

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 (like Warren Buffett)? 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 Definition of Market Efficiency

A perfect market sets up stiff competition among many investors. This state of affairs 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. This is the **Efficient Market Hypothesis (EMH)**.

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 based on the use of *all* available information. (PS: It is not necessary that any one investor has all the information.)

Warning: Market efficiency is a different concept from mean-variance efficiency (the efficient frontier), which is used in the context of portfolio optimization. Economists love the word “efficiency” and thus use it in too many contexts.

► [Mean-variance efficiency](#), § 8.2, Pg.192.

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

Figure 12.1 illustrates the efficient-market concept. Suppose investors consider 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 value tomorrow is really \$60 (for an expected rate of return of 20%) or \$40 next year (for an expected rate of return of -20%). If you could find information telling you with good confidence that a better estimate of next year's price is \$60 (or \$40), then ABC's stock would be mispriced. A market that has overlooked your information would not be deemed efficient. (Your obtaining this information would, over time, become quite profitable for you.)

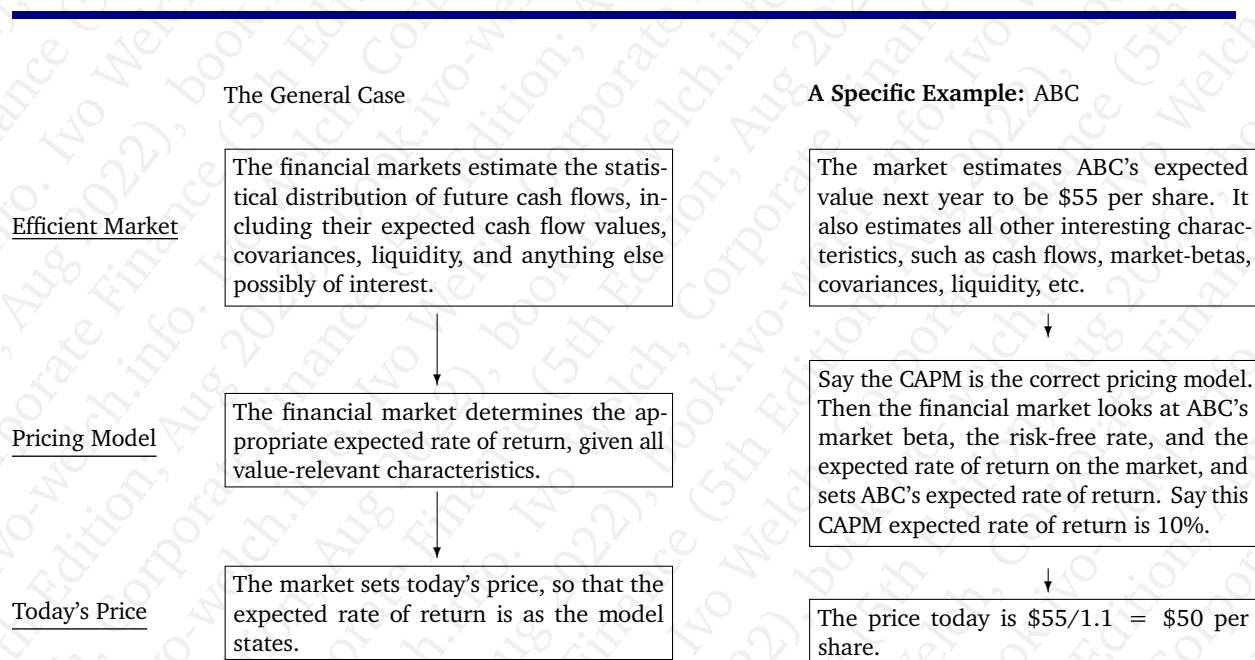


Figure 12.1: Market Efficiency and Pricing Model. The critical question is *If you saw a price of, say, \$45.83 today, what would you conclude has gone wrong? Is it the market or the model?*

What is the model? What is the information set?

The practical use of the “efficient markets” concept raises 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 a rather miserable 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 government will open a fraud 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.

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.

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. As you saw in Chapters 9 and 10, benchmarking stocks to peers is a reasonable method that does, but its empirical reliability is modest. (And the CAPM is empirically simply wrong, despite its great intuition). Simply put, pick any stock, say ABC. We are not sure and cannot agree whether ABC should earn 10%, 20%, or 30% a year. This ambiguity renders market efficiency a concept that itself in practice often evades empirical testing. It is also why market efficiency is sometimes (perhaps unfairly) derided 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.

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 million 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 big U.S. financial markets are, 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

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

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

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

Okay, let me qualify this for long horizons.

😊 Exception: crypto bros

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.

Practically useful?
Definitely yes over short
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.

[Dilbert on Predictability of Noise:](#)
2013-01-05

- 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.

Important

Relation to Perfect Market

Perfect market \Rightarrow 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, it would be too easy to get rich. Too many smart investors would trade and the inefficiency would disappear. Market prices would instantly adjust to prevent this from happening. Therefore, if a market is perfect, it is inevitably also efficient.

Efficient market \Rightarrow 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 — also 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 do not wish to trade further. Appropriately weighted by investment amounts, 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 be efficient.

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. (The other three assumptions may prevent exploiting it.) 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 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.

Efficient market is a weak facsimile of “same information.”

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.

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

☹️ or, it ain't easy getting rich unless you win the lottery or inherit...

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 [where a large number of traders are located] has a small influence on stock returns. Some papers claim it does, so that the market is inefficient. Others dispute this assertion, claiming the historical correlation is spurious and disappears if the statistical tests are done correctly. All agree that the weather influence is small, however.)

Investor competition pushes markets toward efficiency.

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, after you have run a few regressions, say 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

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

➤ [Shorting stocks, § C, Pg.176.](#)

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?!) Their economic self-interested behavior adds to the pressure in driving markets toward efficient pricing, even in a market that is imperfect.

Important

- If a market is perfect, market forces should drive it strongly and quickly toward efficiency.
- If a market is not perfect, market forces should still drive it toward efficiency but not as powerfully. Third-party traders with higher transaction costs may not be able to aid in the process.

Market Efficiency in Modern Financial Markets

Markets are efficient for large corporate stocks, etc.

Don't assume the market is stupid.

😊 Poker player Amarillo Slim once appropriately adapted a Warren Buffett quote that [If You Can't See The Sucker, You're It](#).

Smaller investment assets may be less efficient.

► [Bid-ask spread](#), § 11.3, Pg.289.

The financial markets for U.S. Treasuries, large-country currencies, *large* publicly-traded stocks and funds, and many other assets, seem reasonably close to perfect and thus efficient. They are very competitive. There are thousands of buyers and sellers, even thousands of tax-exempt investors, and modest transaction costs.

For U.S. Treasuries and OECD currencies, it seems unlikely that major investors would have true inside information. It also seems difficult to imagine that you or I could systematically outsmart the prices in such markets. After all, thousands of other traders are at least as smart as you or I. Smart trading desks have thoroughly explored the correlations in the data and deployed billions of dollars to exploit even the smallest of unusual opportunities. They would flock to good bargains and avoid bad bargains (along with us). It would be astonishing if these markets were not very efficient.

However, for small firms, it is possible that the stock market may be less perfect and less efficient. Some insiders may try to hide their trades from the SEC. There are many small stocks (even on the NASDAQ exchange) that trade only rarely and have reasonably large transaction costs.

- 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).

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. One conceptual question that had vexed academics for a long time was how markets could be efficient to begin with. After all, if

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

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).

"Trading Places" and Citrus Futures

The very funny and classic cult comedy [Trading Places](#) 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. You can learn more about futures contracts at the website of the *Chicago Mercantile Exchange* at <https://www.cme.com>.) In the case of orange futures, if it is going to rain too much or if there is a frost in Florida, oranges will become scarcer and the orange futures price will rise.

In a 1984 paper in the *American Economic Review*, Richard Roll found that citrus futures contracts even improve on the predictions of the U.S. Weather Service's forecast for central Florida temperatures. It is a great example of how financial markets help aggregate information better than even the best forecasters. Don't be surprised. After all, there is a lot of skin in this game (money at stake)!

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 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 watch your taxes). And you can probably accomplish this goal by buying just a few large index-mimicking mutual funds — the most popular personal investment strategy among finance professors by far.

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

➤ [Great bets](#), § 12.6, Pg.31.

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?

12.2 Market Efficiency Classifications and 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 assumes 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.

Almost all financial economists, regardless of camp, believe in basic market efficiency for large markets and liquid securities. Not even behavioral economists believe that it is easy to get rich trading on easily available information. Instead, the disagreement between more classical and more behavioral economists is, loosely, about whether stock markets are “99% efficient” or “97% efficient.” Classical finance believes in the former, behavioral finance in the latter.

