PART
One

Introduction to Behavioral Finance

CHAPTER 1

What Is the Efficient Market Hypothesis?

The efficient market hypothesis (EMH) has to do with the meaning and predictability of prices in financial markets. Do asset markets "behave" as they should? In particular, does the stock market perform its role as economists expect it to? Stock markets raise money from wealth holders and provide businesses with that money to pursue, presumably, the maximization of profit. How well do these markets perform that function? Is some part of the process wasteful? Do prices reflect true underlying value?

In recent years, a new question seems to have emerged in this ongoing discussion. Do asset markets create instability in the greater economy? Put crudely, do the actions of investment and commercial bankers lead to bubbles and economic catastrophe as the bubbles unwind? The great stock market crash of October 19, 1987, and the financial collapse in the fall of 2008 have focused attention on bubbles and crashes. These are easy concepts to imagine but difficult to define or anticipate.

Bubbles usually feel so good to participants that no one, at the time, really thinks of them as bubbles; they instead see their own participation in bubbles as the inevitable payback for their hard work and virtuous behavior—until the bubbles burst in catastrophe. Then, the attention turns to the excesses of the past. Charges of greed, corruption, and foul play accompany every crash.

If the catastrophe and the bubble that precedes it are the result of evil people doing evil things, then there is no reason to suppose that markets are themselves to blame. Simple correctives, usually through imposition of legal reforms, are then proposed to correct the problem and eliminate future bubbles and catastrophes. Casual empiricism suggests this approach is not successful.

What if markets are inherently unstable? What if bubbles and their accompanying catastrophes are the natural order of things? Then what? If prices do not, much of the time, represent true value and if the markets themselves breed excessive optimism and pessimism, not to mention fraud and corruption, then the very existence and operation of financial markets may cause instability in the underlying economy. Prices may be signaling "incorrect" information and resources may be allocated inefficiently. The question of whether asset markets are efficiently priced, then, is a fundamental question. The outcome of this debate could shed light on the efficiency of the modern, highly integrated economies in which a key role is played by financial institutions.

It is important to agree on a definition of market efficiency, but there are many such definitions. Practitioners in the everyday world of finance often use market efficiency in ways that are different than the textbook definitions. We delimit the most common definitions in the next two sections of this chapter.

INFORMATION AND THE EFFICIENT MARKET HYPOTHESIS

The EMH is most commonly defined as the idea that asset prices, stock prices in particular, "fully reflect" information.[1] Only when information changes will prices change. There are different versions of this definition, depending on what kind of information is assumed to be reflected in current prices. The most commonly used is the "semi-strong" definition of the EMH: *Prices accurately summarize all publicly known information.*

This definition means that if an investor studies carefully the companies that he/she invests in, it will not matter. Other investors already know the information that the studious investor learns by painstakingly poring over public documents. These other investors have already acted on the information, so that such "public" information is already reflected in the stock price. There is no such thing, in this view, as a "cheap" stock or an "expensive" stock. The current price is always the "best estimate" of the value of the company.

In particular, this definition implies that knowing past prices is of no value. The idea that past stock price history is irrelevant is an example of the weak form of the EMH: *Knowledge of past prices is of no value in predicting future stock prices.*

The semi-strong form implies the much weaker version of the EMH embodied in the weak form of the EMH. It is possible that the weak form is true but that the semi-strong form is false.

The weak form of the EMH is interesting because it directly attacks a part of Wall Street research known as "technical" research. In technical

[1] See Eugene Fama's definition in "Random Walks in Stock Market Prices," *Financial Analysts Journal* 21, no. 5 (May 1965):55–59.

research, analysts study past prices and other historical data in an attempt to predict future prices. Certain patterns of stock prices are said by "technicians" to imply certain future pricing paths. All of this means, of course, that by studying past prices you can predict when stock prices are going to go up and when they are going to go down. Put another way, technical research is an attempt to "beat the market" by using historical pricing data. The weak form says that this cannot be done.

Unlike other versions of the EMH, the weak form is especially easy to subject to empirical testing, since there are many money managers and market forecasters who explicitly rely on technical research. How do such managers and forecasters do? Do they perform as well as a monkey randomly throwing darts at a newspaper containing stock price names as a method of selecting a "monkey portfolio"? Do index funds do better than money managers who utilize technical research as their main method of picking stocks? These questions are simple to put to a test and, over the years, the results of such testing have overwhelmingly supported the weak form version of the EMH.

