Chapter 11

Assessing Risk

Nothing ventured, nothing gained.

PLEASE NOTE: This book is currently in draft form; material is not final.

Life is full of uncertainty. It would be wonderful if we could accurately predict tomorrow's weather (or the questions on next week's exam!). Thankfully, we can take measures to protect ourselves from uncertainty, such as carrying an umbrella (or studying), thus mitigating the risk involved.

In this chapter, we will study how risk can be accounted for in financial decision making. We will discuss some measures of risk and how we can control our exposure to it. The study of finance is, at its core, about the tradeoff between accepting a degree of risk for a potentially higher return.

11.1 Risk and Return Basics

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LEARNING OBJECTIVES

1. Explain risk and risk aversion.
2. Calculate the rate of return and expected rate of return for an investment.

If you are given a choice between these two following options, which would you pick (assume you only get to pick once):

1. You receive $1,000.
2. You flip a coin. If it lands heads, you receive $2,000, but if it lands tails, you get nothing.

Option A is guaranteed, while option B has some uncertainty: we don't know for certain what our outcome will be. Thus, we say that option A is risk free, while option B entails a certain degree of **risk**[1], or uncertainty in outcome.

The option that you prefer will depend upon your level of **risk aversion**[2]. This is the tendency for most people to prefer less risk to more risk, all else being equal. Most people presented with this problem (with these dollar amounts) prefer option A. Some people might prefer to take the risk and prefer option B, in which case we say they are **risk seeking**[3] (an entity who prefers a more risky alternative to a less risky one, all else being equal). And some might not care which of the two they pick, in which case we say they are **risk neutral**[4] (an entity who is ambivalent between choices with different levels of risk, all else being equal).

Different people have different levels of risk aversion, and even the same person can exhibit different amounts, depending upon the specifics of the question! For example, many more are willing to take the gamble if the amounts of money are smaller (say $10 in option A vs. $0 or $20 in option B), or if the wording of the questions are framed differently.

1. Uncertainty in outcome.
2. The tendency for most people to prefer less risk to more risk, all else being equal.
3. An entity who prefers a more risky alternative to a less risky one, all else being equal.
4. An entity who is ambivalent between choices with different levels of risk, all else being equal.

Much of finance involves changing risk exposure, especially the transfer of risk from those who are more risk averse to those who are less. Usually, the more risk averse party rewards, directly or indirectly, the bearer of more risk. The classic example is buying insurance: a policy holder will pay the insurance provider to bear the risk that something unfortunate will happen (like a fire or car accident).

When we talk about financial risk, the outcomes we compare are solely the monetary **returns**[5] that are possible in the different outcomes. These returns are the amount of money we end with, less our invested money. They can be positive or negative (which would occur if the money received is less than our investment). When figuring returns, we need to include any payments received or made (such as interest or dividends) as well of the selling price of the asset. To compare investments of different sizes easily, we will typically discuss the **rate of return**[6], which is the ratio of our return to our investment.

Equation 11.1 Rate of Return

$$\begin{aligned} Rate of Return &= \frac{Return}{Investment} \\ &= \frac{(CashInflows - CashOutflows)}{CashOutflows} \end{aligned}$$

Expected Return

Often, we will want to know what an investment's **expected rate of return**[7] is. When we talk of expected return, we will use the weighted mean of the possible investment outcomes; that is, each possible outcome weighted by the probability of that outcome.

Equation 11.2 Expected Rate of Return (weighted mean)

Expected Rate of Return = (probability of outcome 1 × rate of return of outcome 1) + (probability of outcome 2 × rate of return of outcome 2) + ... + (probability of outcome n × rate of return of outcome n) = $p_1 r_1 + p_2 r_2 + \ldots + p_n r_n$

For example, consider an investment that has a 25% chance of gaining 10%, a 50% chance of gaining 5%, and a 25% chance of losing 10% (a return of –10%). Our expected rate of return is .25 × .10 + .50 + .25 × (–.10) = 0.25 = 2.5%.

