12

Perfect and Efficient Markets, and Classical and Behavioral Finance

How Trustworthy are Market Prices?

This chapter explains the concept of an efficient market, which is not as strict as but closely linked to that of a perfect market. A market is said to be efficient if it does not ignore available information. To illuminate perfect and efficient markets, this chapter also explains arbitrage, an essential concept of finance, without which no study of finance would be complete. We then discuss the consequences of the concepts: What do efficient and/or perfect markets mean for predicting stock performance? How should you interpret the success of famous investors? And how can you use the concept of efficient markets to run an event study to help assess the valuation impact of big corporate events?

12.1 Market Efficiency

A perfect market sets up stiff competition among many investors. This forces them to use all available information as well as they possibly can. This is called **market efficiency**: a situation in which prices reflect *all* available information. In a fully efficient market, you should not be able to use any available information to predict future returns better than the market can.

Market efficiency means the market uses all available information in setting the price.

IMPORTANT

A price is called **efficient** if the market has set the price correctly as if it were using *all* available information. (PS: It is not necessary that any investor has all the information.)

> Warning: Market efficiency is a different concept from mean-variance efficiency (the efficient frontier), which was used in the context of portfolio optimization. Economists love "efficiency" and thus use the term in many contexts.

➤ Mean-variance efficiency, Sect. 8.2, Pg.173.

Exhibit 12.1 illustrates an efficient market. Suppose the market considers an expected rate of return of 10% on ABC stock to be a fair rate of return, given ABC's characteristics. This figure of 10% could come, for instance, from the CAPM. Market efficiency then pins down the relationship between the best estimate of the price next year and the price today. In our example, if the market expects ABC to trade for $55 next year, it should set the price today at $50. The market would not be efficient if it had set today's price at $49 or $51. You can turn this around, too. You should not be able to locate information that tells you today when/if/that the true expected

An example: ABC's price today is based on the best estimate of future characteristics, obtained from a model like the CAPM.

value tomorrow is really \$60 (for an expected rate of return of 20%) or \$50 next year (for an expected rate of return of 0%). If you could find information telling you authoritatively that a better estimate of next year's price is \$60 (or \$50), then ABC's stock would be mispriced. A market that has overlooked your information would not be efficient.

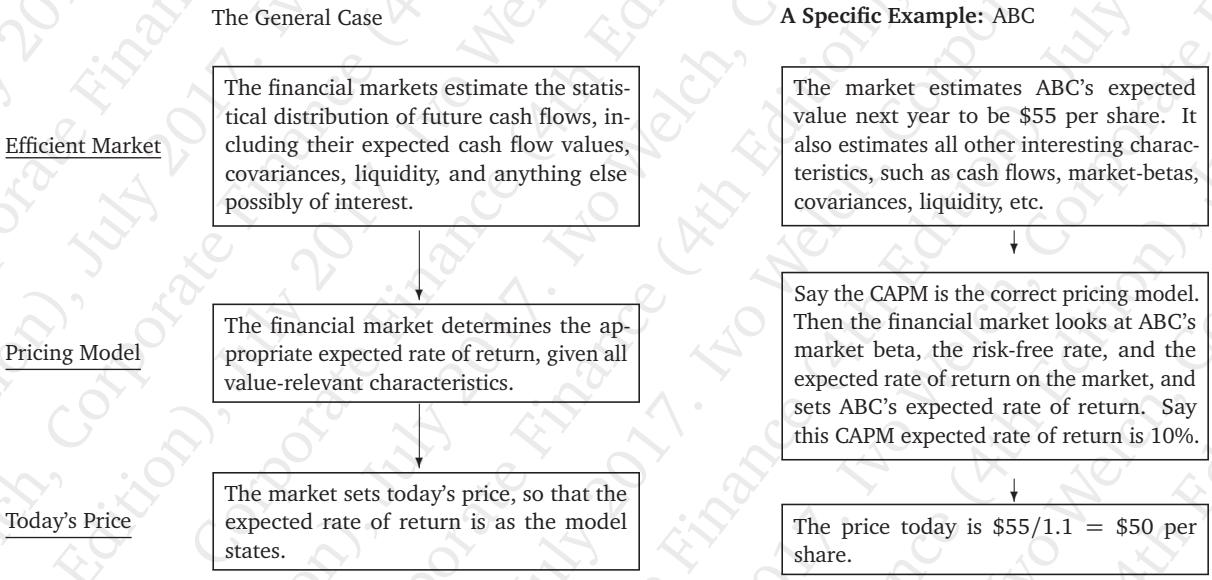

Exhibit 12.1: *Market Efficiency and Pricing Model.* The critical question is *If you saw a price of, say, \$45.83 today, what would you conclude has gone wrong?* Is it the market or the model?

What is the model? What is the information set?

The practical use of the "efficient markets" concept begs two questions:

1. Where does the figure of 10% come from? It has to come from some model that tells you what rate of return ABC should have to offer given its characteristics, such as risk, liquidity, and so on. The CAPM is such a model (though only a modestly successful one). Without a good model of what you should expect the rate of return to be, market efficiency is too vague a concept to be meaningful.
2. If the market is not perfect and different investors have different information, then exactly what information set are we talking about? If you are ABC's CEO, then you may have more information than the public. You may know whether the SEC will open an investigation against you and whether you have the next new hit drink in the lab right now. You could know whether \$50 today is too high or too low. Put differently, the market may be efficient with respect to publicly available information, but it need not be efficient with respect to insider information.

If you find the expected rate of return is really 20%: (a) Your 10% model could be wrong; (b) the market was not efficient.

What should you conclude if you can determine authoritatively that the expected rate of return is really 20%? (This can happen either if you determine that the expected payoff is \$60, not \$55, or if the expected payoff is \$55, but today's price is \$45.83.) You could now draw one of two conclusions:

1. The CAPM is not the correct model. Instead, the market followed some other pricing model and wanted to set the expected rate of return for ABC at 20% in the first place.

2. The stock market is not efficient.

Can you see why market efficiency is so difficult to prove or reject? If you wish to proclaim a belief in market efficiency, and if you then find empirically that prices are not what your model predicted, you would simply proclaim that it was your model for the appropriate expected returns in your financial market that was wrong, not that the market was inefficient. It was your fault, not the market's. You just have to go back and search more—possibly forever—until you find the right pricing model.

Is market efficiency so difficult to disprove that it becomes a "faith"?

Short-Term versus Long-Term Market Efficiency

Over long horizons (say, 1 year or longer), market efficiency is extremely difficult to disprove. The reason is that no one knows exactly what the correct model of pricing is—the CAPM may often be a reasonable model, but it is not infallible and its estimates are rarely accurate in practice. We are not sure whether a stock like ABC should earn 10%, 20%, or 30% a year. This renders market efficiency a concept that in practice often evades empirical testing. It is also why market efficiency is sometimes (unfairly) disparaged as being more religion than science. Based on the existing long-run evidence, some reasonable analysts conclude that financial markets are generally efficient (and our [CAPM] pricing model is wrong); and other reasonable analysts conclude that financial markets are generally not efficient.

Practically useful? Rarely over very long horizons, where efficiency is often more a matter of faith.

Of course, in extreme circumstances, market efficiency can be a useful claim even on such long horizons. We know that no reasonable model of financial markets should give investors great bets like "+$1 million with 99% probability" and "–$1 with 1% probability." Expected returns this high would be way out of line with *any* reasonable pricing model. Even expected rates of return of 100% per year would surely be unreasonable for (most) stocks. Of course, few people doubt that the stock market is, to such a first approximation, efficient—we all know that you just can't earn that much. But there is a large gray zone where it is difficult to distinguish between model error and market inefficiency. Because no one knows for sure what the correct model of expected stock returns is, no one can tell you affirmatively whether the stock market set the price of ABC stock so as to offer investors an expected rate of return on ABC of, say, 10% a year or 12% a year.

Okay, let me qualify this for long horizons.

However, over short horizons (say, a day or so), market efficiency is a surprisingly useful concept. The reason is that over a single day it does not matter as much whether you believe the expected rate of return on ABC is 0%, 10%, or 20% per annum. Even on the high end of 20% per annum, the expected rate of return is still only about 5 basis points per day. Roughly speaking, regardless of whether you believe in the CAPM or not, you should expect day-to-day returns to be just a tiny bit above 0%. You should attribute most daily price movements to random fluctuations, presumably caused by unpredictable news of changes in the economic environment. However, if you can predict day-to-day stock movements (and you have thousands of days of historical stock returns to work with), then chances are that you would not blame the pricing model. Instead, you would probably conclude that the market is not efficient.

Practically useful? Definitely yes over short horizons.

Dilbert on Predictability of Noise: 2013-01-05

IMPORTANT

- Over short time intervals (say, days), market efficiency is a very powerful concept. The expected rate of return should be tiny. If it is different, the market is probably inefficient.
- Over long time intervals (say, months or years), it is difficult to pin down what the appropriate expected rate of return is. This makes it difficult to disentangle errors in the pricing model from market inefficiency.
- Prices should move only when there is news about future cash flows or discount rate changes, where news is defined as the unanticipated component of new information that is arriving. Such news can be firm-specific or market-wide.

Relation to Perfect Market

Perfect market ⇒ efficient market.

Although the efficient market concept is different from the perfect market concept, the two are intimately linked—in fact, so much so that they are often casually confused. The reason is that if a market is perfect, economic forces drive it instantly toward market efficiency. Put differently, if a market were perfect but inefficient, everyone would want to earn great returns and trade the same way. It would be too easy to become rich. Market prices would instantly adjust to prevent this. Therefore, if a market is perfect, it is inevitably also efficient.

Efficient market ⇏ perfect market.

The converse is not true, however. It is quite possible for an imperfect market—for example, one in which there are taxes or different opinions—to be efficient. You could even (crudely) think of market efficiency as the result of the trades of many investors with many different information sets (opinions). The market price is the outcome at which investors no longer wish to trade further. Appropriately weighted, one half believes the market price is too low; the other half believes it is too high. Of course, efficiency should be contemplated market by market. It is probable that some financial markets are efficient while others are not. The closer a market is to being perfect, the more likely it is to being efficient.

Efficient market is a weak facsimile of "same information."

Another way to understand the difference is to compare assumptions. Of the four perfect-market assumptions, only one has any overlap with and bearing on the efficient-market concept: the one regarding "same information set and opinions." And even the information requirements are weaker. It is not necessary that all investors have the same information and opinion (as in the perfect-market setting), just that the market price is the same "as if" the market itself had access to all the information at once. So, a market can be efficient even when investors know different bits and pieces of information and/or to have different opinions, just as long as the market-price is the same that it would be if they were all sharing their information and opinions.

Transaction costs are often culprits in keeping prices from their efficient levels.

Perhaps the most important perfect market assumption driving prices toward efficiency is the absence of transaction costs. Without them, it is easy for you and other investors to trade on any information that the market has not yet incorporated in the stock price—and thereby earn an unusually good expected rate of return. However, the no-free-lunch axiom applies here, too. High transaction costs would make it more likely that you could expect to find violations of efficient markets. But if it is very expensive to trade and if the market is therefore not efficient and does not respond to news immediately, it would also be very difficult for you to take advantage of such inefficiencies.

Investor competition pushes markets toward efficiency.

Here is a practical example of how any market inefficiency would disappear quickly in a perfect market: What would you do if you learned that the market always goes down on rainy days and up on sunny ones? It is unlikely that the average investor requires extra return to hold stocks on sunny days—and, even if the average investor does, it is enough for you if you are not among them. You would never buy stocks when the weather forecast predicts that rain is coming. Instead, you would only buy stocks when the weather forecast predicts that the sun will shine. Investors like yourself—and there are of course many such investors in perfect markets—would rapidly bid up the prices before the sun shone, so that the prices would no longer systematically go up on sunny days. The end result is that if markets are efficient, then you should not be able to earn abnormally good sunny-day returns—at least not this easily. In a reasonable world, to earn higher expected rates of return, you must be willing to take on something that other investors are reluctant to take on—such as higher portfolio risk. Today's weather alone should not do it. (Interestingly, academics do disagree on whether the weather in New York City has a small influence on stock returns. Some papers claim it does, so that the market is inefficient. Others dispute this, claiming the historical correlation is spurious and disappears if the statistical tests are done correctly. All agree that the weather influence is small, however.)

Prices should be generally efficient even in a nonperfect financial market. Who would be willing to hold overpriced stuff?

Conversely, it is easier to believe that markets are *not* (or less) efficient if transaction costs are high. But even if the market is not perfect, market inefficiencies should still raise eyebrows. For example, let's say that the appropriate rate of return on ABC was still 10% and the price was

still $50. Alas, when you run a few regressions, you learn that the expected future price is not really $55 but $51. (The true expected rate of return would thus not be 10%, but 2%.) In a perfect market, some investors may want to short some ABC and use the shorting proceeds to buy another stock. This may not be possible if the market is imperfect and the costs of going short are too high. However, this leaves the question of why investors who already own ABC shares would not want to sell them ASAP. They would not incur the shorting transaction costs and would avoid the then lower-than-appropriate rate of return. (Maybe they are asleep?! Or maybe even the non-short related plain selling transaction costs are too high?!) Such "economic self-interested behavior" adds to the "third-party investor pressure" in driving markets toward efficient pricing, even in a market that is imperfect.

➤ Shorting stocks, Sect. 7.2, Pg.157.

IMPORTANT

- If a market is perfect, market forces should drive it strongly and quickly toward efficiency.
- If a market is not perfect, self-interested individual behavior should still drive it toward efficiency. But this force is much weaker, and third-party traders may not be able to aid in the process.

Market Efficiency in Modern Financial Markets

In the United States, the financial markets for Treasuries, large corporate stocks, index mutual funds, currencies, and others, seem reasonably close to perfect and thus efficient. They are definitely very competitive. There are millions of buyers and sellers, thousands of tax-exempt investors, and modest transaction costs, and it seems unlikely that some investors have real inside information. It is difficult to believe that you or I could outsmart the prices in such markets. After all, thousands of other traders are likely equally as smart. They would flock to good bargains and avoid bad bargains along with us. Of course, the smaller the firm, the less perfect and the less efficient the market in its stock is likely to be. Many small stocks on the NASDAQ exchange trade only rarely, and they can have large transaction costs:

You can reasonably assume that markets are efficient for large corporate stocks.

- The bid-ask spread is often high.
- The posted bid-ask spread is only guaranteed for 100 shares—if you want to trade more shares, the price is likely to move against you.
- Commissions can be high.
- Shorting small stocks can be very costly when compared to the ideal of a perfect world in which you have full access to the proceeds (e.g., to earn interest).

