses several key criteria to find the most attractive 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

EXHIBIT 1.1 The Value of a Stock Comes from Multiple Information Sources



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

stocks of the universe. A quantitative manager will then purchase all 200 stocks for their portfolio.

So let's expand on how these two investors—fundamental and quantitative—differ? Exhibit 1.2 details the main attributes of the following two approaches:

1. *Focus: Company vs. characteristic.* The fundamental investor's primary analysis is on a single company at a time, while the quantitative investor's primary analysis is on a single characteristic at a time. For example, a fundamental investor may analyze a health care company to assess if a company's sales prospects look strong and whether this stronger sales growth is reflected in the company's current stock price. A quantitative investor may also invest in a company based on its sales growth, but will start by assessing the sales growth characteristic. The quantitative investor will determine whether stocks within the group, health care companies, with higher sales growth also have higher stock returns. If they do, then the quantitative investor will buy health care stocks with higher sales growth. In the end, both types of investors may buy a stock due to its good sales prospects, but both come at the decision from a different point of view.

2. *Narrow vs. broad.* Fundamental investors focus their attention narrowly on a small group of stocks. They cover fewer companies since

EXHIBIT 1.2 Fundamentals vs. Quantitative Investor: Viewing Information

Fundamental (Journalist)	Quantitative (Scientist)
Primary focus: company	Primary focus: characteristics
In-depth company analysis	Drivers of performance across companies Law of Large numbers
Targeted stock bets	Spread stock bets across companies
Qualitative assessment—story Forecast future earnings Predict company catalysts	Analyze company relative to broad peer group Disciplined—specific stock picking criteria (repeatable) Understanding what worked in the past
Know company specific risks	Know portfolio level risks
Narrow – Future - Story	Broad – Past - Disciplined

they make more in-depth reviews of each company. Fundamental investors immerse themselves in the company studying everything from financial information, to new products, to meeting management. Ideally, they are searching for exploitable differences between their detailed assessment of the company's value and the market's perception of that value. In contrast, quantitative investors focus more broadly. Rather than reviewing one company at a time, they look across a large group of companies. Quantitative investors' focus on what separates companies from one another; they search for pieces of information (characteristics) that they can use to exploit differences between securities. Since they are dealing with a great deal of data from a large number of companies, they employ quantitative techniques to quickly sift through the information.

3. *Position concentration/size of bets*. Another difference in the two approaches is the size of the positions within a portfolio; they tend to be larger for a fundamental investor and smaller for a quantitative investor. A fundamental investor performs in-depth company analysis so they will have greater conviction in taking larger positions in their selected stocks. A quantitative investor performs in-depth analysis across a group of companies, so they will tend to spread their bets across this larger group of companies.

4. *Risk perspective*. The fundamental investor sees risk at the company level while the quantitative investor is more focused at the portfolio level. The fundamental investor will review the risk to both their forecasts and catalysts for the company. They understand how a changing macro picture can impact their valuation of the company. In contrast, the quantitative investor's broader view relates to understanding the risks across their portfolio. They understand if there are risk characteristics in their portfolio that are different from their chosen stock selection model. For example, a quantitative investor who does not believe growth prospects matter to a company's stock performance would want to investigate if their model had them buying many very high- or low-growth companies.

5. *Past vs. future*. Finally, the fundamental investor often places greater emphasis on the future prospects of the company while the quantitative investor studies the company's past. Fundamental investors tend to paint a picture of the company's future, they will craft a story around the company and its prospects, and they will look for catalysts generating future growth for a company. They rely on their ability to predict

changes in a company. In contrast, the quantitative investor places more emphasis on the past, using what is known or has been reported by a company. Quantitative investors rely on historical accounting data as well as historical strategy simulations, or backtests, to search for the best company characteristics to select stocks. For instance, they will look at whether technology companies with stronger profitability have performed better than those without, or whether retail companies with stronger inventory controls have performed better than those without. Quantitative investors are looking for stock picking criteria, which can be tested and incorporated into a stock selection model.

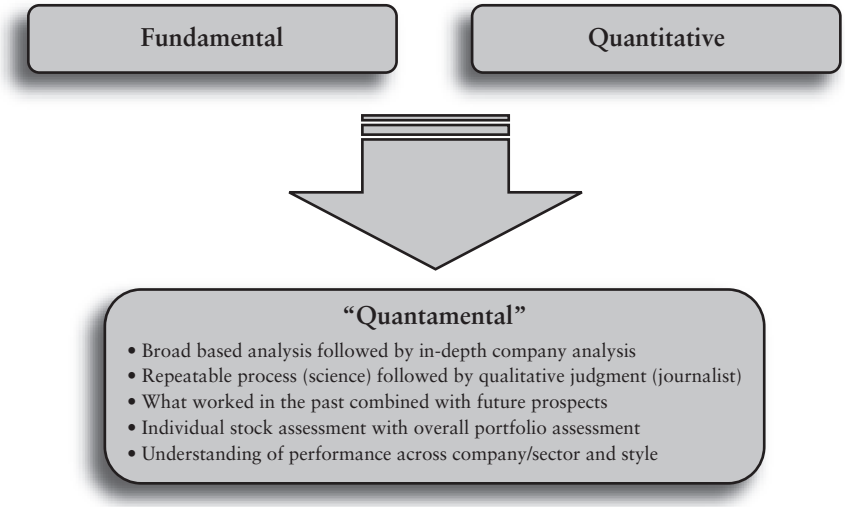
In the end, we have two types of investors viewing information, often the same information, quite differently. The fundamental investor is a journalist focused on crafting a unique story of a company's future prospects and predicting the potential for gain in the company's stock. The quantitative investor is a scientist, broadly focused, relying on historical information to differentiate across all companies, testing large amounts of data and using statistical techniques to create a stock selection model.