Other potential ways of thinking about the expectations surrounding the rate of return are also valid, and investors should be encouraged to think about more than

5. For an investment, the amount of money we end with, less our invested money.

6. The ratio of our return to our investment.

7. The weighted mean of the possible investment outcomes; that is, each possible outcome weighted by the probability of that outcome.

just the weighted mean. We could consider the most likely outcome (in our above example a gain of 5%). We could consider the range of outcomes (a return between +10% and −10%). We could plot our expected returns on a graph, and try to consider the shape of the graph. Each gives us a different insight about the uncertainty involved in the investment.

Of course, we rarely know with this level of precision what the future will hold, so we have to make our best educated guess. A common way to guess is to look at the historical returns from similar investments and find the yearly average, usually assuming each year has equal weight (the arithmetic mean). There are some downsides to this: just because an investment behaved one way in the past is no guarantee that it will continue to behave that way! For example, as of this writing, your authors have successfully not died each day of our lives (so far). If we extrapolate these results into the future, we should expect to live forever! While an extreme example, it should underscore a key financial maxim: historical results are not a guarantee of future performance.

KEY TAKEAWAYS

- Dealing with risk is a key part of finance, especially since most people are risk averse.
- Expected future returns are the weighted average of the possible outcomes. Historical results are often used as a proxy for future expected results.
- Historical results are not a guarantee of future performance!

EXERCISES

1. Genny invested $500. She received two payments of $100 and then sold her stake in the investment for $400. What was her rate of return?
2. An investment has a 10% chance of returning 20%, a 70% chance of returning 10%, and a 20% chance of returning nothing. What is the expected rate of return?
3. An investment has returned 5%, 3%, −4%, 6%, and −7% in each of the last five years, respectively. We have decided that we want to use historical returns as a proxy for expected future returns. What is the expected rate of return? Why might the historical results be a poor estimate of future returns?

11.2 Portfolios

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LEARNING OBJECTIVES

1. Calculate the returns for a portfolio of securities.
2. Explain the benefits of diversification.

Determining the risk of holding a single asset is a difficult task in itself. In reality, investors will typically hold many different assets of potentially different types. Another common alternative is that investors hand their money over to a manager that pools all the investors' contributions to purchase such, which we call a **portfolio**[8] (a collection of financial assets).

While individual stocks or bonds might rise or fall in value, ultimately an investor cares about the performance of the whole portfolio. If we make one bad investment but five good ones, we might come out ahead and be satisfied. Since investors tend to hold stocks as parts of their portfolios, managers need to understand how their company's performance will affect the risk and return of the portfolio.

Determining the return of the portfolio is a simple matter of taking the average of the returns of the components, weighted by the portion of the portfolio initially invested in each. Thus, if we invest $20 thousand in ABC stock and $80 thousand in FEG stock, our weights would be 20/(20+80) = 20/100 = .2 and 80/(20+80) = 80/100 = .8, respectively.

Equation 11.3 Portfolio Return (weighted mean)

Portfolio Return = (weight of security 1 × rate of return of security 1) + (weight of security 2 × rate of return of security 2) + … + (weight of security n × rate of return of security n) = $w_1 r_1 + w_2 r_2 + \ldots + w_n r_n$

If the return on ABC was 10% and the return on FEG was −2%, the return of our portfolio would be (.2 × .10) + (.8 × −.02) = .004 or 0.4%. We can confirm that this is

8. A collection of financial assets.

correct: we earn 10% on our $20 thousand investment for a return of $2 thousand, and we lose 2% on our $80 thousand investment for a return of −$1,600. Adding the returns together gives a positive $400, which is precisely 0.4% of our original $100 thousand investment.

