CHAPTER 2

UPSIDE, DOWNSIDE: UNDERSTANDING RISK

Risk is part of investing and understanding what it is and how it is measured is essential to developing an investment philosophy. In this chapter, we will lay the foundations for analyzing risk in investments. We present alternative models for measuring risk and converting these risk measures into an expected return. We will also consider ways in an investor can measure his or her risk aversion.

We begin with a discussion of risk and present our analysis in three steps. In the first step, we define risk in terms of uncertainty about future returns. The greater this uncertainty, the more risky an investment is perceived to be. The next step, which we believe is the central one, is to decompose this risk into risk that can be diversified away by investors and risk that cannot. In the third step, we look at how different risk and return models in finance attempt to measure this non-diversifiable risk. We compare and contrast the most widely used model, the capital asset pricing model, with other models, and explain how and why they diverge in their measures of risk and the implications for the equity risk premium. In the second part of this chapter, we consider default risk and how it is measured by ratings agencies. In addition, we discuss the determinants of the default spread and why it might change over time.

What is risk?

Risk, for most of us, refers to the likelihood that in life's games of chance, we will receive an outcome that we will not like. For instance, the risk of driving a car too fast is getting a speeding ticket, or worse still, getting into an accident. Webster's dictionary, in fact, defines risk as "exposing to danger or hazard". Thus, risk is perceived almost entirely in negative terms.

In finance, our definition of risk is both different and broader. Risk, as we see it, refers to the likelihood that we will receive a return on an investment that is different from the return we expected to make. Thus, risk includes not only the bad outcomes, i.e, returns that are lower than expected, but also good outcomes, i.e., returns that are higher than expected. In fact, we can refer to the former as downside risk and the latter is upside risk; but we consider both when measuring risk. In fact, the spirit of our definition of risk in finance is captured best by the Chinese symbols for risk, which are reproduced below:

危機

The first symbol is the symbol for "danger", while the second is the symbol for "opportunity", making risk a mix of danger and opportunity. It illustrates very clearly the tradeoff that every investor and business has to make – between the higher rewards that come with the opportunity and the higher risk that has to be borne as a consequence of the danger.

Much of this chapter can be viewed as an attempt to come up with a model that best measures the "danger" in any investment and then attempts to convert this into the "opportunity" that we would need to compensate for the danger. In financial terms, we term the danger to be "risk" and the opportunity to be "expected return".

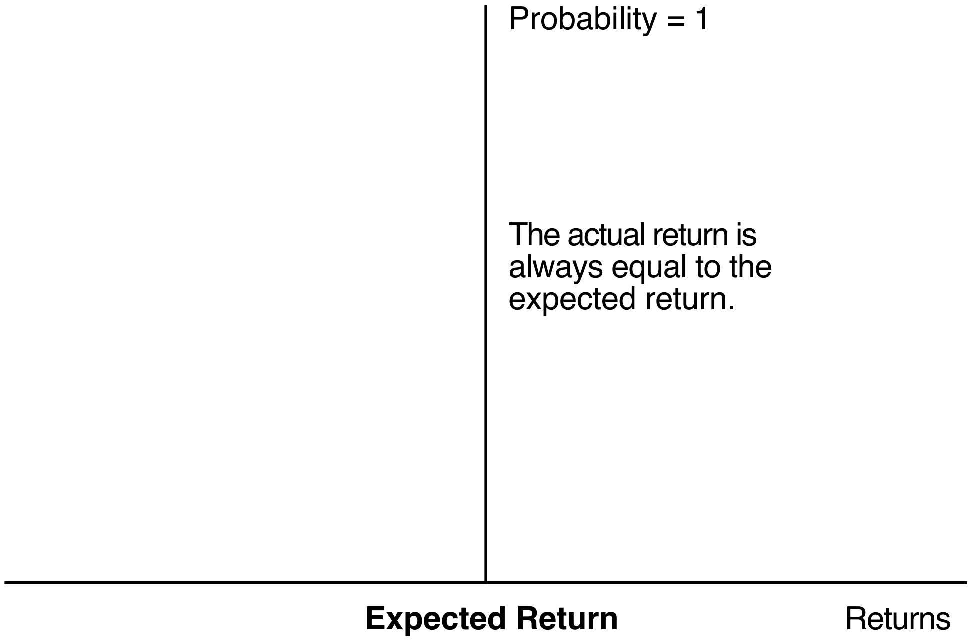
Equity Risk and Expected Return

To demonstrate how risk is viewed in finance, we will present risk analysis in three steps. First, we will define risk . Second, we will differentiate between risk that is specific to one or a few investments and risk that affects a much wider cross section of investments. We will argue that in a market where investors are well diversified, it is only the latter risk, called market ris*k* that will be rewarded. Third, we will look at alternative models for measuring this market risk and the expected returns that go with it.