Because you can trade millions of dollars in large-firm stocks or market indexes relatively easily and at low transaction costs, it may not require huge efficiency violations for behavioral-finance traders to earn money and for classical-finance traders to be left behind. 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 relative faith in efficiency. Let’s look at some such classifications.

Classical versus behavioral finance.

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

Even small deviations could make a lot of money (if they exist).

The Traditional Classification

The traditional definition of market efficiency focuses on information. In the traditional classification, market efficiency comes in one of three primary degrees: weak, semi-strong, 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 the best 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.

In this traditional classification, all finance professors nowadays believe that most U.S. financial markets are *not* strong-form efficient: Insider trading may be illegal, but it works. However, there are still arguments as to which markets are only semi-strong-form efficient or even only weak-form efficient.

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

Many finance professors no longer believe in perfect efficiency.

The Fundamentals-Based Classification and Behavioral Finance

I prefer an alternative classification of market efficiency, which divides economists based on their beliefs 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.

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

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 EMH 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.

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

☺ Nonbelievers have long since left to Wall Street and were probably fired soon thereafter.

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” — remain interesting. After all, bringing new evidence to bear on these disagreements is the process by which we learn more.

My Own Assessment

Buyer beware: Here is my own opinion.

Here is my own view. Be warned: smart people can come to different conclusions. As far as market prices are concerned, I am mostly in the firm-belief camp. As far as other price patterns, activities, or beliefs are concerned, I am more in the mild-belief camp.

Active funds seem to underperform on average. No one knows how to pick the winners ahead of time.

I believe that ordinary individual investors are unlikely to be able to find investing strategies in the public financial markets that earn high excess returns. A very few sophisticated funds may be able to earn a few basis points extra per year. But these funds are scarce and I don't know how to identify them. Even after decades of research that has tried to identify them, academics have usually found only that about half of all funds outperform the market and half underperform the market — and this is *before* we subtract out fund transaction costs. Most finance professors stash their own money in low-cost passive index funds.

► [Evidence on Fund Performance](#), § 12.5, Pg.27.

Investor Psychology?

But I also believe that most investors are not necessarily rational. Pundits love to talk about “investor psychology” or “[herd instincts](#).” For example, investors think they are smarter than they are — that they can predict when specific stocks are overpriced and underpriced. (I know I have done it, too.) This is why I believe that trading in the stock market seems so (inexplicably) active. It is also why many investors remain woefully underdiversified. For example, Nobel-prizing winning research has shown that investors are “loss-averse.” It seems very plausible that loss aversion influences their stock trading patterns. This can make them incur unnecessary capital gains taxes at the end of the year.

Aggregation and Arbitrage Concerns.

Nevertheless, I remain in the firm belief camp as far prices are concerned. I don't find it so plausible that, say, loss aversion necessarily would influence prices. I have two reasons. 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. In the aggregate, prices would not necessarily behave as if there was one loss-averse investor who bought shares at a particular price point. The second

☺ Individual investors may need therapists, but do the financial markets?

is that, if prices were badly set, a few smart investors would try to take advantage of this behavioral bias. They would quickly drive prices back to where they would become efficient again.

Q 12.7. 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 Prominent Market Inefficiencies and Limits to Arbitrage

Occasionally, there seems to be evidence that seems to refute market efficiency. Let's discuss the most prominent ones.

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

Equity Carveouts

Famous finance professors Owen Lamont and Richard Thaler described a [dramatic example of market inefficiency that occurred in 2000](#). The network company **3COM** had spun off the personal organizer device company **PALM** (whose products were later wiped out by Blackberry devices, which in turn were wiped out by Apple iPhone and Android devices). 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 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 in March 2000. This was almost surely a violation for true believers in market efficiency.

Not true market efficiency,

However, three other professors [Cherkes, Jones, and Spatt](#) then explained why it was impossible to get rich from the discrepancy. Taking advantage of the discrepancy would have involved going long in **3COM** and short in **PALM**. Unfortunately, it was practically impossible to find **PALM** shares to borrow (a requirement for shorting in the United States). **PALM** shares later “enjoyed” an almost uninterrupted fall in price, from \$95 in 2000 down to less than \$2 per share by 2003, thereby wiping out the paper opportunity. In sum (pun), even though this episode rejected “true belief in market efficiency,” it did not reject “firm belief in market efficiency.” The price discrepancy was not easily exploitable.

...but firm market efficiency.

Similar violations of summing-up constraints have also occurred a few times in other stocks since then, usually with similar constellations of EMH deviations and transaction costs. Smart investors quickly try to exploit them which usually makes them disappear.

Factor Anomalies: Value and Momentum

Beginning in the 1990s, finance professors have been regularly publishing academic papers claiming that some new quantitative strategy or another has outperformed reasonable average rates of return historically. The most prominent ones were forms of [value investing](#) strategies (buying boring old-economy stocks, selling glamorous high-growth new-economy stocks) and [momentum investing](#) strategies (buying

Value and Momentum Everywhere?

stocks that have gone up and selling stocks that have gone down over the 12 months). Academic papers suggested that these strategies would have offered “excess returns” as high as 1-2% per month. In 2013, researchers from one of the largest hedge funds in the world published a paper with the provocative title “[Value and Momentum Everywhere](#).” It became one of the most cited papers of the decade. What could possibly go wrong?

► Value Investing

Value Investing — the smart move?

Value investing originated after the [stock-market crash of 1929](#) (the famous “Black Thursday” of Oct 24, 1929, and “Black Tuesday” of Oct 29, 1929). Benjamin Graham and David Dodd (two Columbia professors) published a famous book called [Security Analysis](#) that argued that it is better to invest in firms that are less flashy and more down-to-earth (having high book values, low market prices, high dividend yields, etc.). Their most prominent acolyte was himself the most famous investor of the 20th century, Warren Buffett. In the early 1990s, the two most famous finance professors of our era, Eugene Fama and Ken French, analyzed the stock return data more systematically and came to a similar conclusion. They defined value firms as those with high book-to-market ratios and growth firms as the opposite. “Value firms” had indeed outperformed “growth firms” for many decades. They called this better performance the value effect.

Market efficiency violation or appropriate equilibrium return?

Interestingly, Fama and French did not view this empirical pattern as a rejection of market efficiency. Instead, they believed it was due to some as-yet-undefined risk premium for holding value stocks presumed to be riskier than growth stocks. However, I found it difficult to see what the nature of this value risk was. If anything, value stocks seemed less risky, not more risky — they had lower standard deviations of return and lower market betas than growth stocks. From the standpoint of viewing risk in terms of exposures to other risks, no one knew what kind of insurance these growth stocks were offering that made investors content to accept lower returns. Therefore I agreed at the time with the behavioral finance research that interpreted the value premium more as a market inefficiency problem. Whatever the cause for the value effect was, the result was that the investment strategies of most quantitative hedge funds over the last two decades have been heavily influenced by tilts towards value, as have many published papers by academic researchers.

Value Investing has been mostly AWOL for two decades.

One way to examine the value effect is to compare the performance of the Vanguard value fund ([VVIAX](#)) and the Vanguard growth fund ([VWUAX](#)). Over our 17 years from 2005-2021:

► [Vanguard Value and Growth Fund](#), § 7.3, Pg.159.

	Ari	Sdv	Geo	# Years Better
Vanguard Value	10.2%	16.1%	8.8%	6
Vanguard Growth	14.4%	21.1%	12.4%	11

Similarly, Ken French has posted the Fama-French HML factor for decades. This factor is a portfolio investing long in high-value firms and shorting high-growth firms. Its net returns look similar:

	Ari	Sdv	# Years Positive
Fama-French Value Minus Growth	-2.9%	16.7%	7

Ending in 2021, value did not outperform growth for investment-periods that have begun anywhere from 1997 to early 2020. Compared to growth stocks, value stocks have been miserable investments for at least 20 years. My view now is that whatever value investing may have been twenty years ago, it is probably gone as of 2020. Value stocks may outperform or underperform but it is now quite unpredictable.

► Momentum Investing

The second-most important factor anomaly was the **momentum investing** strategy. Momentum investing strategies require going long in stocks that have increased greatly over the last year, and going short in stocks that have decreased greatly. (It requires a few more contortions, but this is a reasonable characterization.) As with value, behavioral finance researchers were quick to adopt momentum as a consequence of investor psychology. They also developed plenty of theories that argued about how the psychology of investors could explain momentum.

What is momentum?