Notice that our portfolio return lies somewhere between the two extremes. Almost always, some investments will do better than others, so that our portfolio's returns won't be as good as our best investments. But the benefit is that our portfolio's returns won't be as bad as our worst investments. This is the key to **diversification**[9] (holding a portfolio of different assets so as not to concentrate exposure on one particular asset). This is embodied by the old saying, "Don't put all your eggs in one basket." Diversification can lower risk to a point, and is the closest thing to a "free lunch" in finance! To see this more concretely, we need to have a specific measure for our risk, which we will introduce later in this chapter.

KEY TAKEAWAYS

- Portfolio returns are a weighted (by % of investment) average of the components.
- Diversification causes the portfolio's returns to be less extreme than our best or worst investments.

EXERCISES

1. We have 30% invested in JKL stock, 40% in MNO stock, and 30% in PQR stock. Returns are 2%, 5%, and −1% respectively. What was our portfolio's return?
2. We have $25 thousand invested in ABC stock, $50 thousand in DEF stock, and $15 thousand in GHI stock. What are the portfolio weights?
3. ABC returned 10%, DEF returned 5%, and GHI returned 7%. Given the weights in #2, what is our portfolio's return?

9. Holding a portfolio of different assets so as not to concentrate exposure on one particular asset.

11.3 Market Efficiency

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LEARNING OBJECTIVES

1. Describe the process of price discovery.
2. Explain market efficiency.

Talking about risk only makes sense if we are dealing with uncertainty. If we truly are superior investors, able to always "pick the winners", then we have no need to diversify significantly. For example, Bill Gates earned most of his fortune by owning a significant stake in one company (Microsoft).

A key difference, however, is that Bill Gates wasn't just an investor, he was also the CEO for a significant portion of Microsoft's history (and thus much more in control of the investment). And his tenure certainly wasn't without uncertainty: for every Microsoft, Google, or Facebook there are numerous other companies that have failed, losing much of their investors' capital. Unfortunately, many investors and managers only remember the success stories and forget those that lost their gamble. We constantly hear of these companies that were successful, but rarely hear of the former high-fliers of the internet bubble.

Furthermore, just as most people think they are "above-average drivers", most investors are deluded into thinking they know more than everyone else in the market. Natural overconfidence, selective memory (we tend to remember our successes better than our failures), and a self-attribution bias (we tend to credit successes with skill but failures to "bad luck") cause investors to believe they are better than they, in actuality, are. There is debate about whether Warren Buffett is a truly skilled investor, or whether he has "gotten lucky" because the market happened to fit his investment style during the years he was active. Given all of the numerous investors over the years, perhaps someone was bound to get as lucky as Buffett and make billions. Of course, many other investors were doomed to failure: many through lack of skill, but undoubtedly many also who were just "unlucky". "It is better to be lucky than good" is a trading proverb that holds much truth.

Thus it is an open question whether skilled investors can **reliably** outperform the market. The argument for market efficiency goes as follows: investors sell or buy an asset based upon their valuation of the asset. This will cause the price to shift until the equilibrium price is reached (this process is called **price discovery**[10]). Once the proper price is reached, abnormal profits can no longer be earned. Furthermore, the market, in aggregate, has more information than any one investor could possibly have. The market price will be reached by this information, so an investor should not be able to abnormally profit from his or her private information. We call this the **Efficient Market Hypothesis (EMH)**[11].

Studies have shown that those with insider knowledge (that is, material **non-public** financial information) about companies can profitably trade on this information, thus offering one refutation of complete market efficiency (in what we term the **strong form of the EMH**[12]). Given that trading on insider information is typically against the law, this is of little benefit to the typical investor!

The **semi-strong form of the EMH**[13] argues that all **public** information has been accounted for by the market (including financial analysis of released statements and analysts' forecasts). If the semi-strong form is true, than investments based upon the fundamentals of a company shouldn't be able to earn excess profits. Successful investors such as Warren Buffett and Peter Lynch are often put forth as counter-examples to the semi-strong form; proponents of the semi-strong form have put forth arguments that these investors were either lucky or had access to investment opportunities or information not available to the market as a whole. Other arguments against the semi-strong form include the existence of anomalies such as asset bubbles (such as the technology bubble and the real estate bubble) and post-earnings drift (the tendency for stock prices to not immediately jump to a new price based upon earnings surprise but slowly "drift" to their new level).