These two investors can and often do create different portfolios based on their different approaches as shown in Exhibit 1.3. The fundamental investor is more focused, with higher conviction in their stocks resulting in fewer, larger positions in their portfolios. The quantitative investor, reviewing a large group of companies, generally takes a large number of smaller positions in their portfolio. The fundamental investor is investing in a stock (or sector) and therefore is most concerned with how much each of their stocks (or sectors) is contributing to performance. The quantitative investor is investing in a characteristic and how well it differentiates stocks. They want to know how each of their characteristics is contributing to performance. Finally, the fundamental investor's detailed view into the company allows them to understand the intrinsic risk of each investment they make—what are potential stumbling blocks for each company. The quantitative investor's goal is to understand specific characteristics across a broad uni-

EXHIBIT 1.3 Fundamental vs. Quantitative Investor: Process Differences

Fundamental	Quantitative
Small portfolio	Large portfolio
Larger positions	Smaller positions
Performance at sector/company level	Performance at characteristic level
Emphasize stock specific risk	Diversify stock specific risk

EXHIBIT 1.4 Benefits of a Combined Fundamental and Quantitative Approach



verse of stocks. They look at risks across their entire portfolio, attempting to diversify away any firm-specific risks ancillary to their strategy.

Now that you understand the basic differences between the two approaches, it might also be clear how using both investment styles can be very appealing. As Exhibit 1.4 shows, the two styles are quite complementary in nature and can provide a robust, well-rounded view of a company or portfolio. Combining the two approaches provides the following benefits:

- *Breadth and depth*. In-depth analysis across a large group of stocks selecting the best subset of companies, which is followed by in-depth review of the small subset of attractive companies.
- *Facts balanced with human insight*. The scientific approach reviewing large amounts of data across many companies complemented by personal judgment at the company level.
- *Past and future perspective*. A detailed historical review of companies combined with a review of future potential prospects of a company.
- *Full risk analysis*. A broad look at risk both within each company owned and across the entire portfolio.
- *Clear portfolio performance*. A thorough understanding of which companies, sectors, and characteristics are driving a portfolio's performance.

In fact, over the years, the defining line between the two approaches has been blurring. Some have coined the term for this joint process as *quanta-*

mental. Many investment managers are combining both approaches in one investment process, which is why whether you are a fundamental or quantitative investor, it is important to understand both perspectives.

Given our preceding discussion, the distinction between the quantitative and fundamental approaches should now be better appreciated. In the remainder of this chapter we restrict our focus to the quantitative equity investment process addressing the last two topics listed at the beginning of this chapter: the core steps in a quantitative equity investment process and some of the basic building blocks used by quantitative investors.

THE QUANTITATIVE STOCK SELECTION MODEL

Before diving into the details of the quantitative investment process, let's look at what is at its core—the stock selection model. As explained in the previous section, the quantitative investment approach is rooted in understanding what separates strong performing stocks from weak performing stocks.[1] The quantitative investor looks for sources of information or company characteristics (often referred to as factors or signals)[2] that help to explain why one stock outperforms another stock. They assemble these characteristics into a stock selection model that can be run daily to provide an updated view on every stock in their investment universe.

The stock selection model is at the heart of the quantitative process. To build their model, the quantitative investor will look throughout history and see what characteristics drive performance differences between stocks in a group such as a universe (i.e., small cap, small-cap value, and large-cap growth) or a sector (i.e., technology, financials, materials).

The quantitative investor's typical stock selection methodology is buying stocks with the most attractive attributes and not investing in (or shorting if permitted by investment guidelines) stocks with the least attractive attributes. For instance, let's suppose retail stocks that have the highest profitability tend to have higher stock returns than those with the lowest profitability. In this case, if a retail stock had strong profitability, there is a greater chance a portfolio manager would purchase it. Profitability is just one characteristic of a company. The quantitative investor will look at a

[1]Throughout the chapter, we discuss whether characteristics can separate a stock with strong future returns from one with weak future returns. Many times reference will be made to a "strong" characteristic that can differentiate the strong- from weak-performing stocks.

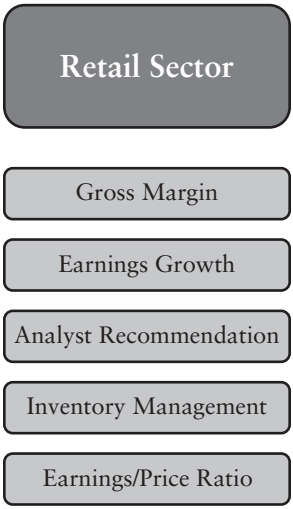
[2]In this chapter, "characteristic" means the attributes that differentiate companies. Quantitative investors often refer to these same characteristics as factors or signals, which they typically use in stock selection models and like models.

large number of characteristics, from 25 to over 100 to include in their stock selection model. In the end, they will narrow their final model to a few characteristics, which are best at locating performance differences among stocks in a particular universe or sector.

Exhibit 1.5 is an example of a stock selection model for the retail sector. If a stock has good margins, positive earnings growth, sell-side analyst like it, solid inventory management, and is attractively valued, especially as it pertains to earnings, then the quantitative investor would buy it. And if it did not have these characteristics, a quantitative investor would not own it, sell it, or short it. This example is for a retail sector; a quantitative investor could also have different models to select stocks in the bank sector or utilities sector or amongst small-cap value stocks.