I. Defining Risk

Investors who buy assets expect to earn returns over the time horizon that they hold the asset. Their actual returns over this holding period may be very different from the expected returns and it is this difference between actual and expected returns that is source of risk. For example, assume that you are an investor with a 1-year time horizon buying a 1-year Treasury bill (or any other default-free one-year bond) with a 5% expected return. At the end of the 1-year holding period, the actual return on this investment will be 5%, which is equal to the expected return. The return distribution for this investment is shown in Figure 2.1.

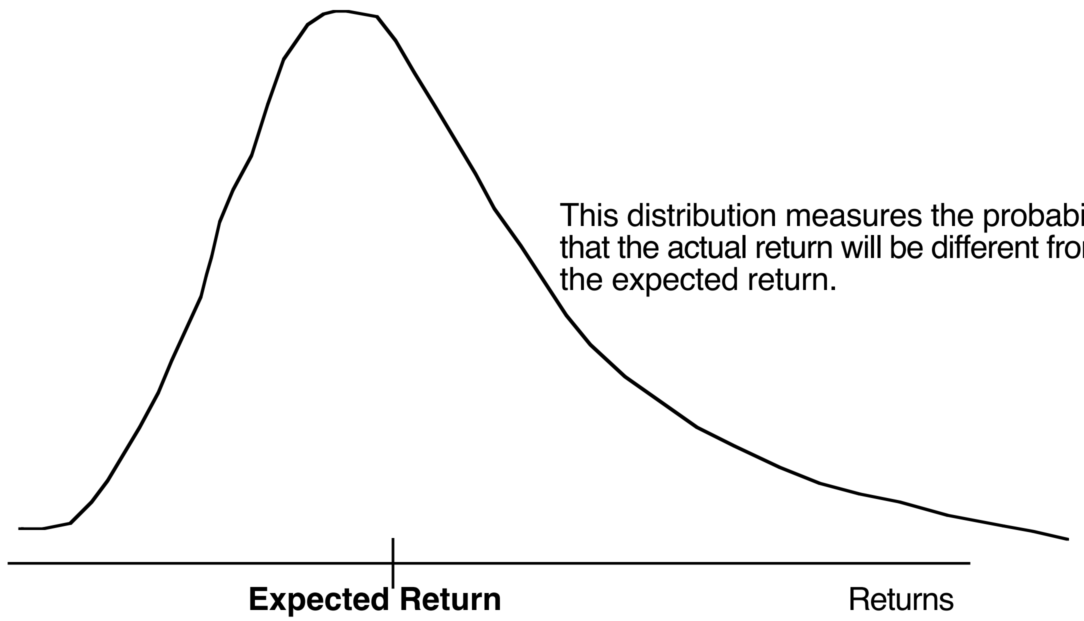
Figure 2.1: Probability Distribution for Riskfree Investment



This is a riskless investment.

To provide a contrast to the riskless investment, consider an investor who buys stock in a company like Cisco. This investor, having done her research, may conclude that she can make an expected return of 30% on Cisco over her 1-year holding period. The actual return over this period will almost certainly not be equal to 30%; it might be much greater or much lower. The distribution of returns on this investment is illustrated in Figure 2.2.

Figure 2.2: Probability Distribution for Risky Investment



In addition to the expected return, an investor has to note that the actual returns, in this case, are different from the expected return. The spread of the actual returns around the expected return is measured by the variance or standard deviation of the distribution; the greater the deviation of the actual returns from expected returns, the greater the variance.

One of the limitations of variance is that it considers all variation from the expected return to be risk. Thus, the potential that you will earn a 60% return on Cisco (30% more than the expected return of 30%) affects the variance exactly as much as the potential that you will earn 0% (30% less than the expected return). In other words, you do not distinguish between downside and upside risk. This is justified by arguing that risk is symmetric – upside risk must inevitably create the potential for downside risk.[1] If you are bothered by this assumption, you could compute a modified version of the variance, called the *semi-variance,* where you consider only the returns that fall below the expected return.

The Most and Least Volatile Stocks: Take a look at the 50 most and 50 least volatile stocks traded in the United States, based upon 5 years of weekly data.

It is true that measuring risk with variance or semi-variance can provide too limited a view of risk, and there are some investors who use simpler stand-ins (proxies) for risk. For instance, you may consider stocks in some sectors (such as technology) to be riskier than

[1] In statistical terms, this is the equivalent of assuming that the distribution of returns is close to normal.

stocks in other sectors (say, food processing). Others prefer ranking or categorization systems, where you put firms into risk classes, rather than trying to measure its risk in units. Thus, Value Line ranks firms into five classes, based upon risk.