Yet over the last 17 years, Ken French's data suggests that the average rate of return on the momentum investment strategy was — drumroll — 0.03% with a standard deviation of 23.8%. This rate of return is statistically and economically insignificant. Momentum investing also had the unpleasant aspect of sudden nasty risk. It lost 83 cents for every dollar invested in 2009!

Momentum has been mostly AWOL for two decades, too.

► But, but, but ...

A scouring of the data — some would call it torture — can still find momentum and value effects in some other markets. One can juice up the returns by investing more in some years only. And both value and momentum strategies still look good over much longer time-periods. It's just that they have not performed particularly well for about two decades. And presumably you don't care much whether value and momentum did well when the Beatles were at the top of the charts. You probably care more about whether they will do well in the 2020s and 2030s.

Yes, it can still be found elsewhere (perhaps).

As for myself, I would not invest my own money into the thesis that value and momentum will or will not return. Frankly, I am not confident that there is *any* factor strategy that has a positive average rate of return *forward-looking*. This opinion is based on four observations. First, it is easy to find a piece in the hay stack that looks somewhat like a needle but is not. There is a lot of data and with enough analysis, it is easy to find some spurious correlations. Second, maybe there is some additional risk (like the 83 cent loss in 2009 for momentum.) Third, transaction costs in these strategies can be considerably higher than they are for buy-and-hold strategies. And fourth and perhaps most convincing, as two other academics ([Pontiff-McLean](#)) have pointed out, smart investors are reading the academic literature, too. When they try to take advantage of an anomaly, they also make it go away.

Why is it that many trading strategies seem to have worked historically?

More than ever, I believe that the EMH has been winning this argument. It is very difficult to find stock selection strategies that can be expected to outperform the rate of return on the stock market. It is better to make sure to be well-diversified than it is to try to beat the market.

Stock factor portfolios? Probably not much left in factors that are famous.

Q 12.8. Which form of market efficiency do momentum trading strategies seem to violate?

Bubbles and Bitcoin

Bubbles are not easy to exploit.

Many, but not all researchers — myself included — believe that corners of the financial markets are subject to bubbles. Most also believe — like me — that these are not easily exploitable, thus rattling our faith in true market efficiency but preserving our faith in firm market efficiency.

Bubbles!

A **bubble** is a runaway market, in which rationality has (at least temporarily) disappeared. There is a lot of academic debate as to whether bubbles in the stock market have ever, in fact, occurred. A strong case can be made that technology stocks experienced a bubble from around 1998 to 2000. It is often called the **dot-com bubble**, the **internet bubble**, or simply the **tech bubble**. I know of good fundamental-based explanations as to why the NASDAQ Index climbed from 2,280 in March 1999 to 5,000 by March 2000 and why it dropped from 5,000 back to 1,640 by April 2001 — but no good non-bubble explanations for both.

Bitcoin!

Today, I am wondering whether crypto-currencies like **Bitcoin** are in a bubble. A Bitcoin is a specialized number sequence that satisfies certain mathematical properties. Finding them requires a lot of calculations, which in turn requires spending large amounts of energy. However, the sequences themselves are otherwise intrinsically worthless. Knowing this sequence will not get you cash flows in the future, as it would for a project in an NPV analysis. The NPV of all future cash flows is zero.

What about other currencies?

At this point, the proponents of Bitcoin usually argue that sovereign currencies and gold also have no use and cash flows down the line. What makes them valuable is only that people trust them. The “only trust remains” claim is false, because you can pay your tax obligations with sovereign currencies. The “no other use” claim is more correct, although gold can also be used for some other purposes, too — dentistry, jewelry, circuit boards. However, the cryptonites do have a bigger point that should not be lost: it is that people trust these currencies as stores of values — so why not also trust Bitcoin?

Why currencies?

To understand why currencies are useful requires a quick trip into history. Before the invention of currency, when you had a goat and wanted to buy bread, you had to walk with your goat all the way to the market and find someone who needed a spare goat and happened to have spare bread. Thus, having a common currency as a medium of exchange was very useful. You no longer had to schlepp your goat all the way back home if there was no bread seller with the need for a goat at that very moment in the market. You could sell the goat for gold to one party and buy bread from another the following day.

What's better about Bitcoin?

So what is the intrinsic value proposition for Bitcoin today? We already have bank accounts and credit cards, so yet another alternative currency adds relatively little value (and this is even if Bitcoin even had the stability and ease of transactions that modern payment systems provide). It probably is also not a great advantage for most people that their Bitcoin can be stolen far more easily. Ordinary people don't like the idea of potentially losing all their money when some hacker breaks in and steals all their Bitcoin, and they, the victims, are left without any recourse to recover their loss. Better a bank that one can call up to complain.

This really leaves two viable uses for crypto currencies. The first use is for people who are not able to use the international world banking system and who need absolute secrecy with respect to their governments. I am not judging the legitimacy of other countries' laws, but Bitcoin allows criminals under these codes to evade local laws. Bitcoin is also often used as payment in ransomware cyber attacks.

Illegal activity and speculation purposes?

The second use is for speculators who extrapolate the past (itself manipulated by [impresarios](#) and existing crypto holders) to the future. They are afraid that they have missed out on the greatest opportunity of a lifetime — the ability to earn huge amounts for nothing. It is simply greed. In this sense, crypto is like a [chain letter](#) or a [Ponzi scheme](#). The last suckers to hop on will lose all their money. As I am writing this, Warren Buffett has just called Bitcoin [rat poison](#). His partner, Charlie Munger, called it [venereal disease](#). As a finance professor, my professional opinion is that Bitcoin is also not suitable either as rat poison or a venereal disease. But I do share the sentiment.

Bitcoin casino.

☹️ I admit I have not tried either.

Short Squeezes and GameStop

In 2021, yet another new phenomenon emerged. Posters on Reddit's WallStreetBets forum managed to go viral and coordinate hundreds of thousands of investors to buy stock in an obscure company with an obsolete business model of brick-and-mortar sales of game cartridges with little future — Gamestop ([GME](#)). With each investor betting just a few dollars, the resulting horde had an effective risk aversion that was more akin to that of a billionaire. And they managed to coordinate collectively on a scheme that would have been illegal for an individual — a short squeeze.

☹️ What's a GameStop?

In the United States, to short shares, you need to borrow them from someone else first. Now imagine I owned all the shares in XYZ and you did not know this. You would ask your broker to short XYZ. The broker would borrow XYZ shares from me, and you would then sell them in the market. I will proceed to purchase the stock you are selling. I again hold all the stock. But you have made a commitment to return the shares to me at my request. If I “call” my shares back in, where can you requisition them now? There really is only one party from which you can buy shares — me. If I charge you \$1 million per share, you have to pay it. This is called a [short squeeze](#). It is unclear whether intentional and coordinated short-squeezes are illegal. Even if they are, it would be unenforceable for widely dispersed and loosely coordinated short squeezes. It is also difficult to prove — trading is anonymous.

What's a Short Squeeze?

➤ [Real-World Shorting](#), § C, Pg.176.

In 2020, [GME](#) traded for about \$4/share. In 2021, after the horde was purchasing [GME](#) shares, its price increased all the way to \$325/share. Not surprisingly, many short-sellers faced margin calls. They had apparently misspeculated. A number of hedge funds were among these short sellers. They had bet against the underlying business but eventually had to throw in the towel and repurchase shares at thirty times the price that they had sold them for just one month earlier. Some funds went out of business. Basically, they had mistakenly assumed that all they needed to do was to analyze the underlying GameStop cash flows (being true or firm believers in market efficiency). No one knew about this novel “horde risk.”

GameStop and "Horde Risk"?

When the stock briefly collapsed again, the losers were not just the hedge funds, but also many retail investors who had bought in later at the direction of the horde. However, many of these small investors had purchased less than one share. Many hundreds of thousands of investors may have lost grand sums of, say, \$30 — in

Entertained by Spite?

exchange for the entertainment value of having participated in the bubble of a lifetime. (GameStop still seems to be periodically affected by horde activity.)

More noise now.

Such coordinated “bank-run type” events have now made it more risky to bring stock-market valuation of individual securities back in line with their fundamentals. Nevertheless, it seems unlikely that it could greatly affect large and deep financial markets, such as those for **VFIAX** (S&P 500). As I wrote earlier, market efficiency is never perfectly white or perfectly black. Large markets are probably very efficient, while small markets may or may not be.

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

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. Assets should already be fairly priced.

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

Yet even today, some still argue about market efficiency. Why is the debate so difficult to settle? It is due to the fact that the **signal-to-noise ratio** in financial returns is low. The **signal-to-noise** ratio analogy comes from physics — the **signal** (here the expected price change) is small compared to the **noise** (here the day-to-day price **volatility**).