The semi-strong version of the EMH is not as easy to test as the weak form, but data from money managers is helpful here. If the semi-strong version is true, then money managers, using public information, should not beat the market, which means that they should not beat simple indexes that mirror the overall market for stocks. The evidence here is consistent and overwhelming. Money managers, on average, do not beat simple indexes. That doesn't mean that there aren't money managers who seem to consistently outperform over small time samples, but they are in the distinct minority and hard to identify before the fact. Evidence from institutional investors, such as large pensions funds and endowments, are consistent with the view that indexing tends to produce better investment results than hiring money managers.

If this were all we knew, then the EMH would be on solid ground. But we know more. There is growing evidence that there are empirical "regularities" in stock market return data, as well as some puzzling aspects of stock market data that seem difficult to explain if one subscribes to the EMH.

We can identify three main lines of attack for critics of the semi-strong form of the EMH:

1. Stock prices seem to be too volatile to be consistent with the EMH.
2. Stock prices seem to have "predictability" patterns in historical data.
3. There are unexplained (and perhaps unexplainable) behavioral data items that have come to be known as "anomalies," a nomenclature begun by Richard Thaler.[2]

[2]See Richard Thaler, *Winner's Curse: Paradoxes and Anomalies of Economic Life* (New York: Free Press, 1992).

The evidence that has piled up in the past 20 years or so has created a major headache for defenders of the EMH. Even though money managers don't necessarily beat the indexes, the behavioralists' research suggests that perhaps they should.

There is a third form of the EMH that is interesting but not easy to subject to empirical validation. The third form is known as the strong form of the EMH: *Prices accurately summarize all information, private as well as public.*

The strong form, of course, implies both the semi-strong and the weak forms of the EMH. However, both the semi-strong and weak forms can be true while the strong definition can be false. The strong form includes information that may be illegally obtained—or, perhaps, information that is legally obtained but illegal to act upon. Needless to say, those breaking the law are not likely to provide performance data to researchers attempting to ascertain whether they are beating the market.

There seems to be a general consensus that the strong form of the EMH is not likely to be true, but one should not rush to such a conclusion simply because relevant data may be hard to come by. What little data we have from those who have obtained illegal information and then acted upon it is mixed. Sometimes crooks win, sometimes they appear to lose. When Ivan Boesky, probably the most famous insider information trader in history, concluded his investment activities and was carted off to jail, it was clear that investors who owned index funds made better returns than investors in Boesky's fund, even before the legal authorities got wise to Boesky's activities. If Boesky couldn't beat the market with inside information, it does give one pause.

Of the three informational definitions of the EMH, it is the semi-strong hypothesis that commands most interest. It is widely believed that the weak form is likely to be true, it is commonly assumed that the strong form is not likely to be true, so interest focuses mainly on the semi-strong hypothesis. Information determines prices and no one can really exploit publicly known information—that is the content of the semi-strong EMH hypothesis.

RANDOM WALK, THE MARTINGALE HYPOTHESIS, AND THE EMH

There is an alternative, mathematical view of the stock market related to the EMH. The mathematical version begins with the idea that stock prices follow a process known as *random walk*. The idea of the random walk is sometimes taken by wary observers as the idea that stock price behavior is simply arbitrary, but that is not what random walk means.

Imagine a coin flip where the coin is completely "fair" in the sense that a heads or tails flip is equally likely to occur. Suppose you start with \$100 in wealth before beginning a series of coin flips. Suppose further that if you flip a heads, you receive \$1, and if you flip a tails, you have to give up \$1. After the first flip, for example, you will have either \$101 (if you flip a heads) or \$99 (if you flip a tails).Your total wealth over time, in this simple example, is following a process known as a random walk. A random walk is a process where the next step (flip outcome, in this example) has a fixed probability that is independent of all previous flips.

What does random walk rule out? If knowing the results of previous coin flips is useful in predicting future coin flips, then the process is not a random walk. Imagine that there have been five flips of heads in a row with no flips of tails. Does this mean it is more likely that the next coin flip will be tails? If so, then the process is not a random walk. The likelihood of a heads or a tails on the next coin flip must be independent of the history of previous flips for the process to be a random walk.

Does this mean, as some assume, that the results are arbitrary? No. We know a lot about this process. What we can't do, however, is predict the next coin flip with any high degree of certainty. If the coin is a fair coin, the heads or tails are equally likely on the next flip regardless of its history.