So how does a quantitative investor create and use their stock selection model? A good analogy is a professional golfer. Like a quantitative investor, golfers create a model of their game. First, golfers analyze all elements of their basic swing from backswing to follow through. They then alter their swing to different conditions (high winds, rain, cold), and different courses types (links, woodlands, fast greens). Next golfers put their model into action. While they are golfing, they make mental notes about what is and isn't working to help enhance their game. Could they tweak their swing? What has been effective under the current weather conditions? How are they playing this type of course?

EXHIBIT 1.5 Sample Stock Selection Model for the Retail Sector



Overall, the golfers' process is much like a quantitative investors' process. They create a model, implement it, and then monitor it, assessing their ability to shoot below par. Like professional golfers who go to the driving range for countless hours to perfect their swing, quantitative investors will spend countless hours perfecting their model understanding how it works under many different market (weather/course) conditions.

With that analogy in mind, we now turn to the entire quantitative investment process.

THE OVERALL QUANTITATIVE INVESTMENT PROCESS

The quantitative process can be divided into the following three main phases (shown in Exhibit 1.6):

- Research
- Portfolio construction
- Monitoring

During the research phase, the stock selection model is created. During the portfolio construction phase, the quantitative investor "productionalizes" the stock selection model or gets it ready to invest in a live portfolio. Finally, during the monitoring phase, the quantitative investor makes sure the portfolio is performing as expected.

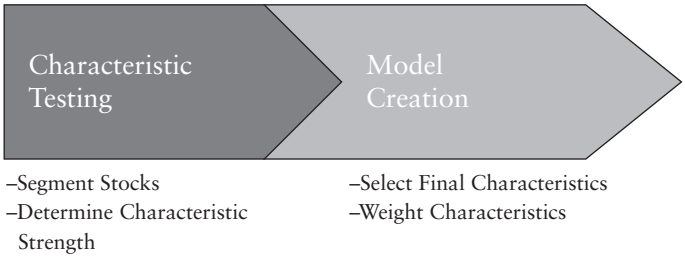
RESEARCH

Let's start with the research phase since it is the basic building block of the quantitative process. It is where the fact-finding mission begins. This is like when the golfer spends countless hours at the driving range perfecting his (or her) swing. In this phase, the quantitative investor determines what as-

EXHIBIT 1.6 Three Core Phases of the Quantitative Equity Investment Process

–Characteristic Testing	–Data Collection	–Risk Analysis
–Model Creation	–Create Security Weights	–Portfolio Attribution
	–Trade Portfolio	

EXHIBIT 1.7 Two Core Steps in the Research Phase of the Quantitative Equity Investment Process

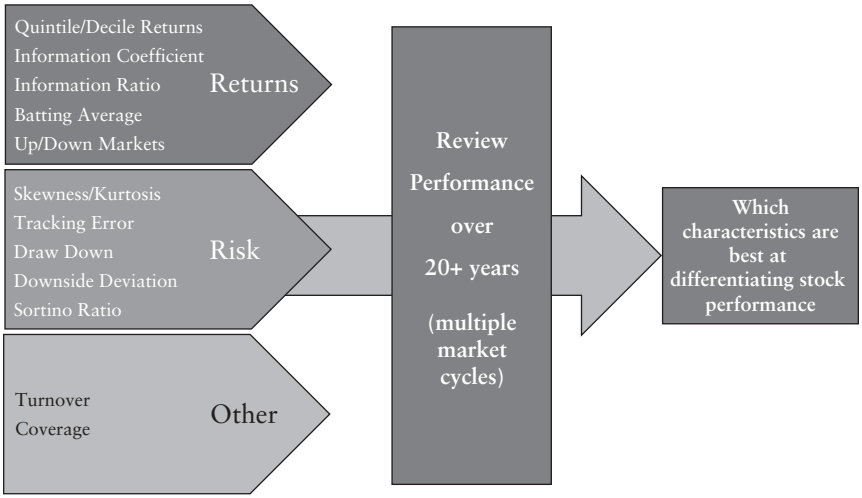


pects of a company make its stock attractive or unattractive. The research phase begins by the quantitative investors testing all the characteristics they have at their disposal, and finishes with assembling the chosen characteristics into a stock selection model (see Exhibit 1.7).

1. *Characteristic testing*. First, quantitative investors determine which characteristics are good at differentiating strong performing from weak performing stocks. Initially, the quantitative investor segments the stocks, this could be by *sector*, such as consumer discretionary, *industry* such as consumer electronics or a *universe* such as small-cap value stocks. Once the stocks have been grouped, each of the characteristics is tested to see if they can delineate the strong performing stocks from the weak performing stocks.
2. *Model creation*. Second, quantitative investors select the final characteristics that are best at picking the most attractive stocks. Then they weight each characteristic in the stock selection model—determining which characteristics should be more relied upon when picking stocks, or if they all should be treated equally.

During the research phase, the quantitative investor tries to get a broad picture of a characteristic making sure it performs well under a diverse set of conditions and performance measures. For their testing, the quantitative investor looks at historical information over 20 years or more in order to cover multiple market cycles. While testing, many performance metrics are reviewed to get an expansive view of a characteristic's ability to differentiate stocks. These metrics span the return category, risk category and other metrics categories as outlined in Exhibit 1.8. Using an array of metrics, quantitative investors are better able to confirm a characteristic's consistency. They make sure that the selected characteristics' score well on more than a single

EXHIBIT 1.8 Characteristic Testing in the Research Phase



metric. Before continuing with the research process, let's review a few of the more commonly used metrics by quantitative investors.