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

Let me illustrate what we can work with. What are typical price change magnitudes? For example, Friday, February 18, 2022 was an ordinary day, though marked by some uncertainty about a potential invasion of Ukraine by Russia. Some stocks declined. Roku (**ROKU**) lost 23%, Draftkings (**DKNG**) 22%, Paramount (**VIAC**) 18%, etc. Other stocks gained. Theralink (**OBMP**) gained 80%, Amplitude (**AMPL**) 21%. The trading volume leaders were Palantir (**PLTR**) with 138 million shares and AMD with 115 million shares. 287 stocks hit a new 1-month high, 780 a new 1-month low. More stocks declined than gained. The S&P index declined by 0.72%, **VFIAX** by 0.70%. Its consumer staples gained a few basis points, its IT stocks fell by 1%, **INTC** losing 5%, Nvidia (**NVDA**) 3.5%, Apple (**AAPL**) 1.5%, and so on. Treasuries rose a little but remained largely unimpressed. The yield on 10-year Treasuries changed from 1.97% to 1.92%. The 1-month Treasury dropped from 6 bps to 3 bps.

Is this information useful for investing purposes? How should you interpret it? Read on.

A Random Walk

Random Walk Formula

In a perfect market, the best way to think of investment asset processes is that prices should follow a **random walk**.^{*} The formula for a random walk is

$$\text{Price Tomorrow} = 1.0 \times \text{Price Today} + \text{Tiny Drift} + \text{Noise}$$

$$P_1 = \rho \times P_0 + m \cdot P_0 + \epsilon \quad E(\epsilon) = 0$$

Ignore the tiny drift m for a moment. The ρ coefficient on the price today has to be very close to 1.0. If it were different, you could easily make money. For example, if ρ were 1.01, the price would be expected to be 1% higher tomorrow. Buying the shares every day over 252 trading days, you would earn over 1,000% per annum. If ρ

^{*}Some folks who want to show off their math training use the term **martingale** instead of random walk. (It came from now-obscure 18th-Century gambling strategies.) For our purposes, the two mean the same thing.

were 0.99, you would short the shares. Same 1,000% return. Ergo, the ρ coefficient has to be very, very close to 1.0, with only the m component pushing on the price *on average*.

This random walk can also be expressed in terms of a rate of return from today to tomorrow. With a little algebra,

$$r_{0,1} = m + \epsilon_{0,1} \quad E(\epsilon) = 0, \text{Sdv}(\epsilon) = s$$

which says that prices are mostly unpredictable, though pushed around by noise with some standard deviation s and still growing by just the tiny bit of m .

If prices follow a random walk, returns are unpredictable.

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

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

where m is a very small positive drift. (m is the subject of asset-pricing models.)

Important

Let’s make it more concrete with an example (with realistic values) for illustration:

The “Noise” (s): What would be a good value for the standard deviation of the error term (s)? As you already know, standard deviations are reasonably stable and easy to estimate. You also already know about typical standard deviations in the U.S. stock-market.

S&P 500: Noise is about 2% per day. Exp return is about 100 times smaller.

The typical day-to-day standard deviation for individual U.S. stocks has been around 2-3% per trading day — of course, somewhat dependent on the specific stock. For well-diversified portfolios, like our stock-market portfolio index **VFIAX**, the standard deviation has been lower — perhaps 1-2% per trading day. In terms of annualized volatility, this translates into about $\sqrt{252} \times 2.5\% \approx 40\%$ per annum for individual stocks and $\sqrt{252} \times 1.5\% \approx 20\%$ for well-diversified market-type portfolios.

► [estimating sd.](#)
§ 7.6, Pg.167.

Incidentally, with its loss of 0.72 bps for **VFIAX**, February 18, 2022 was pretty much an ordinary day in terms of day-to-day volatility.

The “Signal” (m): What would be a good value for the drift m ? As you already know, expected rates of return for stocks (such as the equity premium) are notoriously difficult to estimate. (It is also why models such as the CAPM are struggling.) Rather than rehashing our earlier hand-wringing, let’s just go with a large number for the sake of illustration: 13-14% per annum. Earning 13-14% per annum translates into an average return of about 0.06% (6 bps) per trading day.

Put this all together, and our illustrative portfolio process from today to tomorrow is

$$r_{0,1} = 0.06\% + \epsilon_{0,1} \quad E(\epsilon) = 0, \text{Sdv}(\epsilon) = 1.5\%$$

Over a full year, for 252 trading days, we would expect to see

$$E(r_{0,252}) \approx 13\%/\text{year} \quad \text{Sdv}(r_{0,252}) \approx 24\%/\text{year}$$

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 Ingenhousz (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.

Empirical Evidence About Random Walks

Stock prices indeed tend to follow roughly a random walk. This means that you cannot easily expect to get rich by trading based on past prices. Let's look at two largely futile attempts to do so anyway — technical analysis and active investment fund management.

► Weak-Form Efficiency and Technical Analysis

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. The attempt to do precisely this is called **Technical Analysis**. There are even dozens of programs on the Internet that help you divine the future from past price patterns. The names of some patterns are reminiscent of astrology ("ascending triangle"). Other patterns are cloaked with more pseudo-scientific humbug names ("fast stochastic").

Let me start with some trick questions. Look at the three plots in Figure 12.2. Do you think they show stock-market patterns? Perhaps. Does it make sense to think that all these patterns can predict the future? Absolutely not! In fact, these kinds of charts are as easy to read as tea leaves.

Could there be "cycles" in the market?

The fine art of guessing.

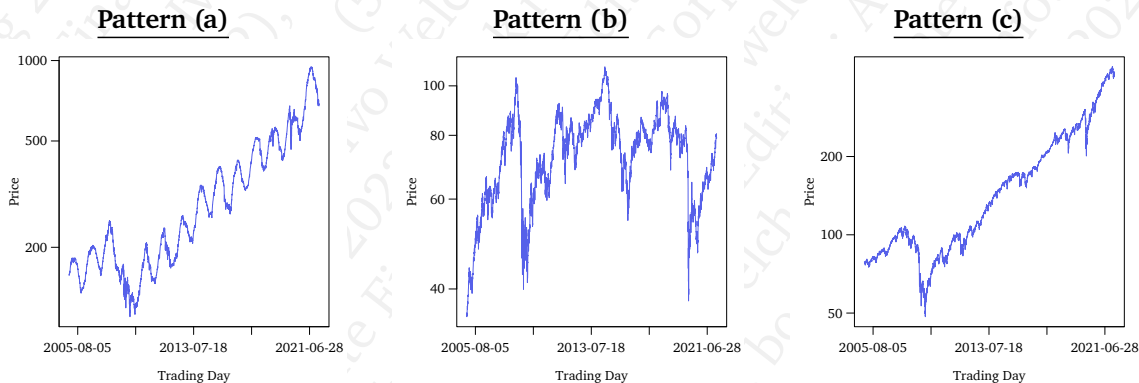


Figure 12.2: Stock Price Patterns, 2005-2021. One of them is fake and would have made it easy to become rich. Which one?

Plot (a) displays perhaps too strong a regular cycling pattern. If this pattern indicated future returns, we could quickly become a wealthy technical analyst. We would buy the stock only when it has “bottomed out” — a pattern that you could reasonably detect if you saw a few days of upward trend. Now, if you look hard enough at the data, can you find some stocks in the real world that have historically behaved like plot (a)? Yes — because with 5,000 stocks and more than 5,000 mutual funds currently trading, by pure chance, maybe one or two could show a pattern that would look remarkably similar to this kind of cycle pattern. But, despite assurances from some stock analysts that you could have made money if you had just trusted their past cycle patterns (and that you should now let them invest your money for a fee), the patterns would *not* represent the future — they would just have been historical coincidence.

What about plot (b)? Is it also cycling too regularly? No! This one was real. It was the Vanguard energy stock portfolio ([VGELX](#)). Do I believe that this past pattern will allow me to predict its future? Not as much as I believe that the sacred chicken of Rome will. (The ancient Romans liked to read the appetites of [sacred chicken](#) — perhaps as good a prediction method as any when perfect markets are at play.)

Plot (c) looks a little too regular in sloping up. Nevertheless, it turns out that this was also a real pattern. It was the overall stock market, specifically [VFAX](#) (S&P 500). Stocks were a remarkably good and steady investment (with a tiny positive m) over the last 17 years, with the exception of the Great Recession of 2008-9. But do not imagine that this tells you that any crashes will quickly be reversed in the future. (Incidentally, plot (a) just added a cycle pattern to the [VFAX](#).)