Most academics tend to embrace the semi-strong form, though many Wall Street traders reject it. One reasonable question to ask is, even if public information can be exploited for gain, can a typical investor access and make use of the data? Believers of the semi-strong form (or those who reject it but believe typical investors can't benefit) advocate investing in "passive" broad market funds that don't invest in particular companies based on analysis (unlike most "actively managed" funds).

KEY TAKEAWAY

- If the market is at least semi-strong efficient, then analyzing public information won't provide a trading advantage (since the price should already reflect all publically available data).

10. The process by which investors sell or buy an asset based upon their valuation of the asset. This will cause the price to shift until the equilibrium price is reached.
11. The theory that the market, in aggregate, has more information than any one investor could possibly have. The market price will be reached by this information, so an investor should not be able to abnormally profit from his or her private information.
12. The belief that all public and non-public information has been accounted for by the market. Those with insider knowledge (that is, material non-public financial information) about companies cannot profitably trade on the information if the market is strongly efficient.
13. The belief that all public information has been accounted for by the market (including financial analysis of released statements and analysts' forecasts). If the semi-strong form is true, than investments based upon the fundamentals of a company shouldn't be able to earn excess profits

EXERCISE

1. Jane believes that by calculating a company's ratios from their past financial statements, she can deduce whether the company's stock price is cheap or expensive. Does Jane believe the market is efficient?

11.4 Standard Deviation

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LEARNING OBJECTIVES

1. Explain how standard deviation is a measure of risk.
2. Calculate the standard deviation of a set of returns.

There are many potential sources of risk, and not all methods of assessing risk are the same. One popular method (though certainly not the only one) for trying to quantify risk is to examine the standard deviation of the outcome returns. Standard deviation is a term from statistics that helps explain to what degree our results are expected to be different from the averge result. We are, in a sense, finding the "average" size of the "miss". For a full treatment of standard deviation as a statistical measure, please consult a statistics text; for our purposes, a basic understanding will suffice.

Figure 11.1 *Standard Deviation Comparison*

Source: JRBrown / Wikimedia Commons / Public Domain

The blue investment has results that are less "clumped" around the mean than in the red investment. The blue investment has a correspondingly higher standard deviation.

Finding standard deviation involves a few steps; if we know all the outcomes and their probabilities, standard deviation is found as follows:

1. Find the expected rate of return.
2. For each outcome, find the difference between the outcome's rate of return and the expected rate, and square the difference. So if the expected outcome is 2.5%, but the outcome's return is -10%, then the

difference is (–.10 – (.025) = –.125. This result squared is $-.125^2$ = .015625. Notice that the squaring effectively eliminates the negative numbers (so it doesn't matter if we miss high or low, just how much we miss by).
3. Find the weighted mean of these: multiply each by the probability of the outcome and sum.
4. Take the square root of this weighted mean to find the standard deviation.

Equation 11.4 Standard Deviation of Returns (all outcomes known)

$$\text{Standard Deviation}=\sqrt{p_1(r_1-\bar{r})^2+p_2(r_2-\bar{r})^2\ldots+p_n(r_n-\bar{r})^2}$$

$$\text{where}\bar{r}\text{istheexpectedrateofreturn(weightedmean)}$$

If we are using historical returns to estimate our expected return, then we need to make a slight adjustment to the formula. Typically, we assume each past observation (usually daily, weekly, monthly, or yearly returns) to have equal weight. Thus, the expected rate of return is just the arithmetic mean. But since we have just estimated the expected rate of return, we need to adjust our standard deviation calculation (for a detailed reason why, please see any standard statistics text, as it is beyond the scope of this text):

Equation 11.5 Standard Deviation of Returns (estimating expected return from historical)

$$\text{Standard Deviation}=\sqrt{\frac{(r_1-\bar{r})^2+(r_2-\bar{r})^2\ldots+(r_n-\bar{r})^2}{n-1}}$$

$$\text{where}\bar{r}\text{istheexpectedrateofreturn(weightedmean)}$$

On the bright side, spreadsheet programs can quickly do this calculation for us.