➤ Bid-ask spread, Sect. 11.3, Pg.258.

In a round-trip transaction, you will face the first three issues once when you buy and once when you sell. Thus, it is unlikely that small stocks will immediately and fully reflect all information appropriately. The historical prices you see posted may be "stale" and may not even reflect the price that would have applied if you had wanted to trade. Market efficiency is never white or black, but always a shade of gray—just as it is for perfect markets. Large, liquid S&P 100 stocks are pretty close to efficient; small NASDAQ stocks may not be.

The fact that large-firm stock markets are pretty efficient means that, by and large, you can trust these financial markets to get asset values about right—at least within the limits of the typical transaction costs—and to get it right *immediately*. As an investor, would you not rather face an inefficient market? If it were inefficient, you might be able to find some good bets (opportunities that earn unusually high expected rates of return). But it would not all be gravy. In an inefficient market, you could not rely on market prices being fair—they could be inappropriately too high or too low. You would never really know whether you are overpaying or underpaying. Investing would be a very messy business. You might have to spend a lot of time

The advantage of an efficient market: Prices can be trusted.

➤ Great bets, Sect. 12.4, Pg.297.

"Trading Places" and Citrus Futures

The 1983 hit comedy *Trading Places*, starring Dan Akroyd and Eddie Murphy, centers around the trading of orange juice frozen concentrate **futures contracts**. (A future is a contract that specifies terms to buy or sell a commodity in the future—in this case, oranges.) If it is going to rain or if there is a frost, oranges will be scarcer and the futures price will rise. You can learn more about futures contracts at the website of the *Chicago Mercantile Exchange* at http://www.cme.com.

In a 1984 paper in the *American Economic Review*, Richard Roll found that these citrus futures contracts predict whether the U.S. Weather Service's forecast for central Florida temperatures is too high or too low. It is a great example of how financial markets help aggregate information better than the best nonfinancial institution. This should not surprise you. After all, there is a lot of money at stake!

and money to determine whether prices are fair. The advantage of efficient markets is that if you hold a portfolio of many large and liquid stocks, you do not have to spend a lot of time and money to perform **due diligence** in order to determine whether stocks are fairly priced. All you need to do is to make sure you are appropriately diversified to meet your risk-reward preference. And you can probably accomplish this goal by buying just a few large index-mimicking mutual funds.

Q 12.1. What does it mean for a market to be efficient?

Q 12.2. As a believer in efficient markets, what would you likely answer when heretics claim that they can reject market efficiency because they have found assets that pay too much for their risk?

Q 12.3. Is market efficiency a more powerful concept over long or short horizons?

Q 12.4. How does an efficient market differ from a perfect market?

Q 12.5. Is it more or less likely for a financial market to be efficient when transaction costs are low?

Q 12.6. Would you expect the market for the dollar-euro exchange rate to be more or less perfect and efficient than the NYSE?

How to Get Squeezed and Lose Money Even When You Are Right

Even in cases where it is probable that the market mispriced stocks, such as technology stocks during the famous "Internet bubble" at the turn of the millennium, it was almost impossible for an individual investor to take advantage of the market inefficiency. Believe me, I know.

In 1998, I shorted Netscape. I believed that Netscape's browser was about to be taken to the cleaners by Microsoft's Internet Explorer. I was right on my prediction—but in February 1999, AOL paid a lot of money to acquire Netscape. Not satisfied with one mistake, I proceeded to my next mistake. I believed Yahoo (YHOO) was worth less than what it was trading for. I speculated that it would go down. After I had lost more than three times my original investment, I realized that I had to either close my bet or risk going bankrupt. Consequently, I terminated my bet. Yes, I would have been right in the end and made a lot of money if I had held on longer, but I simply could not afford the risk (and mental anguish) any longer. I learned from this episode—after 15 years as a financial economist—that even if the stock market is irrational and even if it overvalues a stock by three times, it can also be irrational enough to overvalue it by yet another three times.

Later on, I found out that I was not alone. The most reprinted article in the history of *Fortune* magazine was "Mr. Buffett on the Stock Market," from November 22, 1999, in which famed financier Warren Buffett warned about the overvaluations of tech stocks and Internet stocks. Like me, Buffett had suffered from years of poor performance (and from yet another quarter of misery to follow), as Internet stocks reached ever higher.

Not everyone believes there was a bubble. The book's website (book.ivo-welch.info) has an impromptu email conversation between myself and Eugene Fama (perhaps the most famous finance professor alive and a strong defender of market efficiency). This will give you an authentic impression of the ongoing dialogue among finance professors.

12.2 Market Efficiency Beliefs and Behavioral Finance

Classical versus behavioral finance.

A firm belief in efficient markets is what defines a school of thought known as **classical finance**, an outgrowth of the school of **rational economics**. This belief is that the evidence supports the **efficient market hypothesis**, or **EMH**, which holds that all securities are priced efficiently. In contrast, another school of thought, often dubbed **behavioral finance**, posits that markets sometimes do *not* use all available information. Depending on how strong a believer in classical finance versus behavioral finance you are, you may believe that there are no especially good trading opportunities, few trading opportunities, or plenty of trading opportunities. Both camps agree, however, that market perfection plays a crucial role in determining whether a particular market is efficient or not.

Many large financial markets in the United States are probably close to efficient.

Almost all financial economists, regardless of camp, believe in basic market efficiency for large markets and liquid securities. No respectable economist believes that it is easy to get very rich trading on easily available information. Instead, the disagreement is, loosely, about whether stock markets are "99% efficient" or "97% efficient." Classical finance believes in the former, behavioral finance in the latter. Of course, you can trade millions of dollars in large-firm stocks or market indexes relatively easily and at low transaction costs. Thus, it does not require huge efficiency violations for behavioral finance economists to be right and for classical finance economists to be wrong. Exploiting just the tiny—say, $100\% - 97\% = 3\%$—violations from market efficiency could make you a star investor. (This is also not coincidentally why so many fund managers publicly proclaim their faith in behavioral finance.) However, don't take me too literally here—the 99% versus 97% is an analogy, and there is really a spectrum of beliefs in market efficiency among economists and fund managers. Now, although you should realize that any classification scheme really identifies just segments on a continuous line, you can still try to classify financial economists and investors by their faiths in efficiency. Let's look at some such classifications.

The Traditional Classification

The traditional classification of market efficiency is about the type of information needed to beat the market.

The traditional definition of market efficiency focuses on information. In the traditional classification, market efficiency comes in three strengths: weak, semistrong, and strong.

Weak market efficiency says that all information in past prices is reflected in today's stock prices so that **technical analysis** (trading based solely on historical price patterns) cannot be used to beat the market. Put differently, the market is the best technical analyst.

Semistrong market efficiency says that all public information is reflected in today's stock prices, so that neither **fundamental trading** (based on underlying firm fundamentals, such as cash flows or discount rates) nor technical analysis can be used to beat the market. Put differently, the market is both the best technical and fundamental analyst.

Strong market efficiency says that all information, both public and private, is reflected in today's stock prices, so that nothing—not even private insider information—can be used to beat the market. Put differently, the market is the best analyst and cannot be beat.

Many finance professors no longer believe in perfect efficiency.

In this traditional classification, all finance professors nowadays believe that most financial markets are not strong-form efficient: Insider trading may be illegal, but it works. However, arguments rage on as to which markets are semistrong-form efficient or even weak-form efficient, and even for large and liquid financial markets (such as large firms traded on the NYSE or NASDAQ, or some options on the CBOE). Finance professors regularly publish claims that some new rule would have outperformed reasonable average rates of return historically, often by large margins. Prominently among them are some particular forms of momentum strategies (buying stocks that have gone up and selling stocks that have gone down over the last year) and value strategies (buying boring old-economy stocks, selling glamorous high-growth new-economy stocks). These strategies would have offered "excess returns" as high as 1-2% per month.

Why do many trading strategies seem to have worked historically?

Market efficiency champions quickly point out that many of these strategies' returns were **spurious**: They disappeared almost as quickly as they were discovered, and they probably were never real to begin with. Also, many of these trading strategies would have required such high transaction costs that they would not have been profitable in the real world. That is, even if prices had not incorporated all information, thus leaving the market inefficient, they may have been well within the bounds of transaction costs. Yet some trading strategies, such as momentum or value, do seem to have produced large historical excess returns even after transaction costs. One good question is whether they will continue to work. (Personally, I am not claiming that they will or will not work in the future.) A second good question raised by EMH proponents is what part of these strategy returns was appropriate compensation for risk (not captured by the CAPM) and thus not excessive to begin with.

The returns to collecting information must be in "balance" with their costs.

One conceptual question that had vexed academics for a long time was how markets could be efficient to begin with. After all, if there is no money to be made, why would anyone bother collecting information on firms? And if no one bothers to collect information on them, how can the market incorporate all information and thus be efficient? Eventually, a resolution to this puzzle was offered by Grossman and Stiglitz. They argued that markets can never be 100% efficient—they can only be, say, "99%" efficient. In equilibrium, good information collectors should earn just about enough trading profits to break even on their costs of information collecting. On the margin, the expected costs of learning and trading on more information are exactly equal to the expected trading profits. The informed investors earn this money trading against **noise traders**, who do not collect information and who may trade for idiosyncratic reasons (e.g., to pay for tuition).

Q 12.7. Which form of market efficiency do momentum trading strategies seem to violate?

The Fundamentals-Based Classification and Behavioral Finance

My preferred taxonomy of market efficiency is based on how much prices deviate from value.

I prefer an alternative classification of market efficiency, which divides economists based on their belief in whether prevailing market prices reflect underlying values:

A true believer would argue that financial prices always reflect the best net present value estimate of all future cash flows. This means that stock prices should change correctly if and only if news about fundamentals (cash flows or discount rates) appears.

A firm believer would argue that financial prices may sometimes deviate from the appropriate best estimate of future cash flows. However, transaction costs make it practically impossible for investors to find unusually good bets.

A mild believer would also argue that financial prices may sometimes deviate from the appropriate best estimate of future cash flows. However, unlike a firm believer, a mild believer would argue that there are occasions when it is possible to exploit this misvaluation. This would result in the occasional unusually good bet. Usually, the profitabilities of such bets should remain within economically reasonable magnitudes—a couple of percentage points a year on the high side. Mild believers thus think that smart fund managers can offer investors slightly better bets, but nothing more. There are no guarantees.

A nonbeliever would argue that financial prices regularly deviate from the appropriate value, and to an extent that allows investors to obtain great bets fairly routinely.

These classes are progressively weaker along the market efficiency dimension. For example, a firm believer need not be a true believer. Firm belief can be the right club to join if financial price changes are indeed unpredictable, but not because of news about fundamentals. There could be unrelated noise in stock price changes, especially in the short run. A mild believer need not be a firm believer: Transaction costs may be low enough to permit great trading strategies based on efficient markets violations. A nonbeliever need not be a mild believer: Financial markets may just beg to be exploited. This classification is related to but not the same as the earlier classification. For example, it is possible that markets do not reflect all fundamental information, yet stock returns are unpredictable.

There is even some really weird but dramatic evidence against market efficiency.

Occasionally, there is evidence that refutes even the truest of believers—but this is rare. The most dramatic example occurred in 2000, when the network company 3COM spun off the PDA company Palm. Widely reported in the press at the time, 3COM retained 95% of Palm's stock—and announced that each shareholder of 3COM would soon receive 1.525 shares of Palm. After the IPO, Palm closed at \$95.06 per share. Therefore, 3COM should have been worth at least $1.525 \cdot \$95.06 \approx \$145$. Instead, 3COM shares closed at \$81.81. (It was impossible to exploit this discrepancy, because it was impossible to find Palm shares to short. Palm shares later enjoyed an almost uninterrupted fall in price, down to less than \$2 per share by 2003.)

This evidence as a whole suggests that the financial markets are usually somewhere between mildly and firmly efficient.

Where do most finance professors sit in this classification of beliefs? Virtually no academic is a perpetual nonbeliever, and only a very few remain in the "true believer" camp. Instead, most finance professors are somewhere between the "mild believer" camp (the center of behavioral finance) and the "firm believer" camp (the center of classical finance). The debates between the two more extreme sides of these camps—the more "classical rational economists" and the more "behavioral economists"—are intellectually exciting. After all, bringing new evidence to bear on these disagreements is the process by which we learn more.

Buyer beware: Here is my own opinion.

Let me tell you my personal view. I sit right in the middle between the two schools of thought, somewhere in the firm-to-mild camp. In my view, most investors believe that they are smarter than they are—that they can predict when stocks are going to go up or down. This is why I believe that trading in the stock market seems so (inexplicably) active. Some pundits like to call this "investor psychology." However, I also believe that ordinary individual investors are unlikely to be able to find rate-of-return patterns in the stock market that earn high excess returns. A very few sophisticated funds may be able to earn systematically a few basis points extra per year.

➤ Evidence on Fund Performance, Sect. 12.5, Pg.305.

But these funds are scarce. Even after decades of academic research that has tried to identify better-performing funds, we have usually found that only about half of all funds outperform the market and half underperform the market—even before fund transaction costs.

Behavioral Finance

One final note: Pundits love to talk about investor psychology. And it is indeed the case that individuals suffer from many cognitive biases. For example, Nobel-prizing winning research has argued that investors are "loss-averse," which induces them to make mistakes. It is very plausible that loss aversion influences their stock trading patterns. But it is not so plausible that loss aversion necessarily influences stock prices. There are two problems. The first is that different investors would have started out at different investment levels. They would thus suffer from loss aversion relative to different starting points. This means that, in the aggregate, prices would not necessarily behave as if investors are loss-averse. The second is that, if prices were badly set because of investor loss aversion (or most other behavioral mistakes), a few smart investors would try to take advantage of this behavioral bias. They would quickly drive prices back to where they would look like random walks.

Q 12.8. If you believe that market values do not always perfectly reflect underlying fundamental values, but that trading costs nevertheless prevent you from exploiting this profitably (in large scale), where would you classify yourself?

12.3 The Random Walk and the Signal-to-Noise Ratio

The low signal-to-noise ratio allows our arguments about market efficiency to continue.

Why is the debate over market efficiency so tough to settle? It is the fact that the **signal-to-noise ratio** in financial returns is low. The signal-to-noise description draws on an analogy from physics—the **signal** (the appropriate expected price change) is small compared to the **noise** (the day-to-day price **volatility** that clouds our senses).