Characteristic Testing: Key Quantitative Research Metrics

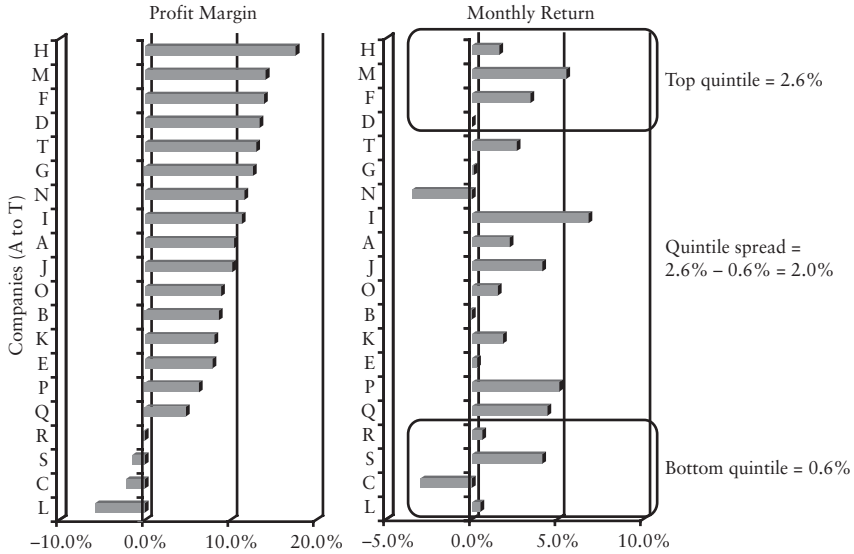
In this section, we review quintile returns and information coefficient that measure whether a characteristic can differentiate between winning and losing stocks. Although profitability was chosen for the examples, other characteristics such as sales growth, P/E ratio or asset turnover could have also been chosen.

Quintile Returns

The quintile return is already prevalent across most research publications, but is gaining popularity in more and more mainstream publications such as the *Wall Street Journal*, *Barron's*, and the like. Quintile returns measure how well a characteristic differentiates stocks. In essence, the stocks that are being reviewed are segmented into five groups (quintiles) and then are tested to determine if the companies in the group with the best attributes (top quintile) outperform the group with the least desirable attributes (bottom quintile).

Exhibit 1.9 provides an example. In this example, we start with 20 companies that we refer to as A through T. The first step—the left-hand side of the exhibit—is to order the 20 companies by profitability from highest to

EXHIBIT 1.9 Determining the Characteristic's Quintile Spread



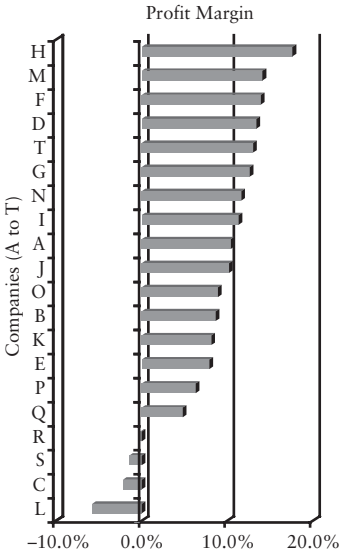
lowest. In the second step, this ordered list is divided into five groups, creating a most profitable group (top quintile) down to the least profitable group (bottom quintile). The top and bottom quintile groups are boxed on the right-hand chart of the exhibit. Finally, the performance of the top quintile is compared to the bottom quintile.

As Exhibit 1.9 shows, the stocks with highest profitability (top quintile) returned 2.6% on average while the stocks with the lowest profitability (bottom quintile) returned only 0.6% on average. So the top quintile stocks outperformed the bottom quintile stocks by 2.0% meaning for this month, the most profitable companies outperformed the least profitable companies by 2.0%. This is commonly referred to as the characteristic's *quintile return* or *quintile spread*. The higher the quintile spread, the more attractive the characteristic is.

Information Coefficient

Another common metric used for determining if a characteristic is good at separating the strong from the weak performing stocks is the *information coefficient* (IC). It does so by measuring the correlation between a stock's characteristic (i.e., profitability) and its return. The major difference between the IC and quintile return is that the IC looks across all of the stocks, while the quintile return only focuses on the best and worst stocks ignoring

EXHIBIT 1.10 Determining the Characteristic's Information Coefficient



Company	Profit Margin Rank	Return Rank
H	1	11
M	2	2
F	3	7
D	4	17
T	5	8
G	6	16
N	7	20
I	8	1
A	9	9
J	10	5
O	11	12
B	12	18
K	13	10
E	14	15
P	15	3
Q	16	4
R	17	13
S	18	5
C	19	19
L	20	14

Information coeeficient = Correlation = 11.0%

those stocks in the middle. The IC is more concerned with differentiating performance across all stocks rather than the extremes.

The calculation of the IC is detailed in Exhibit 1.10. Similar to assessing the quintile return, the sort ordering of the companies based on profitability is done first. However, the next step is different. In the second step, each stock is ranked on both profitability and return. The most profitable company is assigned a rank of 1 all the way down to the least profitable company that is assigned a rank of 20. Likewise for stock returns, the highest returning stock is assigned a rank of 1 down to the lowest returning stock receiving a rank of 20. In the third step, the rank of the company's profitability is correlated with the rank of the company's return. The correlation of the two ranks is the IC that is 11% as shown in Exhibit 1.10. The higher the correlation (i.e., IC), the more likely companies with higher profitability also have higher returns and the more effective the characteristic.