=STDEV.S(outcome1, outcome2, outcome3...)

Thus, if our outcomes for the past 5 years are 5%, 2%, –6%, –2%, and 4%, we can enter:

=STDEV.S(.05,.02,–.06,–.02,.04)

and receive the correct result of 0.0456 or 4.56%.

Most financial calculators can also solve for standard deviation; please consult the instruction manual of your calculator for details.

There are some downsides to using standard deviation as the measure of risk. Standard deviation tells us the most when our outcomes are normally distributed (the "bell curve"). If our outcomes have some extreme outliers (for example, a decent chance for a large positive or negative result), then standard deviation tells us very little about the risk associated with these results. If our results are skewed toward positive or negative outcomes, standard deviation tells us nothing of the effect.

Portfolio Standard Deviation

Figuring out the standard deviation of a portfolio can be done using the same procedure as above: just solve for the portfolio returns and then use them to find the standard deviation. What **won't work** is trying to take the weighted average of the standard deviations of the individual assets! The reason for this is simple, if the assets don't move in perfect tandem, then the diversification will cause the returns of the portfolio to be less volatile (that is, have a lower standard deviation).

Often, when constructing portfolios, investors will try to use investments that specifically behave differently from each other to try to maximize the benefits of diversification (in turn, minimizing risk). For example, consider the following: asset ABC had returns of 6%, 4%, and 2% over the past 3 years, respectively. DEF had returns of 3%, 5%, and 7%, respectively. The standard deviation of both investments is thus 2%. An equal weighted portfolio (that is, 50% of each) will have returns of 4.5% each year, for a standard deviation of 0%!

In reality, we can rarely find assets that behave so differently from each other (most assets, for example will increase in value as the overall economy improves), so there is a limit to the benefits of diversification. We will explore this further in a following section. Additionally, it seems that in times of crisis (for example, in 2008), many types of assets that typically behave in different ways can all lose value together; in other words, right when we need the benefits of diversification most is when the effect is smallest.

KEY TAKEAWAYS

- Standard deviation is one common measure of risk, but not the only one. It does not represent all aspects of risk.
- Standard deviation of a portfolio is not the weighted average of the standard deviations of the components. It must be computed from the portfolio returns.

EXERCISES

1. An investment has a 10% chance of returning 20%, a 70% chance of returning 10%, and a 20% chance of returning nothing. What is the standard deviation of expected returns?
2. An investment has returned 5%, 3%, −4%, 6%, and −7% in each of the last five years, respectively. We have decided that we want to use historical returns as a proxy for expected future returns. What is the standard deviation of these returns?
3. Why isn't a portfolio's standard deviation the same as its components?

11.5 Market History

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LEARNING OBJECTIVE

1. Describe the historical relationship between return and risk for various financial assets.

Over the past few chapters, we have explored different types of financial assets. At this point, it is worth looking at how some of these assets have performed historically.

Table 11.1 Historical Returns and Standard Deviations: Summary Statistics of Annual Total Return, 1926–2010

	Arithmetic Mean	Standard Deviation
Small Company Stocks	16.7%	32.6%
Large Company Stocks	11.9%	20.4%
Long-Term Corporate Bonds	6.2%	8.3%
Long-Term Government Bonds	5.9%	9.5%
Immediate-Term Government Bonds	5.5%	5.7%
U.S. Treasury Bills	3.7%	3.1%
Inflation	3.1%	4.2%

Source: Ibbotson SBBI, 2011 Classic Yearbook: Market Results for Stocks, Bonds, Bills, and Inflation, 1926–2010 (Chicago: Morningstar, 2011).