Let me illustrate the signal-to-noise ratio with a stock's rate of return on a particular day.

Let me explain. What are typical price change magnitudes? For example, June 17, 2016, was a fairly quiet and uneventful day on the financial markets. 10-year Treasuries stood at 1.6%, up 5 basis points; 13-week T-bills traded at 0.3% (unchanged); and just about half of all stocks advanced and half declined. The S&P 500 dropped from 2078.0 to 2071.2, about 30 bp. The Dow-Jones had 12 gainers and 18 losers. On this day, the volume leaders (not the biggest price movers) were Wester Gas (down 5.8%), Greif B (+3.7%), Synchrony (–5%), Alon (+1%), and Linked in (60%). Intel Corp increased from $31.69 to $31.76, up 0.2%. What can you learn from this magnitude? Read on.

The Signal

You cannot expect a real-world trading signal to be as strong as 1% per day: It would amount to over 1,000% per year.

Let's first put your statistical and financial expertise to good use: *In a perfect market, if the shares of a company cost $50 today, what do you expect them to cost tomorrow?* What is a typical daily rate of return on a stock? Could you expect a reasonable model of market prices to predict that 1 day's stock price movement could be something on the order of ±1%? Think about it: If the expected rate of return on a stock were the same as the typical up or down movement of 1% per day, the rate of return on this stock over the 252 trading days in one year would be more than 1,000%. The $50 stock would be worth over $600 by next year. Who would want to sell such a stock? Who would not want to bid a lot more than $50 for it right now? The same argument applies to a price decline of 1% per day. An investment strategy of holding onto such stocks would transform $50 into less than $5 by next year. Who would ever want to hold onto such stocks? The same logic would also apply to a signal that tells you on some days that one particular stock is expected to go up by 1% and on other days that some other particular stock is expected to go down by 1%. Each day, you would earn 1% by either going long or short in the

relevant stock—according to your signal—and end up filthy rich. (The investors on the other side would end up poor.)

So what kind of average daily returns can you expect from the U.S. stock market? Say a reasonable range of rates of return is between 0% and 40% per year. For 252 trading days, absent complications, this gives you daily rates of return of between 0 basis points and about 15 basis points. The majority of stocks should allow you to earn expected rates of return of between 5 and 10 basis points a day. One basis point of signal per day is 3% per year. Thus, when you test for market efficiency with a reasonable model of stock pricing, about 5 to 10 basis points per day is what you would expect to find for most stocks. If your signal allows you to earn 1 bp extra per day, then your strategy will be better by about 3% per year.

Great Mathematicians and Gambling: The Origin of the Random Walk

In the 1700s, it was not beneath mathematicians to study how to gamble in order to gamble better. Jacob Bernoulli (1654–1705) and Abraham DeMoivre (1667–1754) studied the random walk of a gambler's stake in fair games.

Later reinventions and applications of the random-walk concept abound: Jan Ingenhausz (1730–1799), a physician and plant physiologist, placed charcoal powder on an alcohol film and observed that the grains moved randomly. The botanist Robert Brown (1773–1858) reported erratic dancing of small particles in fluids at rest. Albert Einstein (1879–1955) considered such fluids to be composed of discrete molecules, whose many collisions with a "Brownian particle" caused the particle to jump in random directions—a random walk. Einstein's analysis not only explained **Brownian motion**, which has itself become a building block of high-tech finance nowadays, but also bolstered the case for the existence of atoms, which was not yet universally accepted. The first recorded use of the phrase "random walk" was by Lord Raleigh (1842–1919) in 1899. (Raleigh made a connection between diffusive heat flow and random scattering and showed that a one-dimensional random walk could provide an approximate solution to a parabolic differential equation.) The name is believed to have originated with the description of a drunk who stands on a ladder. The drunk can walk up or down and does so in a random fashion—just like stocks.

Fortunately, in 1900, Louis Bachelier introduced the random-walk theory of financial market fluctuations (although Karl Pearson (1857–1936) introduced the term "random walk" only later, in 1905), finding that bond prices could diffuse in the same manner as heat. Unfortunately, this has only pointed out the obvious: It is not easy for an investor to outperform the market. The first rigorous and published investigation of the random-walk hypothesis was done by Alfred Cowles, an eclectic investor and economist at Yale in the 1930s and 1940s. *Mostly Michael F. Schlesinger, Office of Naval Research,* Scienceweek.com, *2001.*

Let's make this into a formula. If your expected rate of return is a small constant m, that is, $\mathsf{E}(r) = [\mathsf{E}(P_1) - P_0]/P_0 = m$, then your best expectation of the price tomorrow (P_1) must be roughly the price today (P_0).

Over short intervals, the stock price should follow a mostly unpredictable random walk with practically no drift.

$$\text{Expected Price Tomorrow} = \text{Price Today} + \text{Tiny Drift} \qquad (12.1)$$

$$\mathsf{E}(P_1) = P_0 + \underbrace{m \cdot P_0}_{\text{Tiny Drift}}$$

This is customarily called a **random walk** with drift. As you just learned, depending on the stock, this tiny drift m may be around 5 to 10 basis points for most stocks. You should not be able to predict better than this drift, because this is your expected rate of return in an efficient perfect market.

Note that price behavior very close to a random walk is a necessary consequence of an efficient market, but you cannot conclude that a market is (truly) efficient just because stock prices follow roughly a random walk. For example, a market would be inefficient if you could find advance knowledge based on some other external signal—say, whether the sun is shining on a particular day—that would tell you whether the stock price will go up or down the following

Don't wag the tail: Market efficiency ⇒ random walk. Random walk ⇏ market efficiency.

day. In this case, stock prices would still follow a random walk, but your signal would allow you to outperform the EMH. The random walk only states that the known lagged price can't be this signal.

A Complication—Transaction Costs

Transaction costs destroy the profitability of many high turnover strategies.

➤ Transaction costs, Sect. 11.3, Pg.256.

The important point of perfect markets (and market efficiency) is that, given today's information, no signal can be very accurate. It should not be possible to predict stock price movements accurately enough to earn, say, 1% on a given day. Of course, in the real world, financial markets are not perfect and there are financial transaction costs that would also prevent you from really exploiting misvaluations, especially short-lived ones that require a lot of trading to exploit. You would have to pay money to your broker to buy the shares, and again to sell them. (This is why financial markets are not exactly perfectly competitive, only approximately perfectly competitive.) Even small transaction costs can render trading strategies with very high turnover unprofitable. Even if the bid-ask spread is only 10 basis points, if incurred 252 trading days a year, you would only be left with $(1-0.1\%)^{252} = 0.999^{252} \approx 78\%$ of your original investment. For a *daily* trading strategy in which you have to pay the bid-ask spread every day, you need to have a signal that allows you to earn at least 23% per year before you break even—and few signals are that good.

It may be best to think of the EMH in terms of after-transaction costs.

In an imperfect market with transaction costs, you can view the efficient market hypothesis in one of two ways:

1. The EMH should hold if you work with post-transaction cost rates of return. One percent per day is still unreasonably large, because typical round-trip transaction costs should not exceed 10 to 30 basis points, depending on the stock and the size of the trade. A daily rate of return of 0.7% is still way too large.
2. The EMH should hold if reasonably many investors have very low transaction costs, perhaps because they already had specific trading desires. For example, a signal may tell some investors to buy a stock today and sell it tomorrow. They would have to pay transaction costs to take advantage of it. But investors who were considering selling the stock *anyway* may need to wait only another day to take advantage of the soon-to-be misvaluation and then sell. Such investors really incur no additional transaction costs. However, if they are *all* asleep at the switch, it may be impossible for others to take advantage of their failures.

So the EMH won't hold perfectly in an imperfect market, but it should be a fairly reasonable description of reality—at least it is one that you can use to compute back-of-the-envelope magnitudes, and it is a hypothesis that can be tested.

Q 12.9. From memory, write down the formula for a random walk.

Q 12.10. What is the typical expected rate of return on a stock on an average trading day?

Q 12.11. What kind of rates of return does a strategy of trading stocks once a day have to offer so that you can earn a positive rate of return? Assume typical real-world trading transaction costs are about 10 basis points.

The Noise

To put more emphasis on the noise, we can write our random walk with drift in terms of the stock prices that you will actually observe:

The daily noise in stock returns is much larger than the daily signal.

$$\text{Price Tomorrow} = \text{Price Today} + \text{Tiny Drift} + \text{Noise}$$

$$P_1 = P_0 + m \cdot P_0 + \epsilon \qquad E(\epsilon) = 0$$

What do we know about reasonably typical standard deviations for the price noise of U.S. stocks? There is no particular theoretical reason why the day-to-day standard deviation of a particular stock could not be 10%, 50%, or even 100%. So it is best for us simply to rely on the empirical data. Historical averages suggest the following:

- The typical day-to-day standard deviation of individual stocks in the market is around 2-3% per day—of course depending on the firm. For well-diversified portfolios, like stock market indexes, the standard deviation is usually lower—perhaps 1-2% per day.

June 17, 2016, was on the low side in terms of volatility, but the typical noise movement of 200 to 300 basis points for individual stocks was clearly much higher than the 5 to 10 basis points that you would expect them to earn.

IMPORTANT

In the financial market context, "random walk" refers to a process in which the *expected* value tomorrow is (almost) the same as the value today. Technically,

$$E(P_1) = P_0 + \underbrace{m \cdot P_0}_{\text{Tiny Drift}} \iff P_1 = P_0 + \underbrace{m \cdot P_0}_{\text{Tiny Drift}} + \underbrace{\epsilon_{0,1}}_{\text{Noise}}$$

where m is a very small positive drift. (Another version of a random walk is $E(P_1) = P_0 + m$; in practice, this version is almost indistinguishable from the one in the formula above.)

Naturally, *actual* values tomorrow will likely be different from their values today. The empirical stock price evidence is highly favorable. Stock prices indeed tend to follow roughly a random walk, at least in the short run. This means that you cannot get rich trading based on past prices.

Q 12.12. What is the typical movement of a stock on an average day?

Q 12.13. If stocks follow a random walk, can the price tomorrow be different from the price today?

Detecting an Interesting Signal in the Noise

Detecting a signal in a lot of noise is difficult.

You now know that the tiny drift is typically around 5 to 10 basis points per day, and the noise is typically about 100 to 300 basis points per day for U.S. stocks and stock portfolios. How easy is it to determine whether you are facing a stock with 5 basis points' signal versus one with, say, 7 basis points' signal? Why 7 basis points? Because it is what you should be earning extra every day if you have a signal that allows you to earn an extra 5% per year in expected performance, above and beyond what your model of risk-adjusted returns says you should be earning. (A performance of 5% per year in risk-adjusted returns would be stellar for just about any fund.) Put differently, to determine whether your signal is real or illusory, you must be able to distinguish between an appropriate 5 basis points and an excessive 7 basis points for the average daily rate of return.

You cannot conclude anything from just 1 day of return

How easy is it to detect an extra signal of 2 basis points when hidden in noise of about 200 basis points? Obviously, 1 daily return is not going to do it. If I tell you that your investment pick happened to earn 50 basis points today, you could not reliably conclude that it was your signal. In fact, if anything, you should believe it was primarily noise. Recall from your statistics course that the T-statistic is defined as the mean divided by the standard deviation, $\mathsf{E}(r)/\mathsf{Sdv}(r)$. If your strategy performs as expected, your 1-day T-statistic would be only $2\text{bp}/200\text{bp} = 0.01$. To have good statistical confidence, you would want a T-statistic of around 2. Your expected 0.01 is a long way off.

You cannot consider multiple returns from the same day as independent observations.

To draw reliable conclusions, you need a lot more independent daily observations. Unfortunately, you cannot use the returns from many stocks from the same day as independent signals. First, your signal may apply only to some particular stocks and not to all stocks. Second, all stocks tend to move together on a given day and are therefore not independent observations. (If all 100 oil stocks go up, and your signal suggested holding oil stocks, you do not have 100 independent observations confirming your signal's ability to predict.)

You can use consecutive days as independent observations. Here is how mean, standard deviation, and T-statistic accumulate over time.

Fortunately, you can regard returns from different days as independent observations. You can therefore use sequential days of investment performance to investigate the quality of your signal. How many daily returns would you need to expect to be able to reliably detect a signal of an extra 2 basis points hidden in noise of 200 basis points? Let's ignore compounding and pretend that rates of return over time are just the simple sum of daily rates of return. In this case, your expected rate of return over N days is N times the expected rate of return over 1 day. Recall from Section 8.2 that the standard deviation of your rate of return over N days is $\sqrt{N}$ times the standard deviation over 1 day. Your expected T-statistic over N days to detect your superior excess rate of return is therefore

➤ How risk and reward grow over time, Sect. 8.2, Pg.172.

$$\text{N-day T-Statistic} = \frac{\text{Excess Mean}}{\text{Standard Deviation}} = \frac{N \cdot \mathsf{E}(r)}{\sqrt{N} \cdot \mathsf{Sdv}(r)} = \sqrt{N} \cdot \text{1-day T-Statistic}$$

Only diversified strategies that perform well for many decades give us the chance to learn whether they are real.

How many trading days (N) do you need in order to expect a T-statistic of 2 if your 1-day T-statistic is 0.01? You need $200^2 = 40,000$ days to have such confidence. This is about 157 years worth of data. This is if your strategy performs as expected—if the world is not changing and your signal's forecasting ability is not deteriorating. If your signal is not about individual stocks but about large diversified portfolios, then the noise is lower than 200 basis points. If it is, say, noise of 100 basis points per day, which may be the case for highly diversified portfolios, then you "only" need about $100^2 = 10,000$ days (39 years) of data. There are many signals for such diversified trading strategies, which can therefore be examined with real-world data. (I already described some of these, principally momentum and book/market value, although it is not perfectly clear whether their high historical average returns were due to risk or market inefficiencies.) Still, with the world and the signal always changing (after all, there may be more and more investors trying to profit from historical signals), the historical evidence alone may not always be entirely convincing.

IMPORTANT

- The quality of your inference about a strategy's performance increases roughly with the square root of time.
- On an average day, the typical stock may easily move up or down by about 20 to 50 times as much as it offers in expected rate of return. Therefore, it takes at least many decades, if not centuries, of data to reliably conclude whether a signal-based strategy of picking individual stocks is real or illusory.

Q 12.14. To be a consistent superstar trader, by how many basis points should you be able to outperform the risk-adjusted financial market per typical day?