When is it better to employ an IC over a quintile spread? IC is a better metric when a quantitative investor is considering owning a greater number of stocks in the portfolio. The reason is that the IC looks at the relationships across all of the stocks in the group. The quintile return is better suited for more concentrated bets in fewer stocks as it places a greater emphasis on measuring the few stocks at the extremes.

The last two examples reviewed how a characteristic (profitability) was able to explain the next month's return for a group of stocks. In both cases,

it looked effective—a quintile return of 2.0% and an IC of 11%. However, in practice, it is also necessary to assess whether the characteristic was effective for not only one month, but over decades of investing encompassing multiple market cycles. To that end, during the research process a quantitative investor will look at the average quintile returns or ICs over an extended period of up to 20 years or more. When looking at these longer time series, quantitative investors use additional metrics to understand the characteristic's effectiveness.

Characteristic Testing: Key Measures of Consistency

Two commonly used measures of consistency are batting average and information ratio.

Batting Average

Batting average is a straightforward metric. In baseball a player's batting average is the number of hits divided by the number of times at bat. A similar metric is used in investing. Batting average is the number of positive performance months (hits) divided by the number of total months (at bats). The higher the batting average, the more consistently the characteristic generates positive performance.

As Exhibit 1.11 displays, to arrive at the batting average we take the number of months the quintile return was positive divided by the number of months tested. In our example, in 47 of the 72 months the profitability characteristic was effective, resulting in a positive return. This translates to a batting average of 65%, which is quite high. Imagine walking into a casino in Las Vegas where you have a 65% chance of winning every bet. That casino would not be in business very long with you at the table.

Information Ratio

Information ratio is also used to measure consistency. This measure is defined as the average return of a characteristic divided by its volatility—basically a measure of return per unit of risk or risk reward ratio. For volatility, quantitative investors use tracking error, which is the standard deviation of excess returns.

Exhibit 1.12 demonstrates the calculation of the information ratio. In this example, there are two characteristics. Which one should be selected? Based only on returns, we would choose Characteristic 2 since it has a higher excess return (3.0%) than Characteristic 1 (2.0%). However, as we can see in the exhibit, Characteristic 2 also has much larger swings in per-

EXHIBIT 1.11 Determining the Characteristic's Batting Average

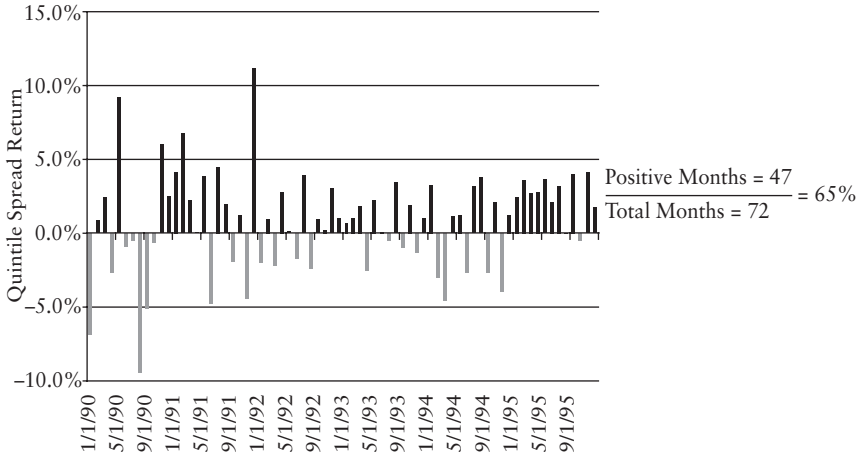
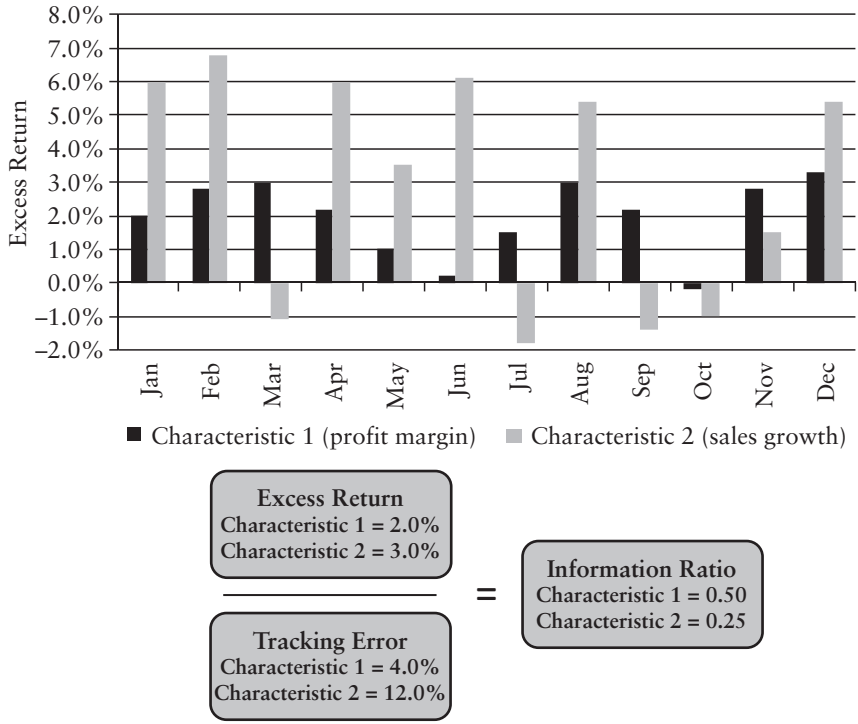


EXHIBIT 1.12 Determining the Characteristic's Information Ratio



formance than Characteristic 1 and therefore more risk. The higher risk of Characteristic 2 is confirmed by its high tracking error of 12.0%, three times greater than Characteristic 1's tracking error of 4.0%. Characteristic 1 looks much better on a risk-adjusted basis with an information ratio of 0.50 (2.0%/4.0%) or twice Characteristic 2's information ratio of 0.25 (3.0%/12.0%). So even though Characteristic 1 has a lower return than Characteristic 2, it also has much less risk making it preferred since the investor is rewarded more for the risk she (or he) are taking.