We see that there is a very strong relationship between the average return and the level of risk (as measured by standard deviation). This corresponds with our understanding that most investors are risk averse; that is, to accept a larger degree of risk (a higher standard deviation) investors demand a larger return. Also, this figure matches our intuition that stocks are riskier than bonds.

While this data is a good starting point for those trying to determine future investor expectations, there are some large caveats. Remember that, during this time period, the United States rose to be one of (if not the only) world "superpowers". We have no idea what this data would look like if, for instance, the Axis nations won WWII or the Soviet Union still existed. Depending upon these trends to continue might be a mistake, since the world continues to change politically, economically, and culturally.

KEY TAKEAWAYS

- The higher the risk, the higher the expected return (usually).
- Historical results are not a guarantee of future performance! (We realize we're repeating ourselves, but we want to underscore this very crucial fact.)

EXERCISES

1. Is there any portion of the historical data that has a surprising result (that is, contrary to our expectations)?

11.6 The Capital Asset Pricing Model (CAPM)

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LEARNING OBJECTIVES

1. Explain the difference between market risk and firm-specific risk.
2. Calculate a portfolio's beta from its components.
3. Calculate an asset's expected return using CAPM.

Riskier assets should demand higher returns. But not all risk is the same, because of diversification. For example:

Figure 11.2 Standard Deviation of a Stock Portfolio vs. Number of Random US Securities

Once we approach about 40 stocks in a portfolio (assuming they are relatively random and not, for example, all technology stocks) we cease to see significant reductions in standard deviation. There are some mutual funds and ETFs that attempt to own virtually the entire market of available securities! Nonetheless, there is a certain minimum amount of risk that must be borne by those investing in stocks due to factors that affect the entire market, which we call **market risk**[14] (also called systematic risk or non-diversifiable risk). Only by adding other asset types (for example, bonds or real estate) can we gain some additional diversification benefits.

The additional risk that any stock has above its market risk is called **firm-specific risk**[15] (also called unsystematic, diversifiable, or unique risk). This encompasses all factors that would affect the company's stock price, but not the market in general. For example, the CEO being indicted for fraud or the approval of a new popular pharmaceutical would be firm-specific event. Diversification reduces firm-specific risk but leaves market risk.

Since firm-specific risk can be virtually eliminated by diversification, investors shouldn't demand a higher return to compensate for it. Market risk, however, can't

14. Minimum amount of risk that must be borne by those investing in stocks due to factors that affect the entire market. Also called systematic risk or non-diversifiable risk.

15. The additional risk that any stock has above its market risk, that encompasses all factors that would affect the company's stock price, but not the market in general. Also called unsystematic, diversifiable, or unique risk.

be diversified away, so investors should demand higher returns for those securities which have a larger sensitivity to broad market events (like the state of the economy). For example, airlines tend to do poorly when the economy tanks (since in a bad economy, people travel less for both business and leisure), so investors should demand a higher return for airlines. Discount retailers, like Walmart, tend to be relatively less affected by a downturn in the economy, so they have less market risk; as a result, investors should demand a lower return for Walmart than an airline. Specifically, we are looking at a stock's **risk premium**[16] (the expected return in excess of the risk free rate), as this is the portion of the return compensating investors for bearing the extra market risk associated with holding the stock.

One way to attempt to quantify a company's market risk is to calculate its historical **beta**[17]. Beta represents the ratio of a company's risk premium versus the market's risk premium. Typically, beta is found by some method of statistical regression of past company returns in excess of the risk-free rate compared to a broad market index's returns in excess of the risk-free rate on a daily, weekly, or monthly basis. Of course, what investors really want is a company's beta going forward, so the historical beta will be a proxy for this value. Most financial sites provide their projection of public companies' betas and will usually describe any adjustments they make from the historical calculation.