Q 12.15. Assume that the typical day-to-day noise (standard deviation) is about 100 basis points. Assume that you have the kind of stock-picking ability that earns you an extra 200 basis points per annum. Assume no transaction costs. Ignore compounding and assume that your rate of return is the sum of returns over trading days. Assume there are 252 trading days per year.

1. With only 1-day performance, how much extra do you expect to earn per day?
2. How bad is your noise over 1 day?
3. What is your expected T-statistic (the excess mean divided by the standard deviation)?

Recall from your statistics course that a T-statistic of 1.96 gives you good statistical confidence above the 95% level. In Section 8.2, you learned that the standard deviation grows with the square root of time.

4. With 252 trading days of performance, how much extra rate of return do you expect to earn per annum?
5. How bad is your noise over 252 days?
6. What is your expected T-statistic now?
7. Work out how many years you would expect to wait before you would obtain reliable statistical evidence that you have a positive ability to pick stocks.

12.4 True Arbitrage and Risk(y) Arbitrage

Measuring investment performance brushes on a closely related topic—what exactly is the financial concept of arbitrage? Intuitively, an arbitrage is a great investment opportunity, perhaps so great that you should not be able to find one. It is the desire of traders to exploit any arbitrage opportunity as soon as it appears that makes financial markets efficient. It is a matter of basic financial literacy for you to understand what arbitrage is.

Do you understand arbitrage?

The Definition of Arbitrage

First recall that the *law of one price* states that two identical items at the same time and location should have the same price. This is true in a perfect market, but even if the market is not perfect, it can be (and in fact usually is) still true. For example, even if all investors disagree about the future, even if there are taxes, even if there are transaction costs, and even if there is only one market maker, it should be, and usually still is, the case that one share of Intel Corp costs the same as another. But in a perfect market, the law of one price does not just *usually* hold; it must *always* hold. If it did not hold, you and the other infinitely many potential buyers could find arbitrage opportunities. The arbitrage concept is so important that you should understand it exactly, not just intuitively.

In a perfect market, the market will be efficient and the law of one price will hold.

➤ Law of One Price, Sect. 1.1, Pg.2.

IMPORTANT

- A **true arbitrage** is a business transaction
  - that offers positive net cash inflows in at least some scenarios,
  - and under no circumstance—either today or in the future—has a negative net cash flow. This means that it is risk-free.

An example: \$5 for free.

- A **risk(y) arbitrage** is a business transaction that may not be risk-free but that still offers an excessive expected rate of return given its (risk and other) characteristics. A good way to think of a risk(y) arbitrage is as a **great bet**. Admittedly, the term "risk(y) arbitrage" is an oxymoron. However, Wall Street uses the term "risk arbitrage" for a particular type of trading (most often in the context of M&A transactions) that is similar to the sense in which we shall be using it. Thus, we shall commit the same sin.

  An example: A chance to win \$1,000,000 with 99% probability and to lose \$1 with 1% probability.

Arbitrage is the "perpetual motion" of economics. It is defined in terms of (the possibility of) negative cash outlays.

Arbitrage is an ex-ante concept, not an ex-post concept—beforehand, not after the fact. For example, it does not mean that a lottery ticket that won was an arbitrage. Ex ante, a lottery ticket is not an arbitrage. Please also pay close attention to what the "no-negative-cash-flow" condition means in the definition of arbitrage:

➤ Ex-ante fair bet, Sect. 6.1, Pg.106.

1. Arbitrage is not the same as "earning money without risk." After all, Treasuries do just that, and they are not arbitrage. The reason is that you have to lay out cash to buy Treasuries. This is a negative net cash flow today.
2. Arbitrage is also not the same as "receiving money today without a clear obligation to repay": If you are willing to accept risk, you can often receive cash today. For example, insurance companies take money in exchange for the possibility that they may have to pay up in the future.

"Risk(y)" arbitrage ≈ great bet. Unlike a true arbitrage, a risk(y) arbitrage could possibly lose a little money.

Now contemplate the difference between the examples of the true arbitrage and the risk(y) arbitrage in the definition. You can lose \$1 with 1% probability in the risky arbitrage, so it is "just" a great bet and not a true arbitrage. One difference is conceptual: Every investor would want to take a true arbitrage opportunity, but an infinitely risk-averse investor would not take a risk(y) arbitrage. This does not mean that, given an either-or choice, a less risk-averse investor would necessarily prefer the small, true arbitrage opportunity. In our example, would you prefer the \$5 true arbitrage, if it cannot be repeated, to the risk(y) arbitrage with an expected payout of close to \$1 million? (If you could scale the true arbitrage opportunity to take it infinitely many times, the true arbitrage opportunity would dominate.) Of course, this example of risk(y) arbitrage is extreme. More realistically, bets are never this great—"very good" is rare enough. And because there is still risk, you may not want to scale up good but risk(y) arbitrage bets in the same way you would always want to scale up true arbitrage bets as much as possible. Eventually, with enough investment in the risk(y) bet, your risk aversion would kick in and stop you from taking more of it.

There should be few arbitrages in competitive financial markets. Only this fact allows us to study and describe (sane) markets.

Most of all, unless financial markets are very imperfect, you should expect not to find many arbitrage opportunities of either type. If you agree with this assessment—basically that the world is sane and that money does not grow on trees—you can draw some surprisingly strong conclusions about how financial markets work. If you disagree, why are you still in this class? If you are right, you should be among the richest people in the world and there is little that this book can teach you.

Q 12.16. Is earning money without risk an arbitrage?

Q 12.17. When and why you would prefer a risk(y) arbitrage to a true arbitrage opportunity.

More Hypothetical Arbitrage Examples

In a sense, positive-NPV projects under certainty are arbitrage.

Of course, it is difficult to find real-world examples of arbitrage. Arbitrage is principally a concept. What would a hypothetical arbitrage opportunity look like? For example, if you can buy an item for $1, borrow at an interest rate of 9% (all costs, including your time), and sell the item tomorrow for $1.10 for sure, you earn 1 cent for certain today without any possible negative net cash flows in the future. If you ever stumble upon such an opportunity, please take it—it is a positive-NPV project! More than this, it is a true arbitrage because you cannot lose money in any scenario; it is riskless. Yet it is obviously not a very important arbitrage by itself. Searching for 1-cent arbitrage opportunities in financial markets is potentially more lucrative, because they often allow transactions to be scaled up. If you could repeat this 1-cent arbitrage 1 billion times, then you could earn $10 million. Unfortunately, although you may find an arbitrage that works once for 1 cent, it is unlikely that you can find such an arbitrage opportunity that works for 1 billion items. After all, you are not the only one searching in the financial markets! True arbitrage opportunities are difficult or outright impossible to find in the real world, especially in very competitive financial markets.

Small arbitrages matter only if they are scalable.

Another hypothetical example of arbitrage would involve stock prices that are out of sync on different stock exchanges. If PEP shares are quoted for $51 on the Frankfurt Stock Exchange, and for $50 on the New York Stock Exchange, you could theoretically buy one share in New York for $50 and sell it in Frankfurt for $51. You then pocket $1 today. If you can do this with 20,000 PEP shares worth $1 million, you earn $20,000 without effort or risk.

Arbitrage could conceivably occur between different financial markets.

But before you conclude that this is an arbitrage, you still have to make sure that you have not forgotten about costs or risks. The arbitrage may be a lot more limited than it seems—or may not even be present at all. Consider the following issues:

But be skeptical. There are many complications to take into account.

1. Could the price change in between the time you buy the shares in New York and the time you sell the shares in Frankfurt (even if it is only 3 seconds)? If such execution-timing risk exists, this is not pure arbitrage because there is a chance of a negative net cash flow. The real-world evidence suggests that price discrepancies between markets often disappear within a few seconds.
2. Did you account for the direct and indirect transaction costs? How much commission do you have to pay? Is $51 the Frankfurt bid price at which you can sell shares in a market, and $50 the NYSE ask price at which you can buy shares? Can you sell the share in Frankfurt and get it quickly enough from New York to Frankfurt to make the closing? Have you accounted for the value of your own time watching the screen for opportunities?

➤ Bid and ask prices, Pg.258.

3. Could the share prices move when you want to transact a significant amount of shares? Only the first 100 shares may be available for $50 for a net profit of $100. The next 900 shares may cost $50.50—perhaps still worthwhile, but less profitable. And buying the remaining 19,000 shares may cost you $51 or more.
4. Did you account for your fixed cost of setting up your business? If it costs you a million dollars to get offices and computers in order to "arbitrage" a few thousand dollars, it is obviously not a real arbitrage. So you must account for how expensive it is to set up your operations.

It may be that small arbitrage opportunities occur from time to time, but large financial firms are constantly running automated computer trading programs that search for even tiny arbitrage opportunities in order to exploit them as soon as they appear—and thereby make them disappear.

Q 12.18. Before you dedicate your life to exploiting a seeming arbitrage between financial markets, what questions should you ask?

12.5 Investment Consequences

Is the past rate of return a good signal for the future rate of return?

How does the EMH matter to you if you are an investor? In an efficient market, there should be no obvious signals to outperform the risk-adjusted appropriate expected return to the tune of, say, 10 basis points a day above transaction costs. For sure, it should not be possible for you or anyone else to earn arbitrage returns. Let's consider two examples—technical analysis and investment fund management.

Weak-Form Efficiency and Technical Analysis

Could there be "cycles" in the market?

The main point of the traditional classification of market efficiency, specifically the "weak" version, is the claim that you should not become rich by trading a strategy that relies only on historical prices. So let me start with some trick questions. Look at the various graphs in Exhibit 12.2. Do they show what stock market patterns could look like? Perhaps. Does it make sense to think that all these patterns can predict the future? Absolutely not! Graphs (a) and (b) display a strong regular cycling pattern. If they indicated future returns, you should quickly become a wealthy technical analyst. You would buy the stock only when it has "bottomed out"—a pattern that you can reasonably detect if you see a multimonth period of losses followed by about a quarter of stable returns. It need not be the kind of regular cycles in the figure: Any good predictable patterns (such as "every time the price hits $22, it drops by $2") would allow you to get rich. Now, if you look hard enough, can you find some stocks in the real world that have historically behaved like these graphs? Yes—because with over 10,000 stocks currently trading, by pure chance, maybe one or two could show a pattern that would look remarkably similar to a cycle pattern. But, despite assurances from some stock analysts that you could have made money if you had just trusted their cycle patterns and that you should trust them henceforth, the patterns would *not* represent the future—they would just be historical coincidence.

Cycles are not reasonably likely—although there are ups and downs in the market, too.

On the other hand, graphs (c) and (d) could actually be representative. On average, each price in the next month is just a little higher than the previous (i.e., the expected rate of return on stocks is positive), but the important aspect of (c) and (d) is that there is a lot of *noise*, up or down. Noise is by definition unpredictable, and stock prices must largely be unpredictable, or you could outsmart the stock market. Incidentally, one of these graphs is a real stock price that I picked at random, while the other is a simulated random walk. Can you detect which one? I cannot! The real-world price series looks just like a simulation of patternless day-to-day random-walk changes. In fact, if you ever look at graphical representations of stock prices, most will look like graphs (c) and (d) and not like graphs (a) and (b). (Solution: Graph (d) was an actual stock price series of Intel.)

The Empirical Evidence on Trends

Predicting with past rates of return mostly appears to fail.

Traders have been trying all sorts of strategies in their efforts to become rich. So how well does technical analysis—which tries to find patterns in historical stock prices—typically do? For example, according to one version, stocks that rise one day are more likely to fall back the next day. Exhibit 12.3 shows tomorrow's rate of return on the tech-heavy Nasdaq market index and on Intel Corp as a function of today's rate of return (from 2000 to 2016). The graphs show no pattern that would allow you to get rich quickly. There is definitely not much juice in trying to predict how a stock will perform tomorrow, given how it performed today. (Although difficult to spot here, there is a small day-to-day reversal in this data—a tiny negative slope. This is caused by the **bid-ask bounce**: If a stock's closing price is a [higher] ask price, on average it will fall back the next day when it will close with either a bid or an ask price with roughly equal probability. If the stock's closing price is a [lower] bid price, on average it will gain the next day. This is a data illusion and not exploitable.) Similar conclusions apply if you extend your use of historical price information beyond yesterday. You can even try out your own technical analysis at

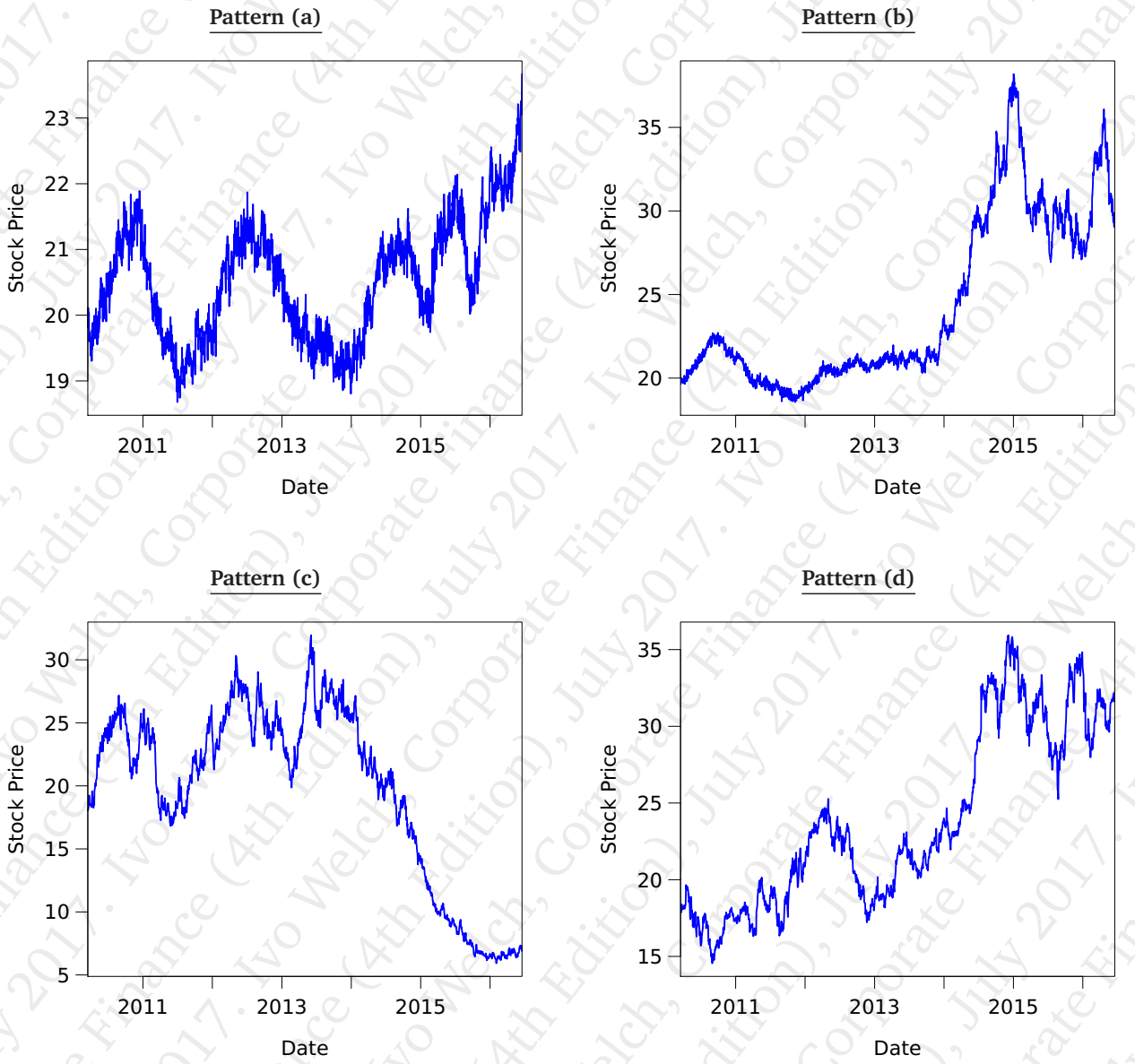

Exhibit 12.2: *Potential Stock Price Patterns.* If these patterns were systematic, some of them should make you rich. Which ones? And which is the real series?