Model Creation

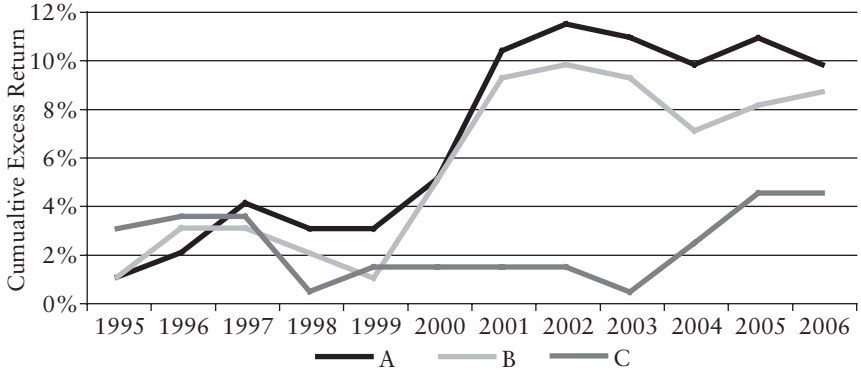
After reviewing and selecting the best characteristics, the quantitative investor then needs to assemble them into a stock selection model. This step of the research process is called *model creation*. It usually involves two main components:

1. Ascertaining whether the characteristics selected are not measuring the same effect (i.e., are not highly correlated).
2. Assigning weights to the selected characteristics and potentially placing greater emphasis on those in which the quantitative investor has stronger convictions.

Let us begin by discussing the first component in model creation: measuring correlation. When including characteristics into a stock selection model, the quantitative investor does not want to include two characteristics that have very similar performance since they may be measuring similar aspects of the company. In these cases, the quantitative manager could be potentially doubling their position in a stock for the same reason. For instance, stocks with a historically high sales growth may perform similarly to stocks with high expected growth in the future or stocks with strong gross margins may perform similarly to stocks with strong profit margins. In either case, we would not include both similar characteristics.

An example is provided in Exhibit 1.13, which shows the cumulative quintile spread return over 10 years for three characteristics (which we have labeled A, B, and C). Characteristic A did the best at differentiating the winners from losers—the stocks it liked outperformed the stocks it did not like by almost 10% over the 10-year period. Characteristic B was next with a return slightly greater than 8% and characteristic C was the lowest with an almost 4% cumulative 10-year return. Given that all three characteristics have good performance, which two should the quantitative investor retain in the model?

EXHIBIT 1.13 Model Creation: Correlation Review



Characteristic Correlation Table

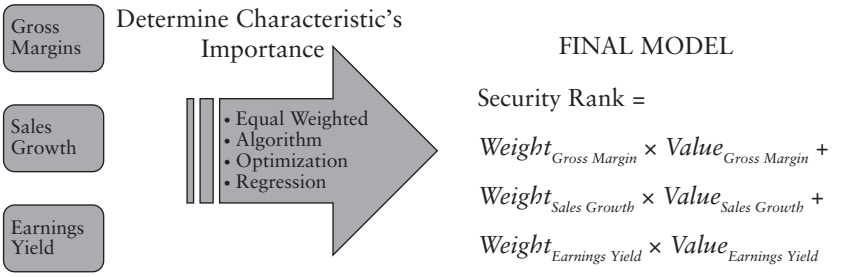
	A	B	C
A	1.00	0.80	0.12
B	0.80	1.00	0.04
C	0.12	0.04	1.00

Although characteristic A and B are better at differentiating winners from losers than characteristic C, A's return pattern looks very similar to B's. This is confirmed by the table in Exhibit 1.13 where characteristics A and B have a correlation of 0.80. Since a correlation of 1.00 means their returns move in lock step, a correlation of 0.80 indicates they are very similar. Rather than keeping both A and B and potentially doubling our positions from similar characteristics, it would be best to keep either A or B and combine the characteristic retained with C. Even though characteristic C is the worst performing of the three, for the stock selection model C provides a good uncorrelated source of performance.

Once the characteristics to select stocks are identified, the quantitative investor is ready to determine the importance or weight of each characteristic. They must decide whether all characteristics should have the same weight or whether better characteristics should have greater weight in the stock selection model.

There are many ways to determine the weights of the characteristics. We can simply equal weight them or use some other process such as create an algorithm, perform regressions, or optimize. Exhibit 1.14 shows how a typical stock selection model is created. In this step, the selected characteristics are combined to determine a target for each stock whether it be a return forecast, rank, or a position size.