The coin-flipping game is a good example of a *martingale*. A martingale has the following property:

$$E[X_{t+s} | X_1, X_2, \ldots, X_t] = X_t \text{ for any } t, s > 0 \qquad (1.1)$$

What does the above equation mean? X_t is the value at time t of some variable X. It might be helpful to think of X as your wealth, so that X_t is the value of your wealth at time t. X_{t+s} is then your wealth at some future date, $t+s$. The E in the equation is the expectation operator. The simplest way to think about E is that $E[X_{t+s} | X_1, X_2, \ldots, X_t]$ is what, on average, you expect the value of your wealth to be at a future date, $t+s$, given your knowledge of your wealth historically.

So, back to our example. You start on date t with \$100 and you flip a coin that is equally likely to be a heads flip as a tails flip. What do you expect your wealth to be s periods from today, t? Since you are just as likely to gain \$1 as to lose \$1 on each flip, your wealth at any future period is expected to be the same as is today. Thus, this process satisfies the martingale property. If your wealth is totally in stocks, and if stocks follow a martingale, so will your wealth. On average, you will neither make nor lose money.

But this is not a very satisfying theory of how stocks behave. Why would anyone own stocks if, on average, they could not be expected to increase their wealth? We need to modify our simple coin-flipping experiment to allow for wealth to increase, but in a way consistent with our martingale assumption. Suppose your wealth grows at \$0.20 per period on average, so that $E[X_{t+s} | X_1, X_2, \ldots, X_t] = X_t + \$0.20 \times s$. Then, your wealth is no longer a martingale.

To transform it into a martingale, define a new variable, Y_t:

$$Y_t = X_t - \{t \times \$0.20\} \tag{1.2}$$

Y_t is a martingale since:

$$\begin{aligned} E[Y_{t+s}] &= E\,[X_{t+s}] - \{(t+s) \times \$0.20\} \\ &= X_t + \{s \times \$0.20\} - \{(t+s) \times \$0.20\} \\ &= X_t - \{t \times \$0.20\} = Y_t \end{aligned} \tag{1.3}$$

Even though wealth is growing over time, we have converted the wealth variable into another variable that is a martingale.

If stock prices follow a random walk, then past stock prices cannot be used to predict future stock prices. Random walk doesn't mean we know nothing or that the result of the process is arbitrary. Instead, one of the implications of random walk is that the outcome on any specific future date cannot be known with certainty. By a simple conversion, similar to what was shown earlier, we can convert the wealth accumulation process into a martingale.

Why all the effort? A martingale is a process whose value at any future date is not predictable with certainty. While X_t is the best estimate of any future value of X after X_t, we still cannot know with any degree of certainty what that value will be.

The idea of a martingale captures the informational definitions given in the previous section in a mathematical statement. Given the information available today, the best estimate of a future stock price is today's price (possibly with a risk-adjusted trend over time).This process is described in Figure 1.1.

Of course, the actual prices will not be on the solid line in Figure 1.1. Instead, they will bound around randomly, but trend upward in a pattern suggested by the bold solid line. The actual price movement might appear (or be expected to appear) as the lighter line that bounces around the solid line in Figure 1.2.

What makes the martingale an appropriate model for the EMH is that on any date, past information offers no real clue to predicting future prices. It is the absence of predictability that is the single most important feature of the martingale process.

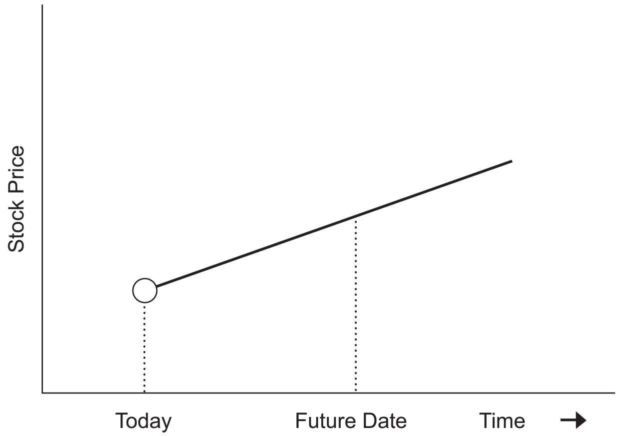

FIGURE 1.1 Expected Future Stock Price

FALSE EVIDENCE AGAINST THE EMH

There are always, at any point in time, legendary money managers who have arguably beaten the market over their respective lifetimes. Warren Buffett comes to mind as one of the more prominent examples. Is the existence of money managers with long track records of having beaten indices evidence against the EMH? To give this question some perspective, conduct a simple thought experiment. Imagine a group of 10,000 people engaged in a