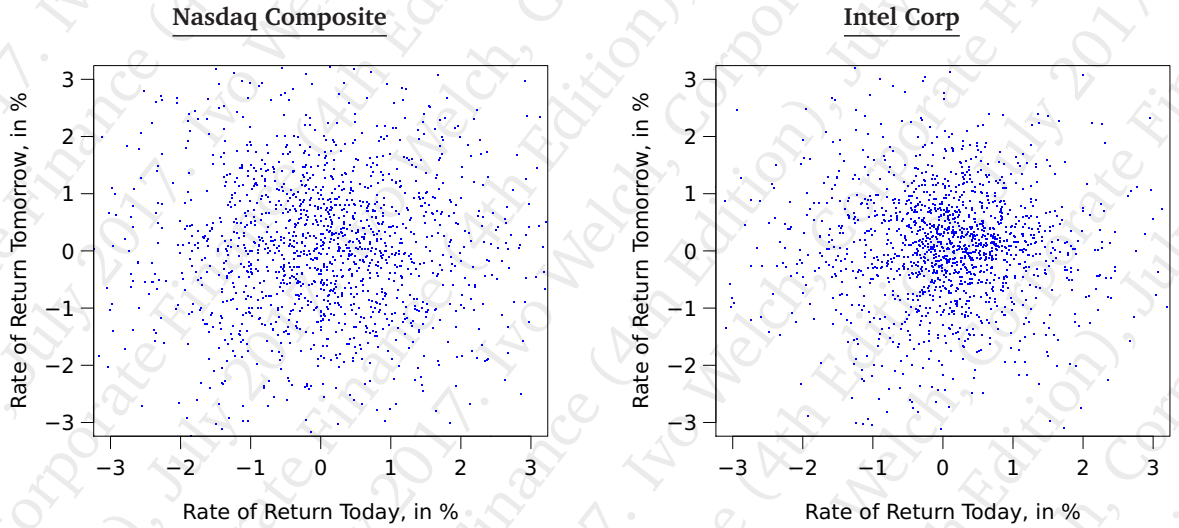

Exhibit 12.3: *The Relation between Lagged and Current Rates of Return.* The left panel is the tech-heavy Nasdaq Composite Market Index (IXIC). The right panel is Intel Corp. Both plots graph the rate of return against itself one day earlier from 2010 to 2016. Obviously, there is no obvious pattern.

Momentum: Firms that did well over the last year (with 1-month lag) continue to do well.

a number of financial websites, such as YAHOO! FINANCE—look up any stock and choose "Charts," then "Technical Analysis"; it is fun, but unfortunately fairly useless.

However, over annual horizons, it appears as if stocks tend to continue their pattern just a little bit. This is the "momentum" effect mentioned earlier. It should be covered in more detail in an investments course. (Of course, as you already know from Section 12.1, it is very difficult to determine whether an extra few percent is an appropriate rate of return to compensate investors for some risk, or whether it is a market inefficiency.)

Are Women Better Investors Than Men?

Analyzing 35,000 households from 1991 to 1997, Terry Odean and Brad Barber found that men trade 45% more than women. Apparently, men are overconfident in their trading prowess. (Men also have a higher propensity to suffer from compulsive gambling and other mental disorders.) On average, the men's investment rates of return were lower than women's by a little less than 1% per year. Much, but not all, of women's better returns could be attributed to the higher transaction costs that men incurred for transactions that did not gain them higher returns.

Despite strong evidence to the contrary, many investors still believe that stock prices do not follow random walks, as evidenced by the plethora of financial talk shows and investment newsletters. It would perhaps be better for the general public to watch more sports and cooking shows and fewer investment shows—especially for males like myself!

Odean and Barber, 2001

Investment Manager Performance Evaluation

What about celebrity investors?

What about all the televised stock analysts who explain which stocks are undervalued and which stocks are overvalued? And what about the aforementioned technical analysis, the art of seeing patterns (shoulders, price barriers, faces, etc.) in historical prices and using them to forecast future prices? And what about famous investors such as Warren Buffett, George Soros, and many others? Should you trust them?

What could you conclude from their stellar past performances? There are three possibilities.

First, recall that the low signal-to-noise ratio means it is difficult to determine why a particular trading strategy has earned high returns:

- Was it because it had a lucky outcome, which will not repeat (random luck)?
- Was it because it took on some risk that your appropriate return model forgot (your fault in measuring performance)?
- Or was it because the market was inefficient (you have a good signal, skill, and trading ability)?

This is not just a problem for academics. In fact, we finance professors are lucky: We can continue to write papers that argue one side or the other. The real conundrum is faced by every investor in the real world every day: How do you distinguish between a good and a bad signal—between skill and luck—when it comes to investing or to selecting a fund manager?

Here are possible objections to believing in their magical investment abilities (and in inefficient markets).

But the signal-to-noise ratio problem is not even the only problem that you need to consider when you pick an investment manager. If you believe that the market is inefficient so that your fund manager can make you money, consider the following:

Evidence? Of course, maybe there are some investors who *can* pick stocks. Unfortunately, they would not want anyone to learn how they do it. In fact, they may want to do so secretly and privately, never eager to appear on anyone's radar screen. This can make it difficult to find investors with superior ability and thus impossible to confirm their abilities.

Why would they tell anyone?

Enough data? Recall our earlier conclusion that a strategy with great performance requires many decades before you can realistically conclude that it has worked. (This is assuming that the world is not changing.) Few strategies have such long track records.

➤ Ascertaining superior performance, Pg.296.

Remarkably, the most common industry standard for evaluating funds is their most recent three years of investment performance. There is no disagreement that most of the 3-year performance of funds is noise. This means that many investors (and especially investors in hedge funds) shift their holdings often based on noise. Why? Either they do not understand how long it takes to determine reliably whether a strategy works (possible), or they do not care too much about reliability (more likely). If they believe that there are many other strategies that also have a close to 50-50 probability of success, then eliminating one strategy that had 3 bad years and therefore only a 49-51 probability of success may not be a costly choice.

The industry standard of three years' performance is not driven by the need to get solid statistical inference.

What is Risk? Here is another lesson for the wise (and unwise). Until 2008, I would have sworn that investing in momentum stocks was a strategy that was reasonably well-diversified and yet outperformed the overall stock market. On average, it had delivered abnormal returns to the tune of about 5-10% per year. Stocks that have gone up over the last year and which are therefore momentum purchase candidates did not seem to be particularly risky. More importantly, momentum stock portfolios appeared well-diversified—a fact that should have moderated their ups and downs. Yet, after many decades of superior performance, in 2009, this momentum strategy suddenly lost 83 percent of its investment! (One plausible reason is that too many hedge funds were trying to chase momentum returns, and they all had to unload at the same time.) Which other seemingly great investment strategies are exposed to some risk factors that have just not shown themselves yet?

Is Momentum Risk?

➤ "Peso" risk., Pg.205.

Pure chance means that some investors succeed many years in a row.

➤ Mutual funds, Sect. 7.2, Pg.159.

Monkeys on keyboards? There are about 10,000 mutual funds today that invest money on their investors' behalf. How many of them are likely to outperform the overall stock market next year (at least before they collect fees) if none of them has any superior investing ability? About 5,000. How many of these outperform the year thereafter? About 2,500. Even if there is absolutely no ability, pure randomness means that about 10 funds outperform the market every year for 10 years in a row. With enough candidates, some funds will inevitably produce consistently positive long-run track records.

Good past performers grow.

Who is still alive? What happens to the funds that have underperformed several years in a row? They disappear quietly. (In fact, they don't even need to appear. The SEC even allows a fund family to "incubate" funds privately for the purpose of obtaining track records. Start 1,024 of these funds, and after 10 years, you should expect to be able to go public with at least 1 of them that has outperformed 10 years in a row!) What happens to the funds that have outperformed several years in a row? They proudly announce their performances, advertise, boast, and collect more investments from outside investors. Their managers are supported by larger "research teams," appear better dressed and more "professional," and fly in executive jets. They are the ones that are most visible. Indeed, if you made money 10 years in a row in the stock market, would you not yourself believe that you have the ability to pick stocks?

Why funds' average historical performance looks good to you as an investor today.

Now put yourself in the shoes of an investor looking at the universe of mutual funds offered today. First, you won't notice funds that have performed poorly. They have already disappeared. Second, you will notice that the larger funds seem to have done better. On average, it will seem that currently available funds indeed can make you money—even if in the real world there is absolutely no ability. This phenomenon is called **survivorship bias**, because it means that you cannot consider the historical performance of existing funds to be a fair projection of their future performance.

If there was superior fund performance, the fund manager—not the investor—would profit the most.

Who gets the rents from trading ability? Even if the financial markets were inefficient and even if some fund managers could in fact systematically outperform the market, in a reasonable market, these fund managers would charge appropriately high fees to capture all the advantages that they provide to investors. After all, it is the fund manager who would have the scarce skill (picking stocks) and not the typical investor. Investors with money would compete to place money with such managers and accept higher and higher fund fees. In the end, it would be highly unlikely that uninformed investors could earn excess returns by investing in some manager's actively trading fund.

In sum, if you are looking for future performance, past performance may be your best guide. But always remember that recent past performance is still a very poor guide.

Many hedge funds are compensated on the upside. This does not solve investors' problem, but the alternative is no better.

Obviously, picking the right investment manager is not an easy task. Many mutual funds earn fees regardless of whether they make you money or not. Would it be better to have them participate in the upside (as is the case for hedge funds)? Maybe, but consider this: I give you stock tips, and I ask for money only if you make money. In fact, I only want 10% of your winnings. "You have nothing to lose." I only get something if I help you make money. Sounds like a deal? Now, if I pick a stock randomly, I have a 50-50 chance of making money. If you gain, I get something. If you lose, I pay nothing. In effect, I am arbitraging you! Remember, next time someone gives you a great stock tip, regard it with some skepticism: It probably has a 50-50 chance of being right. (Maybe I should give you the advice to buy a stock, and your neighbor the advice to sell it. This way, I will surely make money from one of you.) My only mistake is that I have told you my plan.

Dilbert on Management Books: 2013-06-30

The Three Top Investment Books of 1996

The three best-selling investment books of spring 1996 were David and Tom Gardner's *Motley Fool Investment Guide*, based on a popular investment website; Matt Seto's *The Whiz Kid of Wall Street's Investment Guide* (Matt Seto was 17 years of age at the time); and the *Beardstown Ladies' Common-Sense Investment Guide*, authored by septuagenarians whose first book mixed cooking recipes with investment advice. All touted "common-sense methods" to beat the market, earning 30% per year or more. Not a week went by without dozens of prominent radio and TV shows featuring their advice. Why does anyone need a Ph.D in finance? It is difficult to argue with performance!

Naturally, best-selling books are a great business. However, the stock performance of these three experts was not.

1. From 1996 to 2002, the *Motley Fool* recommended a number of hypothetical portfolios (now discontinued!). In 1997, they launched a real-money portfolio, called DRIP. From July 28, 1997, to July 31, 2002, it lost about 10%, while the S&P 500 lost 2.5% and NASDAQ lost 15%. One should not judge a fund by just 5 years of performance (and certainly not without risk adjustment), but it does appear that the *Motley Fool* has not exactly found the Holy Grail of investment opportunities.
2. Matt Seto stopped publishing his stock-picking performance and decided to pursue a career as a student.
3. The Beardstown Ladies, five books richer, were found to have miscalculated their returns: Their returns were not 30%, but 9%—significantly lower than the 15% turned in by the S&P 500 stock market index during their investment period.

How disappointing: On average, about one of them should have continued beating the market, one should have done about the same as the market, and one should have underperformed it. *Time Magazine, March 1998.*

The Empirical Evidence

You must realize that even top investors seem to have at most mild predictive abilities.

So what is the empirical evidence? In general, it suggests that fund managers' luck is far more important than their ability. Whenever academics (or the *Wall Street Journal*) have searched for better performance among analysts or professional fund managers who have outperformed in the past, they have found little or no exceptional forward-looking performance. Exhibit 12.4 shows a typical result in the literature: There were more funds that performed miserably than what we would have expected by pure chance. Fewer than half of the funds could beat the zero benchmark. And many fewer funds than expected by random chance did great.

Are there some persistently good performers at least?

But what about persistence? Maybe there are some funds that are better than others? True. But the empirical evidence is again disappointing. Only about 54% of mutual funds that have outperformed their benchmarks over the last 1-3 years tend to outperform their benchmarks over the following 1-3 years. This is better than 50%, but not by much. And if you subtract fund fees, the average performance drops significantly below 50%. As fund prospectuses so aptly note—and as the evidence suggests—*past performance is no predictor of future performance*.

Dilbert on past performance + hedge funds: 2013-04-17

Do Fund Managers Know?