EXHIBIT 1.14 Stock Selection Model: Characteristic Weightings



Once the combination of characteristics for the model is selected, the quantitative investor determines their weights and then reviews the model. Model review is similar to reviewing a single characteristic. The model is looked at from many perspectives, calculating all of the metrics described in Exhibit 1.8. The quantitative investor would look at how the top quintile stocks of the model perform versus the bottom and look at information coefficients of the stock selection model over time. In addition, how much trading or turnover the stock selection model creates is reviewed or if there are any biases in the stock selections (e.g., too many small-cap stocks, or a reliance on high- or low-beta stocks). In practice, the review is much more extensive covering many more metrics. If the stock selection model does not hold up under this final review, then the quantitative investor will need to change her stock selection model to eliminate the undesirable effects.

PORTFOLIO CONSTRUCTION

In the second phase of the investment process, the quantitative investor uses the stock selection model to buy stocks. It is in this phase that the quantitative investor puts the model into production. Returning to our golfer analogy, this is when he travels to the course to play a round of golf.

During the portfolio construction phase, the model is ready to create a daily portfolio. This phase consists of three main steps:

EXHIBIT 1.15 Three Main Steps of the Portfolio Construction Phase

Step 1: Data collection. Data are collected on a nightly basis, making sure the data are correct and do not contain any errors.
Step 2: Create security weights. New, updated nightly, data are used to both select the stocks that should be purchased for the portfolio as well as how large its position should be.
Step 3: Trade. The stock selection model that has incorporated the most current information is used for trading.

Data Collection

As Exhibit 1.16 shows, data come from many different sources, such as company fundamental, pricing, economic, and other data (specialized data sources). All of these data are updated nightly so it is important to have robust systems and processes established to handle large amounts of data, clean the data (check for errors), and process it in a timely fashion. The quantitative investor seeks to have everything ready to trade at the market opening.

Creating Security Weights

After the data are collected and verified, the next step is running all of the updated company information through the stock selection model. This will

EXHIBIT 1.16 Data Collection Step of the Portfolio Construction Phase

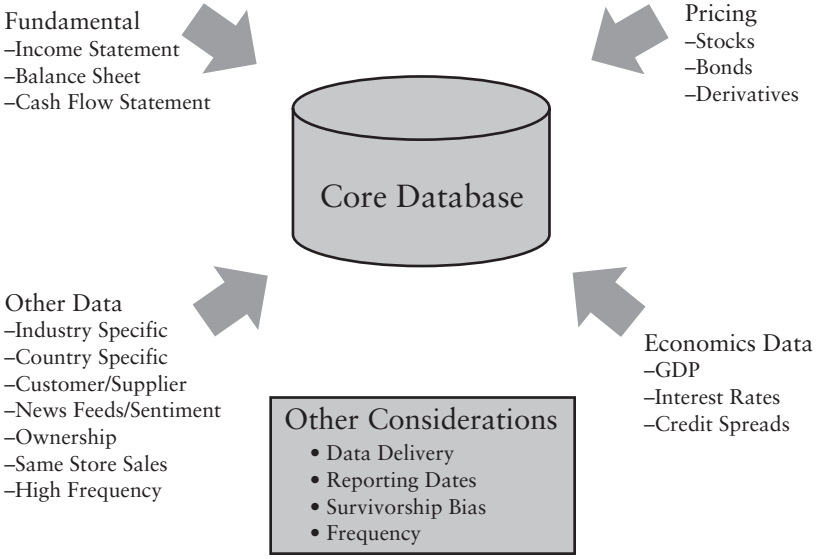
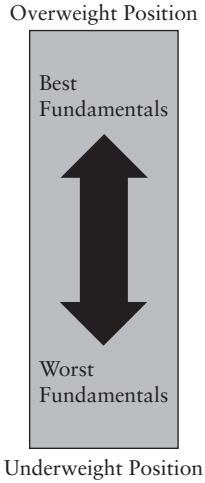
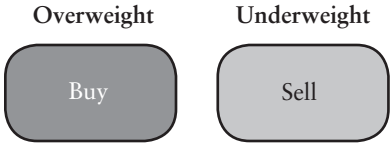


EXHIBIT 1.17 Creating Security Weights Step of the Portfolio Construction Phase



	Company ABC		Company XYZ	
Gross margin	Top 10%	+	Top 20%	+
Sales growth	Top 30%	+	Bottom 20%	–
Earnings yield	Median	0	Bottom 10%	–
Active weight	+		–	



create final positions for every stock in the screened universe. In this step, each stock is ranked using the stock selection model, with the better scoring companies making it into the portfolio.

Exhibit 1.17 provides a simplified example of this, showing a stock selection model with three characteristics: gross margins, sales growth, and earnings yield (i.e., earnings-to-price ratio, the higher the ratio the more attractively priced the stock is). From the example, Company ABC is in the top 10% of companies based on gross margin, top 30% in sales growth, and average on earnings yield. Company ABC may represent a company finding a profitable market, growing into it, and the rest of the market has not caught on to its prospects so it is still valued like an average stock. In this case, the stock rates favorably by the stock selection model and would be purchased. The other stock, the stock of Company XYZ, is not as favorable and would either not be held in the portfolio or if permitted could be shorted. Although Company XYZ also has good margins, its growth is slowing and it is relatively expensive compared to its earnings. The company could be one that had a profitable niche, but its niche may be shrinking as sales are dwindling. Furthermore, the investment community has not discounted the slowing growth and hence the stock is still expensive.

Trade

The final step in the portfolio construction process is to trade into the new positions chosen by the stock selection model. While many investment

approaches trade regularly, even daily, quantitative investors tend not to. Quantitative investors tend to trade monthly or longer. They may wait for the views from their stock selection model to change significantly from their current portfolio before trading into the new views.