An easier way to see the absence of any daily patterns — even in [VFAX](#) — is to plot today’s return based on yesterday’s return. Figure 12.3 does just this. Can you see a pattern? I can’t. Back to my sacred chicken. There is not much financial juice in trying to predict how a stock will perform tomorrow, given how it performed today. Similar conclusions apply if you extend your use of historical price information beyond yesterday.

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

Sort of cycly, perhaps?



Crash and Reverse?

Predicting with past rates of return mostly appears to fail.

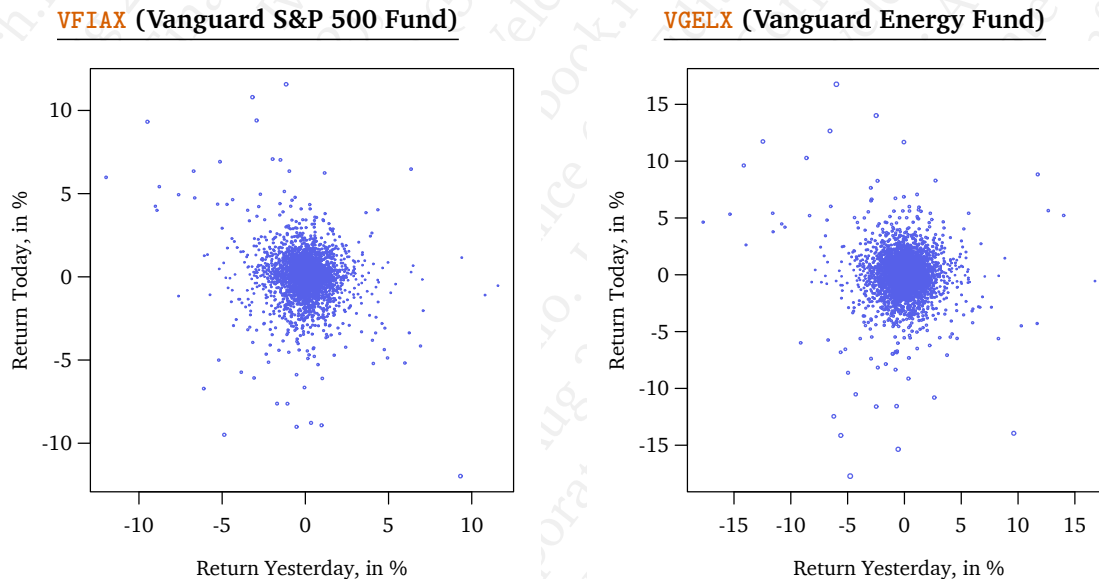


Figure 12.3: The Relation between Lagged and Current Rates of Return. These are based on daily rates of return from 2005 to 2021. There are no obvious patterns.

Start your own non-sense?

You can even try out your own technical analysis at a number of financial websites, such as [YAHOO!FINANCE](https://www.yahoo.com/finance): Look up any stock and choose “Charts,” then “Technical Analysis.” It is fun, but unfortunately as useless as learning to divine the sacred chicken of ancient Rome (<https://www.anecdotesfromantiquity.com>). Hey, at least the chicken helped build an empire — and I am not talking KFC. Shouldn’t their historical performance count for something?

12.5 Your Great New Investment Signal

Performance Measurement.

The question we now want to ask is what kind of data we would need to scientifically and statistically conclude that we have discovered an investment signal that “works” — i.e., that allows us to earn return above and beyond what the standard market random walk delivers.

Lots of investors earn an extra 2% per year by chance. Few do so systematically.

Say our signal-based strategy could deliver an average of 2-3% extra per year. How hard could delivering 2-3% extra per year be? Very hard! Trust me that if you could repeat this high a performance above a benchmark reliably year after year, you would have placed into the rare category of investment superstars. Of course, it is common to randomly earn more than 2-3% for a few years. (Even with my own miserable investing luck, I have managed to achieve this result in some years!) But it is uncommon to do so systematically and reliably year after year after year.

Yet our own problem is different now: We need to answer the question of how we determine whether our presumptive signal delivered dumb luck or actual information.

An excess performance of 2-3% per year means a superior performance of about 1 bp per trading day. The problem is that we need to confirm the signal's validity in an environment where the noise is about 20-30% per year (or 150 bps per day). Incidentally, you could also view the noise as the "good luck" or "bad luck" aspect in this context.

With the noise (standard deviation) of about 100-200 times as high as the signal (expected rate of return), our **signal-to-noise ratio** is quite low. And if our signal gives us pointers only for a few stocks and projects here and there, rather than for large diversified projects and portfolios all the time, then the applicable portfolio noise could not just be 20-30% but 30-50% per year instead. This would, in effect, halve our signal-to-noise ratio.

Our problem is to determine whether our signal is real or illusory. This means we must be able to distinguish between the usual 5 basis points and an unusual 6 basis points average daily rate of return in a soup of 150 basis points of noise every day.

Obviously, one daily observation is not going to cut the mustard. That is, if our signal-based strategy happened to earn 50 basis points today, we could not reliably conclude that it was our signal. In fact, if anything, we should believe that such a large return — 50 times more than our expected excess average return — was primarily noise.

Now trust me (or recall from your statistics course) that the T-statistic is defined as the mean divided by the standard deviation, $E(r) / SD(r)$; and we "sort of trust" numbers with an absolute T-statistic of about 2.0 or more. If our strategy performs as expected, we expect a 1-day T-statistic of about 1 bps/150 bps \approx 0.007. With only one day of data, our expected 0.007 is a long way off. We need more days.

How many? 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, our expected rate of return over D days is D times the expected rate of return over 1 day. Recall from Section 8.2 that the standard deviation of our rate of return over D days is \sqrt{D} times the standard deviation over 1 day. Our expected T-statistic over D days to detect superior performance is therefore

$$\begin{aligned} \text{D-day T-Statistic} &= \frac{\text{Excess Mean}}{\text{Standard Deviation}} = \frac{D \cdot E(r)}{\sqrt{D} \cdot SD(r)} \\ &= \sqrt{D} \cdot \text{1-day T-Statistic} \end{aligned}$$

If we expect a 1-day T-statistic of 0.007, we would expect a 100-day T-statistic of $\sqrt{100} \cdot 0.007 \approx 0.07$ — not even close to 2.0. We can estimate that we will need about 90,000 trading days to expect to reach a T-statistic of about 2.0. That's only about 357 years. And this works only if we expect our signal and the world still to work the same way over the next 357 years. Frankly, it's hopeless. We cannot possibly expect to validate this small a signal in this much noise within a reasonable time span.

It is difficult to distinguish skill from luck.

Detecting a signal in a lot of noise is difficult.

Risk is two orders of magnitude higher than reward.

☺ Song by Imagination: Just an Illusion.

You cannot conclude anything from just 1 day of return

☺ Coffee is stronger than T 1.96 in a stats course.

The number of observations to reliably distinguish between luck and skill seems hopelessly large.

➤ [How risk and reward grow over time, § 8.2, Pg.191.](#)

- 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 50-100 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 an investment strategy's performance is real or illusory. By this time, the process or the signal itself may have changed.

Stronger signals are easier to detect — but who would have such a strong signal?

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

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

Transaction costs are relentless.

Of course, if our signal were ten times as good (delivering not 2-3% but 20-30% per year), then we could expect to cut the mustard with only about 35 years of data. However, who has a signal that can deliver 20-30% per annum? In the competitive stock markets of today, where smart traders immediately flock to any halfway reasonable opportunity, this seems absurd.

Could you gain more observations if you use individual stocks instead of individual days to test your theory? Unfortunately not. Stock returns at the same moment in time are not independent realizations. They tend to move together. For example, if your signal suggested oil was going up, and all 100 oil stocks increased, you did not have 100 independent observations confirming your signal's ability to predict. You really only had one.

We have also ignored transaction costs so far. In an imperfect market with transaction costs, you can view the EMH in one of two ways:

1. It should hold if you work with post-transaction cost rates of return.
2. It should hold if reasonably many investors have very low transaction costs.

There is a special case here. Investors who were already planning to buy the stock anyway could just delay until the signal turns positive. Investors who were already holding the stock and planned to sell it could just delay until the signal turned negative. In this case, they incur no extra transaction costs.

However, if these specific investors are *all* asleep at the switch, it would be impossible for other smart investors to take advantage of their failures.

So the EMH need not hold perfectly in an imperfect market, but it should still be a fairly reasonable description of reality — at least within transaction cost bounds.