There is a whole industry full of fund managers whose job it is to allocate assets to the actual investing funds. Chances are that your corporate pension fund will be managed by some. (So is mine. So is the UCLA endowment.) They of course all swear that they are immune to this, because they *know* which funds are better than others. Beside the occasional Madoff misstep, could they really tell? Goyal and Gupta (JF, 2008) look at 3,400 retirement plan sponsors from 1994 to 2003 and find that they were not particularly prophetic:

Nerdnote: There are some high-tech statistical techniques to take into account that researchers have searched, individually and collectively, for anomalies. This is beyond our scope.

what to expect →	Miserable (T < (–1)) Should be <16%		Average or Better (T > 0) Should be >50%		Great (T > 1) Should be >16%	
AUM	Before Fees	After Fees	Before Fees	After Fees	Before Fees	After Fees
< $5 million	22.4%	37.8%	48.2%	32.1%	**21.2%**	10.2%
–$250 million	25.0%	41.0%	44.8%	28.3%	17.4%	8.5%
> $1 billion	29.8%	45.0%	41.5%	28.3%	15.6%	7.9%

Exhibit 12.4: *U.S. Equity Mutual Fund Performance, 1984–2006.* This table looks at the historical performance of about 1,308 mutual funds, with an average of $650 million assets under management (AUM). You don't need to be too concerned about the details, but the T mentioned in the first row is similar to the T-statistic of the alpha that was mentioned in Chapter 10. A negative alpha and a negative T means underperformance. For example, the second line tells you that if monkeys had done the investing, you would have expected about 16% of the mutual funds to have a T as lousy as –1. In real life, 22.4% of mutual funds with less than $5 million AUM managed to perform as lousy before fees, 37.8% after fees. As a group, only the best small funds with AUM outperformed the random benchmark (21.2% had good performance, instead of the expected 16%), but fees negated this group advantage. Source: Fama-French, JF 2010.

	Years Relative to Hiring	
	–2 to 0	0 to +2
Fired Funds	–1.6%	+3.1%
Hired Funds	7.6%	+2.3%

They fire funds after they have performed poorly, not before they perform poorly. And they hire funds after they have performed well, not before they perform well. So why do these managers pretend that they can do a good job managing your money? Well, how much would you pay for a plan sponsor who admitted that it could not pick funds better than either you or a monkey?

For the most part, it seems that old-fashioned work and insurance (or liquidity) provision work better in earning returns than stock picking.

There are, of course, other ways to make money: Warren Buffett's fund, *Berkshire Hathaway*, for example, runs many businesses (e.g., insurance and aircraft), too. These businesses make money. But it is money earned the old-fashioned way—through hard work, liquidity provision, and risk-taking. Writing insurance is risky business, and it deserves extra return. Warren Buffett himself would of course not attribute his own performance to luck, but to his ability. Still, even he acknowledges that the efficient markets hypothesis is the most natural benchmark. He is on record as stating that "the professors who taught efficient market theory said that someone throwing darts at the stock tables could select stock portfolios having prospects just as good as ones selected by the brightest, most hard-working securities analyst. Observing correctly that the market was frequently efficient, they went on to conclude incorrectly that it was always efficient." Even Buffett is still a mild believer!

➤ Business of liquidity provision, Sect. 11.3, Pg.259.

Where should the burden of proof be?

In sum, most finance professors nowadays would agree that when one particular investor earns an unusual amount of money, even over a few years, it is usually more likely due to luck than to ability. The burden of proof is with the side that is claiming superior signals and investing ability—and a number of former finance professors have taken up the challenge and started their own funds. On the client side, if I were you, I would be very cautious investing my money with anyone who charges high fees.

IMPORTANT

Even in an efficient market, in which no one can pick stocks better than anybody else, with a very large number of investors, many will beat the market. A small number of investors will beat the market again and again.

In the real world, there is little evidence that investors who did well picking stocks in the past are better at picking stocks in the future when compared to investors who did poorly.

Q 12.19. If you want to determine whether fund managers have an ability to outperform the stock market, given that many of them are likely to beat the market, does it make sense to look for these high-ability managers among the better historical performers?

Q 12.20. If a firm employs 10,000 analysts, how many of them are likely to issue forecasts that beat the market 10 years in a row *if* none of them has any special ability and there are no transaction costs?

Q 12.21. Explain what survivorship bias is and how it manifests itself in the mutual fund context.

12.6 A Cynical Perspective

Buy Low, Sell High.

When fund managers earn great returns, they often become famous. To attract new investors, they then talk more about their performance. The first targets are easiest to find at cocktail parties and hedge fund conferences. Thereafter, it is usually admiring students in universities. A few lucky investors even go on to write books. Please read some of them. They all seem so sensible. All you need to do is to buy low and to sell high. Having sat through many presentations and having read many books, I can confidentally state that about half emphasize the "buy low" while the other half emphasize the "sell high." When I am in a good mood, I can fake admiration for their brillant investment insights. When I am in a bad or cynical mood, I offer ambiguous praise that amuses only myself. (These are our university donors, after all.)

Rat Selection

Unfortunately, even though genetic algorithms and artificial intelligence are rather sexy high-tech sophisticated ways to pick investment assets, true genetics and intelligence seem to have been somewhat neglected. Fortunately, Michael Marcovici has remedied this with his "I Trained Rats to Trade, and Win, on Wall Street" true laboratory experiments. Sure enough, a number of them outperformed. Unfortunately, their ability to present their superior ability to potential investors (and thus generate higher fees) is limited by their lacking eloquence.

Grandiose Claims and Dumb Excuses.

Most funds write monthly communiques to their investors. They are largely collection ex-post rationalizations and platitudes. Read some with an open mind. There are some patterns. Funds on the up often write about the credit they deserve for their brillant insights. They describe competitive advantages, signals, edges, exciting and smart strategies, sentiment reading abilities, contrarian acumen, etc. Funds on the down often write that nobody could have known; that Buffett did it, too; unprecedented market turmoil; irrational herd sentiments; unpredictability; temporary profit-taking; dollar averaging; the market failing to understand fundamentals; deteriorating data and decision making of others; fat-tail risk; dislocations; short-sellers; the Chinese, Russians, Saudis, Jews, or Arabs; the Fed doing too little or not enough, and so on. Yet, the simple fact is that neither is on target. Not the ups and not the downs. Most performance in financial markets is luck. In 2016, about a thousand hedge funds closed shop, usually because of poor performance. There are a lot of one-hit wonders among them (and, of course, about half as many two-hit wonders, and about a quarter as many four-hit wonders).

Academics are not so different.

We academics are not so different. John Oliver's May 2016 show on Scientific Studies explains it better than I can. I will try it anyway. If you read academic journals, you will find hundreds of papers showing how to beat the market. Just like fund managers, academics do not get rewarded for writing papers that opine "the markets are fairly priced." They get rewarded for writing papers that find that factor X had amazing returns. It's even better when the factor can be claimed to be behavioral—hedge funds and investors (our consulting clients) love irrational behavior stories. The problem is that even if each individual economist is (or were) scrupulously honest, as a collective, with thousands of us mining the data, we will find many factors that seem statistically significant, yet are entirely spurious. Most of the time, hedge funds try to replicate and further test the academic factors right after the first public posting. When they hold up, many academically oriented hedge funds start trying to exploit past patterns. They all slowly pile up into the factor as they backtest the factor, itself contributing to some further good performance. Virtually every academic equity fund is playing "value" and "momentum" in some strategy or another. And then, one day, they realize that they may have overreached and then all seem to want to withdraw roughly at the same time. This seems to have happened to so-called momentum strategies in 2009.

Intellectual Humility, please.

What about me? Am I not brillant? I placed large short bets on oil in 2013 when it traded above $100/bl. I believed long-term supply and demand could not sustain such a high price. In 2014, the oil price dropped below $50/bl, and made my oil bets my best bets ever. I had talked about this in 2013 to my colleagues, who are now admiring my foresight. It is easy to rationalize how smart and prescient I was. But it's really all non-sense. I don't like to bet on horses, I like to bet on financials. I placed a bet, pure and simple. Ex-ante, someone on the other side believed the opposite. I happened to win. In financial markets, it is easy to place bets and someone ends up winning. In this case, it was me. Does this make me a brillant investor? Or just a lucky one?

Asymmetric-Pattern Strategies

Not Understanding Profit Sources

But funds can wittingly or unwittingly seem even better than random gamblers. It is not difficult to show good historic performance. You can even do it on a roulette table. Just double up. Choose red, and when black comes up, try again and double up. When you have won, go home and record today's investment performance as a gain. With a lot of money, it is likely that you will have years of good performance without losses. Many funds unwittingly follow strategies with such payoffs. They make a little money most of the time until they have dramatically large losses. The 2008 Great Recession showed exactly this pattern for many strategies. Many investors (banks in particular) who had made small amounts of money for a long time suddenly lost it all. Writing options or making markets are other strategies that follow this pattern: modest returns most of the time, followed by a sudden large disaster. I don't think they even knew this and tried to deceive their investors. They just stumbled onto the "has made nice little money for a long time" investment strategy and followed it. My advice: be very skeptical about claims that someone expects to beat liquid financial markets.

It is difficult to be a contrarian.

The opposite of the usual pattern of hedge funds are strategies that lose money most of the time but then gain a lot in a crisis. These are strategies that are very difficult to maintain. Which investor wants to earn negative rates of return for years on end, while their peers are doing well? The bears on real estate in the first half of 2000 went out of business long before the Great Recession of 2007-8. Only a few very lucky investors managed to maintain their shorts—and, just as there are books by and about successful investors, there are movies about these lucky unicorns, too (in this case, The Big Short). Yes, in theory, you can offer a fund with a negative market-beta strategy with negative expected rates of return, because it provides great insurance. In practice, your investors will drift away when the market goes up, and withdraw their gains when the market goes down to cover their losses elsewhere. It's tough to bet against the market.

12.7 Corporate Consequences

How does the EMH matter to you if you are a manager? Does it matter whether financial markets are perfect, efficient, or neither? Because a perfect market implies an efficient market, you need to think about three different cases:

When creating value for your firm, there are three different market scenarios to consider.

1. The market is efficient and perfect.
2. The market is efficient but not perfect.
3. The market is neither efficient nor perfect.

These cases help you organize your thinking about what it takes to create value—which is *the* most important question if you are the CFO. Can you add value by changing your capital structure? Can you create value by splitting your shares, so that every share becomes two shares? Can you create value by paying out dividends next year rather than this year? Can you create value by changing how you present your earnings to investors? Can you create value by taking over other companies when they are priced too low if you do not have any unique knowledge or anything unique to add?

If the Financial Market is (Close to) Perfect

If the financial market is perfect, the answers to these questions are simple—they are always no. It does not matter how the firm communicates its earnings to investors, what its capital structure is, how many shares it has, how it pays out its dividends, and so on. In fact, you already know that the firm is worth the value of its underlying projects' present values. Everything else is irrelevant.

In perfect markets, all that counts are the firm's underlying projects.

Earnings reporting: For example, if you have previously reported your foreign division's earnings separately and now you consolidate them into your main earnings, you will indeed increase the firm's reported earnings. However, it will not create anything intrinsically valuable. Such a change should not add or subtract firm value. Your firm owned the subsidiaries' cash flows before and after its reporting change. Your investors can add or subtract the subsidiaries' numbers themselves, whether you include or exclude them in your overall report.

You cannot fool your investors by how you report your earnings.

➤ Do reported earnings matter?, Sect. 14.1, Pg.363.

Capital structure: For example, say your firm is currently financed with equity only and worth \$100, but if you had a 50-50 debt-equity ratio it would be worth \$102. In this case, an arbitrageur could buy your firm, issue \$51 in debt and \$51 in equity, and pocket \$2. With legions of entrepreneurs competing to do this, your firm value would instantly adjust to \$102. Thus, a \$100 price for your firm would be absurd.

There must be no value to changing capital structure.

➤ Capital structure arbitrage, Sect. 17.2, Pg.459.

Stock splits: In a stock split, each old share becomes multiple new shares. For example, if each share trading at \$80 were to become two shares, the new shares should trade for \$40 each in a perfect market. Nothing fundamental about your underlying projects would have changed. Splitting by itself cannot add value. If this were not the case—for example, if shares would be worth \$41 each after the split—arbitrageurs would buy the old shares for \$80, and sell them an instant later for the equivalent of $2 \cdot \$41 = \$82$, pocketing \$2.

Stock splits must be irrelevant, too.

➤ Stock splits, Sect. 20.2, Pg.568.

Dividends: The same argument applies to dividends. In a perfect market, a \$100 firm that pays \$10 in dividends should be worth \$90 thereafter—no value is magically created or destroyed. Keeping the money for another year in the marginal zero-NPV investment (e.g., Treasuries) is as good as paying it out. Investors in a perfect market can borrow against this extra future money and use it today.

Still trying to fool investors, this time with dividends? Fugeddaboutit.

➤ Stock dividends, Sect. 20.2, Pg.568.

The lesson is simple: As a manager, you should forget about the smoke and mirrors and instead focus exclusively on finding and executing projects with positive net present values.

If the Financial Market is Not Perfect but At Least Efficient

An efficient market means "the price is right." Thus, you can learn from your own market price.

If markets are not perfect but efficient, the implications are not as profound. However, it means that you can still obtain valuable market intelligence. Your market price is the aggregate assessment of many investors who have put their money where their mouths are. The market price aggregates a whole lot of information that you as a corporate manager may not learn as easily yourself. For instance, if your stock price seems very high relative to current fundamentals, it probably means that the market sees great opportunities ahead for your firm and expects that you will take them. Thus, you should consider growing the business. Naturally, a high firm value allows you to raise more funds from the financial markets at favorable rates. On the other hand, if the stock price is very low, it probably means that the financial market anticipates your business to go down or expects you to waste the remaining money. In this case, you should think carefully about whether you should reinvest investors' money into the business or into repurchasing the (relatively cheap) stock.

You can also learn from other market prices.

In addition to learning from your own company's market price, you can also learn from all sorts of other market prices. You can find out how good your competitors' opportunities are, and whether you should get into the fray. Commodity price information can also be very helpful. If the price of oil in the forward market is \$100/barrel, it probably does not make sense for you to plan ahead based on an oil price of \$70/ barrel. The financial market price for oil forwards is very large and efficient. It makes no sense for you to plan your business around much lower or higher oil prices in 6 months, simply because if you really knew this better, you could get rich easily without needing any of your current businesses—just start trading oil futures. This may sound obvious, but it is sometimes easy to overlook the obvious in the heat of battle. For instance, a large conglomerate oil company in the 1990s planned to explore for more oil, based on a working assumption of doubling oil prices within two years. This company could just have purchased oil in the market instead of drilling. Why explore for oil if you can buy oil cheaper in the market? If you are a farmer planting, the futures exchanges provide you with forward prices for corn and wheat, and you can use this free price information to help you decide which crop to plant.