So how is beta used? A stock that tends to move in the same direction as the market (most stocks) will have a positive beta. Stocks with a beta of 1.0 will move in the same proportion as the market: if the market is up 1% over the risk-free rate, these stocks will also tend to be up 1% (statistically speaking). Stocks with betas higher than 1.0 are more sensitive to market moves; betas lower than 1.0 indicate less sensitivity. The beta of the broad market index must be, by definition 1.0 (since it must move in perfect tandem with itself).

Since the betas of all stock are perfectly correlated with market risk (and, hence, each other), the beta of a portfolio of stocks is the average (weighted mean) of the betas of the components.

Equation 11.6 Portfolio Beta (weighted mean)

Portfolio Beta = (weight of security 1 × beta of security 1) + (weight of security 2 × beta of security 2) + ... + (weight of security n × beta of security n) = $w_1\beta_1 + w_2\beta_2 + \ldots + w_n\beta_n$

16. The expected return in excess of the risk free rate.

17. The ratio of a company's risk premium versus the market's risk premium.

For example, if we have $20 thousand invested in ABC stock (which has a beta of 1.5) and $80 thousand invested in DEF stock (which has a beta of 0.7), then our portfolio's beta is:

$$(\frac{20}{20+80} \times 1.5) + (\frac{80}{20+80} \times 0.7) = (0.2 \times 1.5) + (0.8 \times 0.7) = 0.86$$

A portfolio holding every stock in the same weights as the market overall should have a risk premium equal to the market's risk premium (also called the equity risk premium). It should also have a beta of exactly 1.0. Since the relationship of each component to both the portfolio's return and beta is the same (weighted mean), the two measures must be proportional to each other. Specifically, each component's contribution to the risk premium of the overall market portfolio must be proportional to the component's market risk (the beta):

Equation 11.7 Proportional Risk Premium

$$\begin{aligned}\frac{RiskPremiumofStockA}{BetaofStockA} &= RiskPremiumofMarket\\ \frac{RP_A}{\beta_A} &= RP_{MKT}\\ \frac{r_A - r_{RF}}{\beta_A} &= r_{MKT} - r_{RF}\end{aligned}$$

Continuing with our example stocks: if the market risk premium was 4.0%, then ABC (beta=1.5) should have a risk premium of 1.5×0.04=0.06 or 6%, and DEF (beta=0.7) should have a risk premium of 0.7×0.04=0.028 or 2.8%.

Of course, any given observation might deviate from the relationship predicted (beta is a statistical number), but the key idea is that our **expected** returns should hold to this relationship. If we rearrange this equation to solve for the expected return of stock A, we get what is called the Capital Asset Pricing Model (CAPM):

Equation 11.8 Capital Asset Pricing Model (CAPM)

$$\begin{aligned}\frac{r_A - r_{RF}}{\beta_A} &= r_{MKT} - r_{RF}\\ r_A &= \beta_A \times (r_{MKT} - r_{RF})\\ r_A &= r_{RF} + \beta_A \times (r_{MKT} - r_{RF})\end{aligned}$$

This is a very important result, as it implies that we can predict a stock's expected return if we know the risk-free rate, beta of the stock, and the market risk premium.

Thus, if stock GHI has a beta of 1.2, and we know that the risk-free rate is 2% and the expected market returns are 7%, the expected returns for GHI should be 0.02 + 1.2 × (0.07 – 0.02) = 0.08 or 8%.

We can also use the relationship to compare two stocks directly:

Equation 11.9 Proportional Risk Premiums (two stocks)

$$\frac{Risk Premium of Stock A}{Beta of Stock A} = \frac{Risk Premium of Stock B}{Beta of Stock B}$$
$$\frac{RP_A}{\beta_A} = \frac{RP_B}{\beta_B}$$
$$\frac{r_A - r_{RF}}{\beta_A} = \frac{r_B - r_{RF}}{\beta_B}$$

Issues with CAPM

While the realationship embodied in CAPM is very important to understand, the theory is not without its limitations. While determining the expected risk-free rate is fairly accurately obtained from observing the bond market (typically using long-term US government bond yields as a proxy), figuring an accurate forward looking beta and equity risk premium is much more difficult. The bulk of estimates of the equity risk premium in the US fall in the 2%–5% range, though arguments for rates well outside this range are not unheard of!