MONITORING

The third and final phase in the quantitative equity investment process is monitoring performance and risk. This step is important to check if any hidden biases are embedded in the portfolio and that the portfolio is performing in-line with expectations. Returning one last time to our golfer analogy, this is when the golfer is making mental notes as to what is and isn't working during the round to improve his game in the future. This step can be broken into two activities: risk management and performance attribution.

Risk Management

In risk management, the main emphasis is to make sure that the quantitative investor is buying companies consistent with her stock selection model. Returning to the retail model discussed earlier in this chapter, the model liked companies with good profit margins but had no view on the company's beta. So the quantitative investor would want to make sure that the companies included in her portfolio have high profit margins but average beta. If the portfolio started to include high-beta stocks, the quantitative investor would want to make adjustments to the process to eliminate this high-beta bias. There are many types of risk management software and techniques that can be used to detect any hidden risks embedded in the portfolio and ways to remedy those identified.

Another aspect of risk management is to make sure that the portfolio's risk level is consistent with the modeling phase. The quantitative investor wants to assure that there is not too high or low tracking error relative to expectations. Again, risk management techniques and software can be used to monitor tracking error, sources of tracking error, and remedy any deviations from expectations.

Performance Attribution

Performance attribution is critical in assuring the actual live portfolio's performance is coming from the characteristics in the stock selection model and is in-line with performance expected during the modeling stage. Performance attribution is like monitoring a car's gas mileage: If the gas mileage

begins to dip below what the driver expects, or is known to be, then the driver would want to look under the car's hood. Similarly, if the stock selection model is not producing the desired results, or the results have changed, then the quantitative investor would need to look under the hood of the stock selection model. If performance is not being generated from the selected characteristics, then the quantitative manager would want to check out the model in more detail. One possibility is that another characteristic is cancelling the desired characteristics or perhaps there is something wrong with the model itself. Another possibility is that there are data issues.

The monitoring phase is critical in making sure that the stock selection model is being implemented as expected.

CURRENT TRENDS

Let's look at some recent trends in the quantitative investment industry.

Many quantitative equity investors are looking for additional sources of alpha by using alternative data sources to help select stocks. One notable source is industry-specific data (e.g., banking, airlines, and retail). Additionally, quantitative investors are turning to the Internet to better understand news flows for companies through Web-based search engines. Furthermore, quantitative investors are using more conditioning models. Conditioning occurs when two characteristics are combined together rather than choosing them side by side in a stock selection model. Traditional models would look for companies that have either attractive margins *or* growth. With conditioning models, companies that have both attractive margins *and* growth are sought.

Dynamic modeling is gaining a renewed popularity. It consists of timing characteristics, determining when they should enter or leave a stock selection model based on business cycle analysis, technical market indicators, or other information. For instance, during recessionary periods, a quantitative investor may want companies with strong profitability, while in expansionary periods companies with good growth prospects are sought. A stock selection model would contain profitability when the economy is entering a recession, and then include the growth characteristic once it felt that the economy is moving into an expansionary period. This is an example of how quantitative investors may be bringing more personal judgment to the process, similar to fundamental investors.

Finally, with the advent of high-frequency trading and more advanced trading analytics, many quantitative investors are reviewing how best they implement their stock selection models. Some characteristics such as earnings surprise may have short-lived alpha prospects, so quantitative investors

would want to trade into these stocks more quickly. Other characteristics are longer-term in nature, such as valuation metrics, so investors would not have to trade into companies with attractive valuations as quickly. Furthermore, trading costs are being measured with greater granularity, allowing quantitative investors to measure transaction cost and incorporate these better estimates into their research modeling phase.

KEY POINTS

- Investing begins with processing many different types of information to find the most attractively priced assets. Fundamental and quantitative investors differ in their approach to the available information. The fundamental investor's primary focus is on a single company at a time, while the quantitative investor's primary focus is on a single characteristic at a time.
- Quantitative and fundamental approaches are complementary. By combining the two approaches, you can obtain a more well-rounded investment process including breadth and depth in analysis, facts based with human judgment, a past and future perspective of a company, and a more well-rounded view of risk and performance of the portfolio.
- The quantitative equity investment process is made up of three phases: research, portfolio construction, and monitoring. During the research phase, the stock selection model is created. During the portfolio construction phase, the quantitative investor "productionalizes" the stock selection model or gets it ready to invest in a live portfolio. Finally, during the monitoring phase, the quantitative investor makes sure the portfolio is performing as expected.
- At the heart of the quantitative equity investment process is the stock selection model. The model includes those characteristics that are best at delineating the highest from lowest returning stocks. Models can be created for industries, sectors, or styles.
- Two common metrics used to judge a characteristic's effectiveness are quintile returns and information coefficients. Two more metrics used to understand the consistency of a characteristic's performance over time are batting average and information ratio.
- During the portfolio construction phase, data is collected from multiple sources and run through the investor's stock selection model to arrive at a list of buy and sell candidates. The buy candidates will have the strongest characteristic values in the investor's stock selection model, and the sell candidates the weakest characteristic values.

- The monitoring phase is where the investor assures that the performance in their portfolio is consistent with their expectations. During this phase, investors make sure there are no hidden bets in their portfolio and that the characteristics in their stock selection model are performing as expected.

QUESTIONS

1. Identify at least three ways that a quantitative investor's process may differ from a fundamental investor's process.
2. What are three ways in which the quantitative and fundamental approaches complement one another?
3. When would a quantitative investor use an information coefficient (IC) over a quintile return?
4. Why do quantitative investors create stock selection models for?
5. What types of data is used in traditional stock selection models?