Personal opinion alone (without synergies) is not a good argument for taking over other companies.

Let's consider a specific example of how you can learn from market prices in an efficient market. Put yourselves in the shoes of a smart and successful manager of an aircraft manufacturer. Every morning, you read the newspaper, and every morning you think that company X should really be worth a lot more. It makes no sense to you that X has annual earnings of \$10/share but its shares are trading at only \$50/share. X just seems undervalued. Should you go out and buy it? If the market is perfect, the answer is no. You would have no competitive advantage in owning X. The hordes of arbitrageurs could have accomplished it in an instant, and less expensively than you ever could. On the other hand, owning X would not do any harm, either. But let's take away the perfect market assumption and leave only the efficient market one. This means that both your aircraft company's price and the price of X are correct. Buying X because you think that X is undervalued is likely to be wrong. After all, our working assumption is that the financial markets have used all available information to find the best possible price.

However, in an imperfect market, it is possible for an acquisition to add value...

However, in the absence of perfect markets, the efficient market does not mean that you should never be able to create value by buying other companies. You can indeed sometimes create value. The trick is that you must be able to do something that investors cannot do for themselves, because the market is imperfect. Most likely, this would be related to your business's real operations. For example, if X is a supersonic aircraft parts supplier, you may have better information about the supplier's product. You may know that you will reward it with a huge contract soon. Or, by owning the patents of this supplier, you may make it more difficult for other aircraft companies to compete with you. Or you may find cost savings by cutting out the middleman in purchasing these parts, or improving X's products through your own intellectual capital, or by increasing the scale of operations. All of these can add value to the firm—value that

outside arbitrageurs cannot accomplish without you. (This violates the infinitely many potential buyers assumption of a perfect market.)

But be careful: Market efficiency means that you cannot create value for your shareholders simply by your personal view that X is undervalued. Yes, you may be smart, but the financial markets are just as smart and presumably could recognize just as well whether X is undervalued—in fact, chances are that the target was rightly valued to begin with and it was you who got the target value wrong. For example, if X manufactures diapers, it is highly unlikely that you would create value for your shareholders, even if the firm is trading for only 5 times earnings and this makes no sense to you.

...as long as you have more than just an opinion that the market got prices wrong.

The same argument applies to all sorts of other corporate actions. You may be able to create value by reducing perfect market barriers. For example, you may be able to create value by reducing the costs with which investors can trade your shares (e.g., by listing on an exchange). Or you may be able to reduce the mistrust that your investors have in your creditworthiness by hiring a good auditor or by reporting your earnings in a transparent fashion. Indeed, there is evidence that many corporate activities can create value by reducing the perfect market frictions, even in very efficient financial markets. For example, when firms split their shares 2-to-1, it is not necessarily the case that the two post-split shares are worth exactly half of the pre-split share of, say, $80. Instead, they tend to be worth a little more, say, around $40.20. The likely reason is that managers signal their confidence in the future by splitting shares today. This brings more information to the market.

In an imperfect market, you can also create value with financial transactions that reduce market imperfections.

➤ Splits as signals, Sect. 20.4, Pg.580.

If the Financial Market is Not Even Efficient

Loosely speaking, financial markets tend to be reasonably, but not always perfectly, efficient. Perfect market efficiency is almost surely *not* a good description of reality. Even in a perfectly rational market, as an executive, you may know the firm value better than the market—for example, you may know that your company is about to sign a large contract, but this information cannot yet be disclosed. What should you do if you know that the stock price is not equal to the appropriate market value? The right way to conceptualize your problem is to consider what you would do if you were the sole owner of the firm. You would really care about firm value. (As its executive, you should want to maximize this value on behalf of the owners.)

What should you do if markets are not efficient?

➤ Strong market efficiency, Sect. 12.2, Pg.290.

If your shares are undervalued, you should recognize that your cost of capital is effectively too high, given the true characteristics of your project. The reason is that you cannot raise risky capital at fair prices—especially equity capital. The CAPM clearly is no longer the right model for the cost of capital.

If you are undervalued, sometimes it is better to pass up positive-NPV projects...

For example, assume you know that your current projects will return $500 tomorrow. Also assume that you have no cash and that you can only raise financing through equity. Now assume you come across a new project that costs $100 and will return a terrific $200 tomorrow. The problem is that your investors do not believe that the firm will return $700, falsely believing that the combined firm will only be worth, say, $200. Thus, to raise $100, you would have to sell 50% of your firm, and keep only 50% of the true $700 return, for a true $350 share of it. You would therefore be better off passing up this new project and just taking the $500 from the old project. Put differently, the opportunity cost of new capital to fund this project is way too high for you.

➤ Separation of financing and investing, Sect. 11.1, Pg.251.

...and use your cash to repurchase your own shares.

You would definitely not want to raise cash at these "high" prices. Instead, you would want to do the opposite. The best use of corporate cash may now be to repurchase your own cheap, underpriced shares—for example, from other investors. However, there is an intrinsic paradox here: As an executive, you are supposed to act on behalf of your shareholders. Therefore, repurchasing underpriced shares from them at bargain prices would not be what would make the selling shareholders better off. (It would, however, make your remaining shareholders better off.)

➤ Share repurchases, Sect. 20.2, Pg.568.

If you are overvalued, sometimes it is better just to issue more shares.

If your shares are overvalued, your cost of capital would be very low. You should be tempted to take more projects. This is easiest to see if you again consider what you would do if you were the primary owner of this overpriced firm. You would want to sell more equity shares at higher prices and pay the money out in dividends to existing shareholders. (Alternatively, you can just invest in Treasury securities.) Here the paradox is, of course, that just one instant later, as CEO, you are now the representative of these new shareholders to whom you have just sold overpriced shares. They will not be happy campers. (Many researchers believe that this is exactly what happened when AOL purchased Time-Warner at the height of the Internet craze in the late 1990s. AOL used its overpriced shares to buy Time-Warner's real assets.)

These are robust insights for CEOs who are not conflicted and wish to act on behalf of their existing shareholders.

IMPORTANT

When managers have superior information:

- If the firm is undervalued, CEOs should assume a relatively high cost of capital and consider repurchasing the firm's own shares.
- If the firm is overvalued, CEOs should assume a relatively low cost of capital and consider issuing more of the firm's own shares.

A good decision rule for managers is to take projects up to the point where the marginal costs and benefits of projects are the same as what they could obtain from repurchasing or issuing the firm's own shares.

➤ Overconfidence, Sect. 13.7, Pg.347.

(It can become a bit more complex if you see yourself as a representative of both new and old shareholders, though.) But be careful: Most executives are notorious for *always believing* that the financial markets do not fully reflect the value of their companies even if they have no inside information—as an executive, you should be wary of your own perceptions and biases!

Q 12.22. For convenience, assume a zero discount rate. You have no cash on hand and can only raise financing for new projects by issuing more equity. You know that your existing project will truly return $500 next year. Everyone knows that your second, newer project costs $200, but only you know that it will return only $180 next year. This newer project is the only one that investors think is in line with your current expertise—you cannot raise funds and deposit them elsewhere (or any new investors would smell a rat).

1. Does your second, newer project have a positive or negative NPV?
2. If your investors know both true projects' costs, but they also (incorrectly) believe that you have the magic touch and any of your expertise projects will earn a rate of return of 100%, what fraction of the firm would you have to sell to raise $200 to start the new project?
3. If you act on behalf of your existing investors, should you take this new project?

Comparison and Summary

Here is a summary of the two conceptual classifications of how markets work:

A summary of the two market concepts and their consequences.

Efficient versus inefficient markets: If the market is efficient, you can learn from financial market prices, because they accurately incorporate the information of financial market participants. This means that you cannot create value by buying other companies just because you think that these companies are worth more than they are trading for.

If the market is inefficient, you may be able to identify underpriced firms that you can take over, or even create value by working on how information about your own company comes to the market.

Perfect versus imperfect markets: If the market is perfect, you can focus exclusively on your projects' net present values. You can forget about most financial choices, such as what your capital structure should be, how you should report earnings, and so on.

If the market is imperfect, you can create value, often by reducing the market imperfections themselves. For example, you could signal what you know about your company's prospects by reporting earnings sooner. On occasion, this can even become a dilemma: For example, what should you do if you know that a project has a positive NPV but the financial market does not believe you? If you take it, your stock price may go down. Now you have to think about the lesser of two evils—passing up on the project, or passing up on a higher stock price.

Don't be too dogmatic: Nothing is perfectly perfect, or perfectly imperfect.

In the real world, financial markets are definitely not 100% perfect. For large firms, they are very close to efficient, but this is not necessarily so for small firms. Still, the economic magnitudes of deviations should be fairly modest. As a real-world manager of a publicly traded corporation, it is generally better for you to focus on underlying value creation than on actions that investors can accomplish for themselves without you. It makes sense for you to believe that market prices are almost always informative, but not to believe too slavishly that they are also always fully efficient—you may have better information than the market. Use it wisely when you have it.

12.8 Event Studies

Market reactions should be immediate and reflect all value changes.

The immediacy of price reactions in any efficient market offers a surprisingly useful real-world application: In some cases, market price reactions can allow you to estimate value consequences more easily than traditional NPV techniques, using a technique called an event study. An **event study** is an empirical analysis of the effect of a set of events on the price of assets. The idea of an event study is that if the public market is valuing projects appropriately, and if the value of an unexpected event or action is $1 million, then the stock price should increase by $1 million at the instant the event becomes publicly known. You can therefore (often) back out cash flow value changes from stock price changes. The details of how to conduct such a study are in the appendix.

Capital-Structure-Related and Other Event Study Results

Event studies have been used on many different events. In finance, they often tell us whether corporate actions are good news.

Researchers have run event studies on all sorts of interesting events, ranging from new legislation, to corporate name changes, to analysts' opinions, to corporate earnings, to stock splits, to corporate dividends, to corporate debt and equity issuance and retirement, to deaths of the founder, and so on. Here are some of the more important findings. (You will see some more evidence obtained from event studies again in later chapters, especially in the chapters on capital structure and payout policies.) On the day of the announcement, firm values *increase* on average:

- When firms announce increases in dividends, share repurchases, or stock splits (by about 0.1-1%; if you are interested, there is a longer explanation in Chapter 20).

- When firms are taken over by other firms (by about 10-30%).
- When firms announce earnings that significantly beat analysts' expectations.
- When drug firms announce that the FDA has approved one of their drugs.
- When the founding CEO dies (by about 3-4%).

Bad news...

Conversely, firm values *decrease* on average:

- When firms announce new stock sales (by about 1-3%).
- When firms overpay for other firms in acquisitions.
- When firms announce lower-than-expected earnings.
- When firms fend off an acquirer who has made a bid.
- When drug firms announce that the FDA has rejected one of their drugs.

Unfortunately, because we do not know the markets' probability assessments prior to these announcements (some of the effects would have already been anticipated and thus already incorporated in the stock price), these value estimates are conservative lower bounds.

Government Regulation—who benefits? who does not?

Event studies have also informed us whether certain government regulations had a positive or negative impact on firms. For example, we know which firms were helped and which were hurt when the telecommunications, trucking, and airline markets were deregulated—or how the Treasury's rescue program of 2008 ("TARP") helped some banks, but not others.

The Effects of Sanctions on South Africa

South Africa's apartheid regime (1948–1994) rightly deserved to be overthrown. To accelerate its demise, the U.S. Congress imposed banking and tax-related sanctions on firms doing business with South Africa's apartheid regime.

We may all wish we could report success—that sanctions on South Africa's racist regime had been effective. Unfortunately, the event study evidence clearly shows that sanctions played no economic role. Upon the announcement of new sanctions or corporate divestments, neither prices of targeted U.S. companies nor of South African financial securities moved. One explanation is that there were too many loopholes and non-U.S. firms that were willing and able to evade the embargo.

Although we can conclude that, despite all its publicity, the embargo was largely ineffective economically, sanctions may still be appropriate on moral grounds regardless of their economic effectiveness. Whether to boycott socially objectionable behavior is a decision that policymakers should make, not economists. The role of the financial economist is only to inform policymakers of the ultimate effectiveness of their actions. Even this one failed on the economic effectiveness benchmark.

Teoh, Welch, and Wazzan, Journal of Business, *1999.*

Q 12.23. In a perfect market, what kind of response ("unusual" stock price change and "unusual" rate of return) would you expect when your company announces that it has struck oil and plans to pay a special dividend next month? What reaction do you expect over this month? What reaction do you expect on the day that it pays the dividends?

Q 12.24. What kind of corporate events are greeted as good news by the financial markets? What events are greeted as bad news?

Summary

This chapter covered the following major points:

- Market efficiency means that the market uses all available information in setting prices to offer "appropriate rates of return."
- In the short run, the appropriate expected rate of return on stocks must be small. Therefore, market efficiency prescribes that stocks roughly follow random walks.
- In the long run, it is rarely clear what this "appropriate rate of return" should be. Because noise makes it difficult to measure the average rate of return accurately, it is also difficult to test either models like the CAPM or long-run market efficiency.
- Beliefs in efficient markets come in different forms.
  - The standard efficient markets classification emphasizes what information it would take to beat the market: weak form (past stock price patterns are not enough to beat the market), semistrong form (other historical firm information is not enough to beat the market), and strong form (inside information is not enough to beat the market).
  - A more current efficient markets classification emphasizes the rationality of the stock market: true believer (stock prices always reflect underlying project NPVs), firm believer (small deviations between price and value, but difficult to take advantage of), mild believer (small deviations between price and value, and somewhat possible to take advantage of), or nonbeliever (arbitrage opportunities abound).
- The overall evidence suggests that it is not easy to become rich—a belief shared by most finance professors. The relative strength of their beliefs in market efficiency—the extent to which professors believe that market prices always reflect underlying value—separates finance professors into "rationalists" (or "classical" economists) and "behavioralists."
- In a perfect and efficient market, investors should not find arbitrage opportunities:
  - True arbitrage is a riskless bet with no negative net cash flows under any circumstances. Everyone would like to take all true arbitrage opportunities. When and if they appear, they are likely to be very small.
  - Risk(y) arbitrage is more like a great bet. An infinitely risk-averse investor would not want to take it, because there is a chance that risk(y) arbitrage will lose money.
  - Both true and risk(y) arbitrage opportunities should be very rare in the real world. An investor who is not too risk-averse may or may not prefer taking one large, great bet to taking one tiny, true arbitrage.
- Given the millions of investors, many will beat the stock market by chance, and some investors will beat the stock market many years in a row. Market efficiency does not mean that there are not some investors who will beat the stock market 10 years in a row *ex post*; rather, it means that any one particular investor is unlikely to beat the stock market *ex ante* 10 years in a row.
- Managers can learn valuable information from market prices, both from their own share prices and from other prices. To improve corporate firm value, managers must create fundamental value—they must undertake positive-NPV projects. Simple activities such as purchasing a random firm to lower risk or splitting shares will not add value.
- Event studies allow you to ascertain the corporate value impact of sharp events, such as election results, legislative action (FDA rulings), or corporate events (dividend increases).