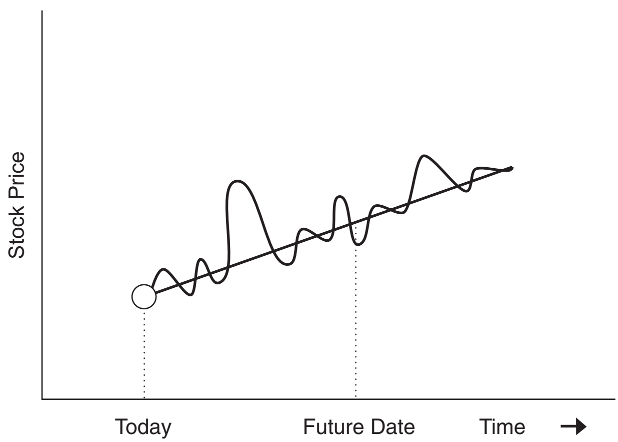

FIGURE 1.2 Actual Future Stock Price

coin-flipping experiment. In each period, each of these 10,000 people flips a coin and notes the result. What would we expect if the coins were, in all cases, fair coins? The likelihood of heads or tails is identical and equal to 50 percent on each and every coin toss.

In the first trial, you would expect, on average, about half of the 10,000 folks to flip heads and about half to flip tails. This would mean 5,000 flipped heads and 5,000 flipped tails. This wouldn't be the exact outcome, but it serves as a useful approximation to the actual outcome. Now, flip again. After the second trial, you would expect about one-fourth of the participants (2,500) to have flipped two heads in a row and one-fourth (2,500) to have flipped two tails in a row. Continue on in this manner through eight coin flips and what would you have? On average, you would expect about 39 flippers to have flipped eight heads in a row and about the same to have flipped eight tails in a row. Are these 39 flippers evidence that there is something to the science of coin flipping?

What about the number of folks who flipped heads seven out of eight times? There should be about 312 of those folks on average. That makes over 350 people who flipped heads at least seven out of eight times. Isn't that evidence that these people are good head flippers?

No, clearly such evidence is useless. If coin flipping is completely random, with a 50 percent chance each time of either flipping heads or tails, you will still get a significant number of extreme outcomes, even after repeated trials. In fact, failure to get the extremes of eight in a row or seven out of eight a reasonable number of times would be evidence that the flipping was not truly random. The same is true of evidence from money management. If money management outcomes are completely random and no one is really any good at stock picking, then a small percentage of money managers will, nevertheless, appear to be good on the basis of their track records.

One of the anomalies the behavioralists have uncovered is that things that are random often appear not to be random.[3] That is, they don't look random. There seems to be an expectation by observers that if a random process is creating a data series, then that data series should have a random appearance. It turns out that there are many more ways for the outcome of a randomly generated data series to look like a pattern than there are ways for it to look random. Put another way, output from a randomly generated process will typically exhibit trends, repetition, and other patterns even though the results are generated by a truly random process.

[3] See Chapter 12 for a broader discussion of this topic.

WHAT DOES IT MEAN TO DISAGREE WITH THE EMH?

Behavioral finance argues that the EMH is false and that academic finance needs to rethink its foundations. What does it mean for the EMH to be false? There are three different ways that behavioralists have waged warfare against the EMH: the first is logical, the second is psychological, and the third is empirical. The logical argument is what economists call *economic theory.* The psychological arguments are derived mostly from experiments in human psychology that throw doubt on the realism of the assumptions that underlie finance theory. Finally, the empirical arguments exhibit patterns of "predictability" in financial data that belie the assumed "nonpredictability" of future asset prices.

The three different ways to confront the EMH correspond to casual observations that have persisted and echoed through financial markets since their beginning. These observations were dismissed just as casually by finance economists as minor and unscientific. Until very recently, the preponderant view among finance economists was that markets were efficient and that casual observers were wrong. Sometimes, it was argued the casual observers had a vested interest in their assertions that the market was inefficient. After all, virtually the entire money management industry is built on the proposition that intelligent and diligent research and thinking can produce investment returns that exceed random stock picking or indexing, contrary to the semi-strong hypothesis of the EMH.

In the chapters that follow, we consider each of the three ways that the EMH has been challenged in the academic literature. A natural question is: if not the EMH, then what? What paradigm would supplant the EMH if the behavioralists succeed in undermining it? We look at that question after considering the behavioralist critique.