A warning: It may be difficult to earn 1 bp extra per day, but it is easy to waste 1 bp per day on transaction costs even though trading costs in equity markets are low — for small transactions, as low as 1 cent per share now. This means that 1 bp is the minimum spread on a \$100 stock. Unfortunately, even lowly 1 bps accumulate. If your strategy requires daily trading, it means that you are already 2-3% per year behind and your strategy needs to earn not 1 bp/day but 2 bp/day. If the signal turns out to be illusory, instead of being a superstar trader beating the market benchmark by 2% per annum, you would be lagging it by 2-3% per year.

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

Q 12.10. What has been the typical volatility of the U.S. stock-market index on an average day?

Q 12.11. If stocks follow a random walk, can the price tomorrow be different from the price today?

Q 12.12. What is the typical expected rate of return on a stock on an average trading day?

Q 12.13. 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 1 basis points.

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 that a T-statistic of about 2.0 gives you good statistical confidence. 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.

Q 12.16. Where will the Dow-Jones index be at the end of your course? Then look back to your prediction when you are done.

Investment Manager Performance Evaluation

Most smart professional fund managers have come to absorb these hard facts of life and developed proper humility. They focus on good diversification, tax minimization, pay-in and payout patterns, etc., sometimes tailored to the clients, and less on attempting to predict better or worse than the market.

Smart people realize it's mostly luck.

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 me)!

Odean and Barber, 2001

However, this is not necessarily the case for many analysts and talking heads. They want to make a mark for themselves. This is easier to do with extreme and outrageous statements. They could get famous if they turn out lucky. If not, what's the loss?

Blabberheads are not to high standards.

Really? Analysts regularly claim to be able to identify stocks that are underpriced by 5%, 10% or more. For example, on Feb 17, 2022, Tesla was trading for \$876. The [29 analysts](#) following Tesla had an average 12-month price target on Tesla of \$1,121 (with a range from \$300 to \$1,580), suggesting an expected rate of return of 28%. They must indeed be brilliant! While I worry about 2-3% per year, even subtracting out an estimate of overall stock-market rates of return, they purport to be able to predict an enormous rate of return.

Why are people listening to them?

If their signals are really this good, why are they even still on TV? They should be running their own funds and keeping silent about their financial prowess. Fortunately, because they have not, academic researchers were able to investigate their performance. Unfortunately, the empirical evidence suggests that analysts have been no better at predicting outcomes than dart throwers. So why do people still pay attention to these talking heads? I don't know. I am not a psychologist. Maybe "hope never dies."

What could you conclude from their stellar past performances?

But let's say we see someone who has invested really well — like a famous investor (e.g., Warren Buffett). How should we view Warren? Should we trust an "expert" with a glowing track record? Maybe. But let's consider the caveats.

Luck? Risk that did not rear its head? Market Inefficiency?

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 the outcome due to sheer luck, which will not repeat (randomness)?
- 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)?

[Dilbert on Hard Work, Luck, and Success: 2012-12-30](#)

This is not just a problem for academics. In fact, we finance professors are lucky: We have continued to write papers that argue one side or the other even when we are skeptical about the future. Our money and jobs are not on the line. The real

conundrum is faced by every investor in the real world every day. We have already talked about the challenge in some detail. How do you distinguish between a good and a bad signal — between skill and luck — when it comes to investing on your own or to selecting a fund manager?

But the problems go further. If you believe that the market is inefficient so that your investment manager can make you money, consider the following:

Is 3 years 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.

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.

Are we sure about the 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 that 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 that has just not shown itself yet?

Lucky 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.

Who is still here? 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 one of them that has outperformed 10 years in a row!) What happens to the funds that

Be concerned and skeptical.

► [Ascertaining superior performance.](#)
Pg.21.

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

Is there Tail Risk?

► ["Peso" risk.](#)
Pg.228.

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

► [Mutual funds.](#)
§ C, Pg.179.

Good past performers grow.

$$2^{10} = 1024$$

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

😊 [Survivorship Bias](#)



Why would they tell anyone?

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

Who gains, who loses?

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

[Dilbert on Management Books: 2013-06-30](#)

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 who 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?

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 there were none in the world that could pick any better than chance. 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.

Would we even see the 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 opaqueness can make it difficult to find investors with superior ability and thus impossible to confirm their abilities.

Who would get 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.

It is not an easy task to choose the right investments or investment manager. The best business to be in seems to be that of the investment manager. As a manager, you earn fees regardless of whether you make clients extra money or not. (In fairness, there are many good things that investment advisors can do, but selecting stocks to beat the market isn't one of them.)

Would it be better to have investment managers participate in the upside (as is the case for hedge funds), so that they have skin in the game? 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.

► The Empirical Evidence for Active Management

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. Table 12.4 shows a typical result in the literature: There were more funds that performed miserably than what we even 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.

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

what to expect if random →	Miserable should be <16% of funds		Average or Better should be >50% of funds		Great should be >16% of funds		
	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%

Table 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). The second (small-font) line tells you that if all funds were run by the sacred chicken, you would have expected about 16% of all mutual funds to do as miserably. 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 outperformed the random benchmark (21.2% had good performance, instead of the expected 16%), but fees negated this group advantage, too. Source: Fama-French, JF 2010.

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 empirical evidence so amply suggests — *past performance is no predictor of future performance.*

Are there some persistently good performers at least?

[Dilbert on past performance + hedge funds: 2013-04-17](#)

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 are almost all university and non-profit endowments.) Of course, they all swear that they understand the problems but are immune to them. They are professionals who *know* which funds are better than others. Could they *really* tell? Two finance researchers, [Amit Goyal and Sunil Wahal](#), looked at 3,400 retirement plan sponsors from 1994 to 2003 and found that they were not particularly prophetic:

Do Fund Managers Know?

* **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.

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



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

► [Business of liquidity provision](#), § 11.3, Pg.294.

Where should the burden of proof be?

😊 The ultimate finance authority, [John Oliver](#) loves index funds!

The pension funds hired fund managers *after* they performed well, not *before* they performed well. They fired funds *after* they performed poorly, not *before* they performed poorly. So why do these pension fund managers pretend that they can do a good job managing your money? Well, how much would you, as a client, be willing to pay for a plan sponsor who admitted to an inability to pick investment funds better than the sacred chicken?

There are, of course, other ways to make money: Warren Buffett's fund, *Berkshire Hathaway*, for example, runs many businesses, too. These businesses — like Berkshire's insurance and energy 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 is smart enough to acknowledge that the EMH 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 — [he recommends index funds for most investors!](#) Then again, he is paid not to be the firmest of believers.

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. So far, none has done great. On the client side, if I were you, I would be very cautious investing my money, especially with any fund that charges high fees. Most finance professors invest their own money into low-cost index funds instead.

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 12.17. 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 12.18. 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 12.19. Explain survivorship bias and how it manifests itself among mutual funds.

More Warnings

When fund managers earn great returns, they often become famous. To attract new investors, they then go out and talk more about their performance. The first targets are easiest to find at cocktail parties (you!) and industry conferences, itself an interesting business. Thereafter, it is usually admiring students looking for jobs. Enjoy these speakers and venues, but please remain skeptical.

Buy Low, Sell High.

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 confidently 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 “brilliant” investment insights. When I am in a bad mood, I offer somewhat cynical ambiguous praise that usually amuses only myself — such as “we would be lucky to get them to work with us.” (These are our university donors, after all.)

Most “investment advice” books are worse than dieting books. Think astrology.

A recent craze has focused on genetic algorithms and artificial intelligence. Unfortunately, even though they appear to be rather sexy high-tech sophisticated ways to pick investment assets, most lack something more basic: human intelligence. Fortunately, Michael Marcovici has remedied the situation with his [“I Trained Rats to Trade, and Win, on Wall Street”](#) true laboratory experiments. He taught lab rats to trade in the foreign-exchange and commodity-futures markets. Whenever they listened to a sound, the rats had to press either a green or a red button — green if they expected the prices to rise, red if they expected the prices to drop. The rats managed to outperform some of the world’s leading human fund managers. Sure enough, a number of the rats outperformed some of the world’s leading human fund managers. Unfortunately, the rats’ ability to present their superior ability to potential investors (and thus generate higher fees) was limited by their lack of eloquence. (He should have gone with clucking chicken instead!)

Rat Selection



Most funds write monthly communiques to their investors. They are largely collections of ex-post rationalizations and platitudes. There are some patterns. Funds on the up often write about the credit they deserve for their masterful 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 foreseen the problems — even Buffett read the tea leaves wrong, 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 and on.

Grandiose Claims and Dumb Excuses.