Preview of the Chapter Appendix in the Companion

An online appendix illustrates a specific event study—the value relevance of the elections of 2006 for the overall market, health care stocks, and oil stocks. It explains the limitations of event studies—specifically, how it is important to take out the *expected* events and focus only on the unexpected, i.e., the real news.

Keywords

Behavioral finance, 289. Bid-ask bounce, 300. Brownian motion, 293. Classical finance, 289. Due diligence, 288. EMH, 289. Efficient market hypothesis, 289. Efficient, 283. Event study, 313. Fundamental trading, 290. Futures contract, 288. Great bet, 298. Market efficiency, 283. Noise trader, 290. Noise, 292. Random walk, 293. Rational economics, 289. Risk(y) arbitrage, 298. Semistrong market efficiency, 290. Signal, 292. Signal-to-noise ratio, 292. Spurious, 290. Strong market efficiency, 290. Survivorship bias, 304. Technical analysis, 290. True arbitrage, 297. Volatility, 292. Weak market efficiency, 290.

Answers

Q 12.1 The "efficient market" phrase is shorthand for "the market uses all available information in the setting of its price." There are further nuances about what "available" means, which creates different classifications of market efficiency.

Q 12.2 As a believer in market efficiency, you would point out that the heretics are wrong in how they measure the risk-reward trade-off (the model for what expected rates of return should be). Your second line of defense would be to ask the provocative question of why the heretics are not yet rich. (Of course, you would have to claim it was by pure chance if the heretic that you are talking to *is* rich.)

Q 12.3 Market efficiency is a much more powerful concept over short horizons, because the expected rate of return over a short horizon (say, a day) is very small (a few basis points) in virtually all reasonable models of market pricing.

Q 12.4 An efficient market is one in which the market uses all available information. In a perfect market, market pressures by arbitrageurs will make market efficiency come true, so a perfect market should be efficient. However, an efficient market need not be perfect. For example, stocks could be priced fairly even when there are taxes.

Q 12.5 Markets are more likely to be efficient when transaction costs are low, because this makes it easier for smart investors to compete away any unusual opportunities.

Q 12.6 The foreign currency market may well be the biggest market in the world, with the dollar and the euro being the world's two main currencies. With so many smart investors trading on the exact same instrument, and with incredibly low transaction costs, we would expect arbitrageurs to take advantage of even the smallest inefficiency. Thus, it would seem likely that the foreign exchange market is much more efficient—and much closer to perfection than, say, U.S. stock markets.

Q 12.7 Momentum strategies seem to violate even weak-form market efficiency—unless you believe that their returns are just normal because they reflect some sort of normal compensation for risk.

Q 12.8 If you believe that market values do not always perfectly reflect underlying fundamental values, but that trading costs nevertheless prevent you from exploiting this profitably (in large scale), then you should classify yourself as a firm believer in market efficiency.

Q 12.9 The random-walk formula is on Page 293. It states that the expected price tomorrow is the price today plus a drift. The drift can be a small constant or a very small fraction of the price today.

Q 12.10 There are about 250 trading days per year. More accurately, it is 252 on average. If a stock has an expected rate of return of 20% per year—which is definitely on the high side for most firms—the daily rate of return would be $1.2^{1/252} - 1 \approx 7.24$ basis points. If you computed the non-compounding $0.20/252 \approx 7.84$ basis points, or even used 365 calendar days instead of 252 trading days, you would still get a reasonably similar answer—the average daily rate of return is very small.

Q 12.11 A *daily* trading strategy would have to offer above 20% per annum in order to overcome typical transaction costs. The calculation in the text came to about 23% per annum.

Q 12.12 The typical movement (variation) of a stock is around plus or minus 2% to 3% a day. The average rate of return on a day is much lower. Thus, the signal-to-noise ratio is very low.

Q 12.13 Even if the stock price follows a random walk, its actual price can definitely—and most likely will be—different from today's. Only the *expected* price is the same as the price today.

Q 12.14 If you want to be a superstar trader who outperforms by, say, about 4% per year, you would have to earn an extra $\sqrt[252]{1.04} - 1 \approx 1.6$basis points per day.

Q 12.15 With 100 basis points per day of noise and 200 basis points per year of excess performance:

1. With 1 day's performance, you would expect $200/252 \approx 0.794$ basis points per day.
2. The noise was given as 100 basis points per day.
3. The expected T-statistic is about $0.794/100 \approx 0.00794$.
4. Over 252 days, the performance was given as 200 basis points.
5. The noise would be $100 \cdot \sqrt{252} \approx 1,587$ basis points.
6. The expected T would be about $200/1,587 \approx 0.126$.
7. You need to solve $(0.79 \cdot N)/(100 \cdot \sqrt{N}) \geq 1.96$, or $0.0079 \cdot \sqrt{N} \geq 1.96$. The critical N is approximately 250 years.

Q 12.16 No! Treasuries earn money without risk, but they are not an arbitrage, because investing in them requires a negative net cash flow upfront.

Q 12.17 If the true arbitrage opportunity can only be done once and gains \$10, it is probably worse than a risk(y) arbitrage that loses 1 cent with 1% probability, and gains \$1,000,000 with 99% probability.

Q 12.18 Good topics to consider when thinking about how plausible an arbitrage is include: time and execution risk, direct and indirect transaction costs, price impact of trades, and fixed costs.

Q 12.19 Yes, it makes sense to look for high-ability managers among historical high performers. However, many high-ability managers will have underperformed historically, and many low-ability managers will have outperformed historically.

Q 12.20 If each of the 10,000 analysts has a 50-50 chance to beat the market in any given year, then the answer is that $10,000/2^{10} \approx 10$ analysts beat the market 10 years in a row.

Q 12.21 Survivorship bias means that you, as an investor, will only see the funds that were ex post successful. Most unsuccessful funds do not show up in the historical statistics of funds in existence today. Existing funds will therefore have had positive performances in the past.

Q 12.22

1. This project has a negative NPV, $-\$200 + \$180 = -\$20$, at the zero interest rate. (A positive interest rate would make it even more negative.)
2. If you do take this second newer project, all your investors would believe that your firm would be worth $(\$500 + \$200) \cdot (1 + 100\%) = \$1,400$. To raise \$200 in funding, you would therefore have to sell $\$200/\$1,400 \approx 14.286\%$ of your firm.
3. The true value of your firm will be $(\$500 + \$180) = \$680$, and the 14.3% stake is worth only \$97.14. Put differently, your old investors have just sold a \$180 project for \$97.14, giving them a net profit of \$82.86. You can also compute this directly: Your old investors will therefore own $(1 - 14.286\%) \cdot \$680 \approx \$582.86$. This is \$82.86 more than the \$500 that they would own if you did not take the new project. You should take it if you are acting on behalf of the existing investors.

Q 12.23 The immediate share price response to the news that you have struck oil would be positive. Over the following month, you would not expect any unusual upward or downward drift: It should be about zero. Finally, when your firm pays out the special dividend, the rate of return should be zero on average, too, because the market would have known that the dividend would be paid. Of course, its share price will have to drop by the amount of the dividend paid to keep the return around zero. Chapter 20 explains how this may not be the case in the presence of market imperfections, especially personal income taxes on dividend payouts.

Q 12.24 Good news: becoming an acquisition target; the announcement of new dividends, share repurchases, and stock splits; earnings significantly higher than analysts' projections; FDA approvals; and CEO deaths. Bad news: Acquiring other firms at too high a price; the issuance of new equity stock; earnings significantly lower than analysts' projections; declining an acquirer's bid; and FDA rejections.

End of Chapter Problems

Q 12.25. What kind of evidence would heretics against market efficiency ideally want to muster? If they fail to find this kind of evidence, does it mean that you should conclude that markets are efficient?

Q 12.26. Define "efficient market" and explain how it differs from a perfect market.

Q 12.27. Peter Lynch, a famous former fund manager for Fidelity, suggested that it is wise to invest in stocks based on "local knowledge"—you invest in the stock of your local supermarket if you notice that it does better than expected. In an efficient stock market, is this a wise recommendation?

Q 12.28. Evaluate the following statement: It does not matter what portfolio you are holding in a perfect and efficient stock market.

Q 12.29. A paper by Frieder and Zittrain looked at a large sample of spam email touting a particular stock. Such distributions increased the trading volume and resulted in a 4–5% gain over the 2 days following the spam release. Is this evidence against market efficiency?

Q 12.30. What are the three main categories in the traditional market efficiency classification? Give an example of what each excludes.

Q 12.31. Comment on the following statement: "An efficient market seems like an impossible concept. In an efficient market, no one can earn excess returns. Therefore, no one collects information. Therefore, prices do not contain information, and collecting information should earn excess returns."

Q 12.32. Describe the fundamentals-based classification of the strength of belief in market efficiency. Explain how one individual can be at one level but not in the level above or below.

Q 12.33. Does a random walk imply that the expected rate of return on a stock is zero?

Q 12.34. Define arbitrage. How is it different from a great bet? Is one always better than the other?

Q 12.35. Would it make sense for a model of the financial world to assume that there is no arbitrage? Would it make sense for a model of the financial world to assume that there are no great bets?

Q 12.36. Assume that the typical day-to-day noise (standard deviation) is about 100 basis points. Assume that you have the kind of stock-picking ability that earns you an extra 400 basis points per annum. Assume no transaction costs. Ignore compounding and assume that your rate of return is the sum of returns over trading days. Assume there are 252 trading days per year.

1. With only 1 day of performance, how much extra do you expect to earn per day?
2. How bad is your noise over 1 day?
3. What is your expected T-statistic (the excess mean divided by the standard deviation)?
4. With 252 trading days of performance, how much extra do you expect to earn per annum?
5. How bad is your noise over 252 days?
6. What is your expected T-statistic now?
7. Work out how many years you would expect to wait before you would obtain statistically significant evidence to prove that you have a positive ability to pick stocks.

Q 12.37. What kind of costs should you consider when evaluating whether an opportunity is an arbitrage?

Q 12.38. The typical hedge fund investor evaluates its fund based on the most recent three years of performance. What do you think of this practice?

Q 12.39. Why does the average mutual fund in the market today appear to have been a great performer? Does this evidence suggest that these funds will be good performers in the future, at least on average?

Q 12.40. Do you expect fund managers with high ability to prefer compensation that is more performance based? How good an "insurance" is this for fund investors?

Q 12.41. If a corporation acquires another firm, it can lower the firm's uncertainty. This should lower its cost of capital. This should create value. Is this correct?

Q 12.42. Give an example of how the cost of capital for taking a project can be too high if the market has undervalued your firm.

Q 12.43. For convenience, assume a zero discount rate. You know that your current projects cost $400 today and will truly return $500 next year—but your investors believe they will return only $400. In addition, you have no cash on hand and can only raise financing for new projects by issuing more equity. A new project costs $200 and will return $220 next year. Your investors mistakenly believe that your firm will earn an internal rate of return of 0%, either with or without this new project. Acting on behalf of your existing investors, should you take this project? Does it have a positive NPV?

Data and Programming for Masters Students

The SEC provides the full text for insider and institutional holding data, as well as for mutual fund holdings. However, the data are not parsed into an easy-to-process panel data set. (Zacks, Morningstar, and others provide such panel data, but they are very expensive.)

The first two tasks are looking at the performance of a number of investment portfolios. The method to do so was discussed on Page 243 in Chapter 10. Reread the discussion there first.

Task A: First, calculate the monthly rates of return on low-momentum stocks and high-momentum stocks. Assume low-momentum stocks are those that underperformed the market by more than 10% from 13 to 2 months earlier, and high-momentum stocks are those that outperformed by 10%. This is known without delay, of course.

Now plot the performance of these portfolios over the last 30 years. Which one was a better investment? Which one was a more risky investment?

Does it matter whether Januaries are included or not?

Task B: Plot the compounding monthly time-series performance of a "high-ROA" portfolio and of a "low-ROA" portfolio. For definitions of what entails high- and low-ROA stocks, use the accounting definition. Did high ROA companies offer higher average rates of return than low ROA companies?

Task C: Investigate whether you can reject that prices today are first and foremost forecast best by prices yesterday. Use a market index, like the S&P 500. What happens when you run a regression of tomorrow's price on today's price? Is the intercept about zero and the slope coefficient about 1?

It turns out that regression estimates can be misleading when an independent variable is not exogenous, but itself a lagged value of the dependent variable. Don't believe me? Try the following. Draw a placebo data set of T=100,000 days, which you generate first from a known process, such as $\log(P_t) = \log(P_{t-1}) + \epsilon$ or even simply $P_t = P_{t-1} + \epsilon$. Now run the same regression of tomorrow's price on today's price. If you had a good and unbiased estimator, the intercept should be about zero and the slope coefficient should be about 1. Try it.

Task D: Draw 100,000 random analysts with on-average superior forecasting power: Each analyst i is a normally distributed draw with an alpha of 50bp/year above the index, but with a standard deviation of 200bp/year. Then, each analysts draws her annual portfolio rate of return that is $N(12\% + \alpha_i, 30\%)$. After 5 years of observation, count the number of funds in which the analyst outperformed their benchmark with a T-statistic of 2 or more. Repeat the same exercise in another case in which the alpha mean shift is not 50bp but 0bp on average. The "power" of a test is how good your 5-year $T > 2$ test is at discriminating among the two cases. How powerful is it?

Task E: Eventstudies rely on market efficiency and sharp surprises to assess the economic effects of a change. They are common tools in management consulting and expert witness work. Here is an example: Show what happened to small stocks on the night that Trump defeated Clinton? What happened to healthcare stocks on the night that Trump defeated Clinton? To coal stocks? (Note: Ken French provides industry portfolio returns!)