As a more general critique, there are proposals that there are systematic risk factors beyond just market risk. For example, some multi-factor models (such as including a variable for company size) seem to be better predictors of expected returns. Ideally, the market portfolio shouldn't just include stocks, but the entire field of investments (including real estate, fine art, and even baseball cards). Empirically, CAPM is not as accurate as we wish it to be in predictive power.

KEY TAKEAWAYS

- Firm-specific risk can be diversified away, but market risk can't.
- The risk premium of assets should be proportional to their betas.
- The beta of a portfolio is the average (weighted mean) of the betas of its components.

EXERCISES

1. Are the following examples of firm-specific or market risk?
   a. An oil company failing to find oil in one of its oil fields.
   b. GDP numbers beating expectations.
   c. The SEC finding accounting irregularities with a company.
2. How might a drop in the price of oil cause both firm-specific and market risk effects?
3. We have $25 thousand invested in ABC stock (beta=1.5), $50 thousand in DEF stock (beta=0.7), and $15 thousand in GHI stock (beta=1.2). What is the portfolio's beta?
4. Long term gov't bonds are returning 4%. The equity risk premium is 5%. If XYZ stock has a beta of 0.6, what is its expected return?

11.7 The Bigger Picture

PLEASE NOTE: This book is currently in draft form; material is not final.

LEARNING OBJECTIVES

1. Explain how risk and return play a role in financial management.
2. Describe some ethical considerations regarding risk and return.

At the core of all of finance is the question of appropriate tradeoff between risk and return. We have looked in detail at one measure of risk, standard deviation, and further separated the portion due to the market and the portion that can be "diversified away". As financial managers, we will need to evaluate projects based upon their returns and their potential contribution to non-diversifiable risk, since our investors will expect appropriate returns for the risk assumed. This will play a key part in our investigation of the cost of captial, which in turn will affect our evaluation of which projects our companies should undertake.

Furthermore, the concepts introduced in this chapter are the foundation of much of modern portfolio theory. Any who plan to study investments further will use these principles in constructing efficient portfolios.

Ethical Considerations

Analysis of risk involves many assumptions and calculations, and those who do not have the appropriate background can be very dependent upon the advice of we who have studied finance. An unscrupulous actor could misrepresent the actual risk of an investment to the detriment of clients, customers, investors, or management. For example, there are many cases of traders at large banks trying to hide the actual amount of risk they have in their portfolios, and they often aren't discovered until their positions have lost much money. Or a dishonest investment advisor could put clients into assets that are overly risky given the clients' age, income, or risk tolerance. Misrepresenting the risk of an investment is just as bad for the investor as misrepresenting the potential return.

Another area where ethics can play a part regards diversification. If we are trying to emulate a market portfolio, we might introduce stock positions in companies that engage in business practices that we disagree with. Thankfully, we don't need to have a position in every company to reap most of the benefits of diversification, but ethical diversification is not just as simple as purchasing any broad market ETF.

KEY TAKEAWAYS

- Risk and return play a key part in determining a company's cost of capital.
- Misrepresenting risk is potentially as damaging as misrepresenting return!

EXERCISE

1. You learn of an investment opportunity that expects great returns, but also has great risk associated with it. To raise the capital needed, you decide to ask your grandfather, who lives on a fixed income, to contribute. What questions might need to be considered to determine if this is an ethical course of action?

11.8 End-of-Chapter Exercises

PLEASE NOTE: This book is currently in draft form; material is not final.

End-of-Chapter Problems

1.
2.
3.
4.
5.