Yet, the hard fact of life is that neither the ups or the downs are on target. Most hedge-fund performance in financial markets is just luck. In 2016, about a thousand hedge funds closed shop, mostly 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).

Realistically, competitive-market traders are mostly lucky or unlucky.

Academics are not so different.

Perhaps I shouldn't be so hard on the industry. We academics are really not so different. John Oliver's May 2016 show on [Scientific Studies](#) explains our shortcomings 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 that "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 claim to be related to behavioral and investor psychology — hedge funds and investors (also often our consulting clients) love such stories.

We find spurious factors and publish them all the time, too.

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 find many factors that seem statistically significant, yet are entirely spurious. Most of the time, quantitative hedge funds try to replicate and further test the academic factors right after the first public academic posting. If they confirm the findings, they then start trying to exploit past patterns. They all pile up into the factor as they back-test it, itself contributing briefly to some further good performance. (Virtually every academic equity fund has played "value" and "momentum" in some strategy or another, perhaps the reason for the disappearance of these effects.) And then, one day, the funds realized that they may have overreached.

Intellectual humility, please.

What about me? Am I not brilliant? 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/b. This made my oil bets my best bets ever. I had talked about this in 2013 to my colleagues, who were then admiring my foresight. It was easy for me to rationalize how smart and prescient I was. But in all truth, my rationalization was really all non-sense. It really was primarily a gamble. I placed a bet, pure and simple. Ex-ante, other people just as smart 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 genius investor? Or just a lucky one? In truth, with some reflection, probably more a lucky than a genius one.

Pennies Before Steamrollers

Not understanding profit sources

Sadly, we are not yet done. There is one more important point. Funds can wittingly or unwittingly give the illusion that they are better than random gamblers. It turns out that it is not difficult to show good historic performance *on average* and/or for a long time.

Small profits often; large losses rarely.

You can even show such good historical performance on a roulette table. It's called the "double-up strategy." For example, place money on red. If you lose (black comes up), place a bet twice as high. Do so until you win. Then 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.

Here is how to look good 99% of the time.

Writing financial options is an explicit way to create an investment strategy that follows this pattern: by charging other for insurance against large market drops, you make modest returns most of the time, followed by sudden large disaster losses. Dynamic trading strategies can also show such option-like payoff patterns, and many other investment strategies share these characteristics, too. "Making markets" (that is, being the intermediary for buyers and sellers) seems to be one of them — dealers

earn pennies on inventory for many years, until a sudden spike in volatility gets the dealer stuck with large losses.

Many funds don't even know that they follow strategies with such payoffs. The Great Recession of 2008-9 uncovered such patterns for many strategies previously believed not to suffer from them. Many investors (banks in particular) that had made small amounts of money for a long time suddenly lost it all. The momentum strategy in 2008 showed this pattern, too. Buffett had a funny quip here — “only when the tide goes out do you discover who has been swimming naked.”

I don't think that academics or investment managers even understood the payoff patterns of their strategies, nor do I think that they tried to deceive their investors. They had just stumbled onto “it has made nice money for a long time” investment strategies. They followed them because they worked. My advice: be very skeptical about claims that someone expects to beat liquid financial markets.

The opposite of these “gathering pennies in front of a steamroller” strategies lose money most of the time but then gain a lot in a crisis. These strategies are very difficult to maintain. Which investors want to earn negative rates of return for years on end, while their peers are doing well? Only a few lucky bear investors can manage to maintain shorts. Tesla shares may eventually nosedive, but most Tesla short-sellers have already gone bankrupt.

So, yes, in theory, you can offer a fund with a negative market-beta strategy and low expected rates of return, because it provides great insurance that investors should want. In practice, your investors will drift away when the market goes up, and withdraw their gains when the market goes down and they have to cover their losses elsewhere. (I was on the board of a hedge fund that experienced exactly this.) It's tough to bet against the market, even successfully.

12.6 True Arbitrage vs. 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. Traders want to exploit any arbitrage opportunity that makes financial markets efficient as soon as it appears. It is a matter of basic financial literacy for you to understand what arbitrage is.

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.

You only see who is naked when the swimming pool is drained.

Common sense — one cannot beat a perfectly competitive market.

Small losses often; large gains rarely.

Betting against the market is tough.

Do you understand arbitrage?

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

► [Law of One Price, § 1.1, Pg.2.](#)

- 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 is not an arbitrage, though it would be an insanely great bet.

Important

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

► [Ex-ante fair bet, § 6.1, Pg.115.](#)

“Risk(y)” arbitrage \approx great bet. Unlike a true arbitrage, a risk(y) arbitrage could possibly lose a little money.

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:

1. True 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.

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.

Most of all, unless large public financial markets are very imperfect, you should expect not to find many great or arbitrage opportunities of either type there. If you agree with this assessment — basically that the world is sane enough not to have easy money grow on easily accessible trees where millions of others are passing by every day — then you can then draw some surprisingly strong conclusions about how these financial markets must work. If you disagree with this assessment, 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 and I can teach you.

However, if easy opportunities are scarce and money does not grow on trees, there are still plenty of important skills to learn. You can control risk; you can hedge and implement smart tax strategies; and you can find opportunities and superior projects in those markets that are not yet *too* perfect and *too* competitive. Look especially where you have a unique advantage, that will allow you to systematically outperform the others.

Q 12.20. Is earning money without risk an arbitrage?

Q 12.21. When and why you would prefer a risk(y) arbitrage to a true arbitrage opportunity?

More Hypothetical Arbitrage Examples

Of course, it is difficult to find real-world examples of arbitrage. Arbitrage is principally a conceptual issue. 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.

Another hypothetical example of arbitrage would involve stock prices that are out of sync on different stock exchanges. If **VFIAX** 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 **VFIAX** shares worth \$1 million, you could earn \$20,000 without effort or risk.

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

☺ Cannabis is not a tree, much less a legal one!

It's not all lost. On the contrary!

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

Small arbitrages "matter" only if they are scalable.

Arbitrage could conceivably occur between different financial markets.

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

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:

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?
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.

► Bid and ask prices, Pg.290.

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

Limits to Arbitrage

Many arb strategies require shorting, which can be expensive.

There is yet another problem with near-arbitrage. Let’s say that you have found a discrepancy between the value of two assets and you are sure they will converge *eventually*. You would need to buy the cheaper version and go short on the more expensive version. There are, of course, the transaction costs of doing so, especially shorting. But let’s say that they are small.

If A should not have happened, what prevents 2A from happening?

The bigger problem is different: If the relative valuation makes no sense at 10 bps, what stops it from going to 20 bps, at least for a while? If you have to borrow money in order to make this bet, the temporary widening of the near-arbitrage could even kill you.

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 one. 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 Warren Buffett warned about the overvaluations of Tech stocks. Like me, Buffett had suffered from years of poor performance (and had to suffer yet another quarter of misery), as Internet stocks reached ever higher.

Of course, I did not learn from my experience. I am only human. Bolstered by investment profits elsewhere over many years and convinced of my superior chicken acumen, I decided to short Tesla stock in early 2020. I predicted Covid would cross from China into the rest of the world, and it did. Which crazy consumer would want to buy a new car in what I (correctly) predicted to be the greatest calamity of our lifetime? And how could a startup car vendor be worth more than Mercedes-Benz, BMW, and VW *together*, while the Germans were retooling to enter the electric vehicle market, too? Within 5 years, they should be able to catch up. Instead of my brilliant prediction, the Fed pushed interest rates so low that the stock-market rose instead of fell. And supply chain issues in 2021 suddenly made cars scarce. Tesla shares were the best performers in the market and tripled. I still do not understand why. As of early 2022, I remain deep in the hole.

Learn some humility from my experience, please. To my credit, at least, I did not fall into the Bitcoin or GameStop rabbit holes!

(The movie “[Margin Call](#)” is a not-too-unrealistic depiction of how a trading firm unwound its holdings just before the Great Recession. Highly recommended.)

Let’s go back to Bitcoin. As I already wrote, I believe that Bitcoin is a bubble. I see no value at the end of the chain. I am positive that Bitcoin will not become a major world currency. When speculators collectively realize that there will be no future suckers extrapolating the past and hoping for free money, the speculators will disappear, too. Bitcoin will collapse. However, given that Bitcoin now (at the end of March 2022) trades for \$40,000, what prevents it from trading for \$400,000? One makes (almost) as little sense as the other.

There is, of course, also the other “little” problem: it is not possible to reliably short Bitcoin. Bitcoin trades mostly on exchanges that will themselves go bust if

Shorting bitcoin could kill you!

► [Bubbles and Bitcoin](#), § 12.3, Pg.14.

And shorting reliably may be impossible.

Bitcoin suddenly collapsed. This means that they are not likely to be able to pay up if the short bet pays off a lot.

Larry David is funny!

I just hope that by the time I write the next edition of my book, I will not have to double up on my prediction of Bitcoin's demise, with Bitcoin trading for \$400,000. I am never wrong, just like [Larry David's Super Bowl commercial](#) for the FTX crypto exchange.

12.7 Corporate Consequences of Market Efficiency

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

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:

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

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

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.

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

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 increase or diminish 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.

► [Do reported earnings matter?](#)
§ 14.1, Pg.415.

There must be no value to changing capital structure.

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 arbitrageurs competing to do this, your firm value would instantly adjust to \$102. Thus, a \$100 price for your firm would be absurd.

► [Capital structure arbitrage.](#)
§ 17.2, Pg.526.

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](#), § 20.2, Pg.648.

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? Fugeddboutit.

► [Stock dividends](#), § 20.2, Pg.648.

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

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.

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

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 friend of mine who sat on the corporate board of a large conglomerate oil company objected to its capital budget. The company planned to explore for more oil, based on a working assumption that oil prices would recover and double within two years. Whether the projections would turn out to be true or false was actually irrelevant. This oil company could just have purchased oil in the market much more cheaply instead of drilling for it. Why bother exploring for

You can also learn from other market prices.

oil if you can buy a confirmed reservoir as cheaply in the market? Eventually, they came to their sense. 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. Hordes of professional arbitrageurs would have traded and eliminated the opportunity 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. Unlike anyone else, only 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 by improving X's products through your own intellectual capital, or by increasing the scale of operations. All of these strategies can add value to the firm — value that outside arbitrageurs cannot accomplish without you. (This kind of unique ability to create value violates the “perfectly competitive market with infinitely many potential buyers” assumption of a perfect market.)

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

But be careful: Market efficiency means that you cannot create value for your shareholders simply by your personal view (without special information) 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 you manage a company manufacturing aircraft parts and X manufactures pharmaceuticals, it is highly unlikely that you would create value for your shareholders by buying X, even if the firm X is trading for only 5 times earnings and this seemingly-low valuation makes no sense to you.

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

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 that investors incur when trading your shares (e.g., by listing on an exchange). Or you may be able to reduce the mistrust that your investors might 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 sort of corporate move brings more information to the market. Importantly, it is not the split per se that makes the share price go up, but the expected increase in future real cash flows that does.

► [Splits as signals,](#)
§ 20.3, Pg.660.

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 likely 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,](#)
§ 12.2, Pg.9.

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 you are a startup whose current projects will return \$500 tomorrow but you are not yet able or legally allowed to disclose this. The problem is that without this information, outside investors may value your firm only at \$150. Also assume that you have no cash and that you can only raise financing through selling more equity to potential outside investors. 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 think that the firm will return \$700, falsely believing that the combined firm will only be worth, say, \$250. Thus, to raise the additional \$100 in capital that you would need, you would have to sell 40% of your firm (truly worth \$280), and keep only 60% (truly worth \$480) of the true \$700 return. \$You would therefore be better off passing up this new project and just taking the \$500 from the old project. Put differently, your true opportunity cost of new capital (selling something worth \$280 for \$100) to fund this project is way too high for you.

► [Separation of financing and investing,](#)
§ 11.1, Pg.280.

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.)

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

► [Share repurchases,](#)
§ 20.2, Pg.648.

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

If your shares are overvalued, your cost of capital would be too 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 corporate managers who are not conflicted and wish to act on behalf of their existing shareholders.

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.

Important

► [Overconfidence](#), § 13.8, Pg.397.

(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 12.23. 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 of Market Concepts

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

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, and/or create value by improving how and when information reaches 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 good project vs. passing up on a higher stock price.

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, you are generally better off focusing 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.

A summary of the two market concepts and their consequences.

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

12.8 Event Studies

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, through the use of a technique called an event study. An **event study** is an empirical analysis of the effect of a set of events on the prices 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.

Market reactions should be immediate and reflect all value changes.

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 founders, 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:

Good news...

- 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 pharmaceutical 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.

Anticipation ameliorates responses.

In both cases, because researchers usually 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), the true all-inclusive value changes of these events are likely to be more extreme than the observed event-study responses. This makes the empirical effects 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.

Q 12.24. 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 12.25. What kind of corporate events are greeted as good news by the financial markets? What events are greeted as bad news?

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.

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 by exploiting financial market inefficiencies — 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.”
 - ☺ **Touché: Something I overheard at a conference:** A famous hedge fund manager asked “if you are so smart, how come you are not rich?” — to which the equally famous finance professor responded “if you

are so rich, how come you are not smart?"

- 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 and to disappear quickly.
 - 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 uninformed activities such as purchasing another firm to lower risk or splitting shares will not add a lot of value — if any.
- Event studies allow you to ascertain the corporate value impact of sudden events, such as election results, regulatory action (FDA rulings), or corporate events (dividend increases).

Keywords

behavioral finance p.8; bitcoin p.14; brownian motion p.18; bubble p.14; classical finance p.8; dot-com bubble p.14; due diligence p.7; efficient market hypothesis p.1; efficient market hypothesis p.8; efficient p.1; emh p.1; event study p.41; fundamental trading p.9; futures contract p.7; great bet p.32; internet bubble p.14; market efficiency p.1; martingale p.16; momentum investing p.11; no-free-lunch axiom p.5; noise trader p.7; noise p.16; random walk p.16; rational economics p.8; risk(y) arbitrage p.32; semistrong market efficiency p.9; short squeeze p.15; signal-to-noise ratio p.16; signal p.16; strong market efficiency p.9; survivorship bias p.26; tech bubble p.14; technical analysis p.18; true arbitrage p.32; value investing p.11; volatility p.16; weak market efficiency p.9;

Answers

AQ 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 create different classifications of market efficiency.

AQ 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.)

AQ 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.

AQ 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.

AQ 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.

AQ 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.

AQ 12.7 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.

AQ 12.8 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.

AQ 12.9 The random-walk formula is on Page 17. 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.

AQ 12.10 The typical movement (variation) of a stock has been around plus or minus 1-2%. The average rate of return on a day is much lower. Thus, the signal-to-noise ratio is very low.

AQ 12.11 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 (almost) the same as the price today.

AQ 12.12 There are about 252 trading days in an average year. This answer allows for a reasonable choice of expected returns. For example, 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 7-8 basis points per day.

AQ 12.13 A *daily* trading strategy would have to offer above $1.0001^{252} - 1 \approx 2 - 3\%$ per annum in order to overcome typical transaction costs.

AQ 12.14 To outperform by, say, about 4-5% per year, you would have to earn an extra 2 bps per day.

AQ 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.

AQ 12.16 Your best estimate of the Dow-Jones Index at the end of the course should be today’s level grossed up by a little more than the risk-free rate over the same time-span. How it will perform is anybody’s (your!) guess.

AQ 12.17 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.

AQ 12.18 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.

AQ 12.19 Survivorship bias means that you, as an investor, will disproportionately 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 seem to have had more positive performances on average in the past than they actually did.

AQ 12.20 No! Treasuries earn money without risk, but they are not an arbitrage, because investing in them requires a negative net cash flow upfront.

AQ 12.21 If the true arbitrage opportunity can only be done once and gains \$10 (or \$1 million with 1% probability), it is probably worse than, say, a risk(y) arbitrage that loses 1 cent with 1% probability, and gains \$1 million with 99% probability

AQ 12.22 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.

- AQ 12.23**
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.

AQ 12.24 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.

AQ 12.25 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 12.26. 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 12.27. Define "efficient market" and explain how it differs from a perfect market.

Q 12.28. 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 12.29. Evaluate the following statement: It does not matter what portfolio you are holding in a perfect and efficient stock market.

Q 12.30. A long time ago, a paper by Frieder and Zittrain (2008) looked at a large sample of spam email touting a particular stock. Such spam then seems to have 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 at the time?

Q 12.31. What are the three main categories in the traditional market efficiency classification? Give an example of what each excludes.

Q 12.32. 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 12.33. 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 12.34. Does a random walk imply that the expected rate of return on a stock is zero?

Q 12.35. Define arbitrage. How is it different from a great bet? Is one always better than the other?

Q 12.36. 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 12.37. 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 12.38. What kind of costs should you consider when evaluating whether an opportunity is an arbitrage?

Q 12.39. 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 12.40. Why does the average mutual fund in the market today appear to have been a good performer? Does this evidence suggest that these funds will be good performers in the future, at least on average?

Q 12.41. 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 12.42. 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 12.43. 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 12.44. 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?