There is one final point that needs to be made about how variances and semi-variances are estimated for most stocks. Analysts usually look at the past – stock prices over the last 2 or 5 years- to make these estimates. This may be appropriate for firms that have not changed their fundamental characteristics – business or leverage – over the period. For firms that have changed significantly over time, variances from the past may provide a very misleading view of betas in the future.

II. Diversifiable and Non-diversifiable Risk

Although there are many reasons that actual returns may differ from expected returns, we can group the reasons into two categories: firm-specific and market-wide. The risks that arise from firm-specific actions affect one or a few investments, while the risk arising from market-wide reasons affect many or all investments. This distinction is critical to the way we assess risk in finance.

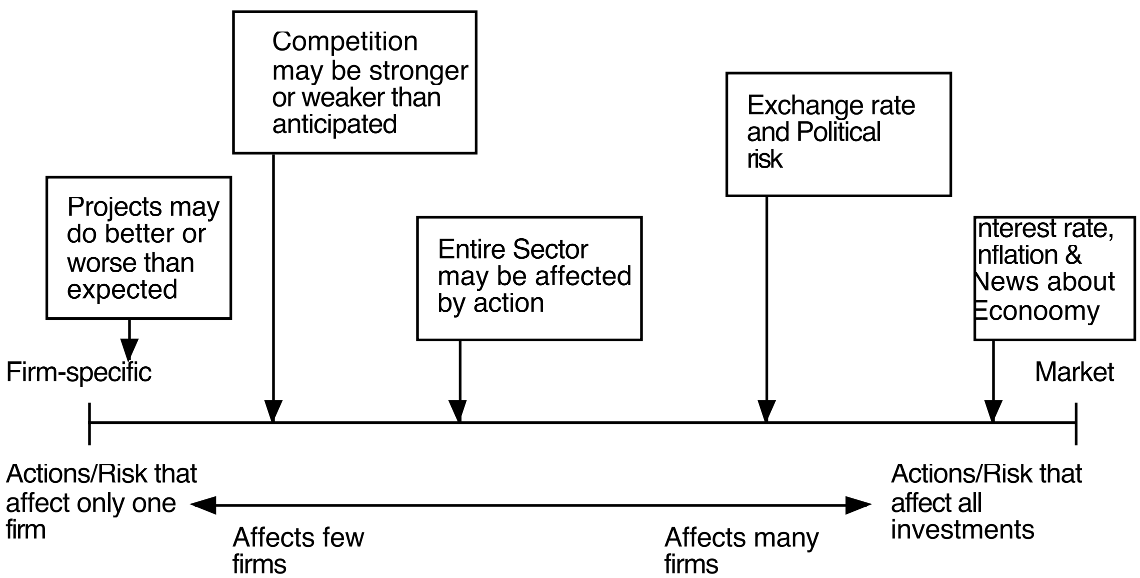
The Components of Risk

When an investor buys stock or takes an equity position in a firm, he or she is exposed to many risks. Some risk may affect only one or a few firms and it is this risk that we categorize as *firm-specific risk*. Within this category, we would consider a wide range of risks, starting with the risk that a firm may have misjudged the demand for a product from its customers; we call this *project risk*. For instance, consider an investment by Boeing in a new larger capacity airplane that we will call the Super Jumbo. This investment is based on the assumption that airlines want a larger airplane and will be willing to pay a higher price for it. If Boeing has misjudged this demand, it will clearly have an impact on Boeing's earnings and value, but it should not have a significant effect on other firms in the market. The risk could also arise from competitors proving to be stronger or weaker than anticipated; we call this *competitive risk*. For instance, assume that Boeing and Airbus are competing for an order from Qantas, the Australian airline. The possibility that Airbus may win the bid is a potential source of risk to Boeing and perhaps a few of its suppliers. But again, only a handful of firms in the market will be affected by it. Similarly, the Home Depot recently launched an online store to sell its home improvement products. Whether it succeeds or not is clearly important to the Home Depot and its competitors, but it is unlikely to have an impact on the rest of the market. In fact, we would extend our risk measures to include risks that may affect an entire sector but are restricted to that sector; we call this *sector risk*. For instance, a cut in the defense budget in the United States will adversely affect all firms in the defense business, including Boeing, but there should be no significant impact on other sectors, such as food and apparel. What is common across the three risks described above – project, competitive and sector risk – is that they affect only a small sub-set of firms.

There is other risk that is much more pervasive and affects many if not all investments. For instance, when interest rates increase, all investments are negatively affected, albeit to different degrees. Similarly, when the economy weakens, all firms feel the effects, though cyclical firms (such as automobiles, steel and housing) may feel it more. We term this risk *market risk*.

Finally, there are risks that fall in a gray area, depending upon how many assets they affect. For instance, when the dollar strengthens against other currencies, it has a significant impact on the earnings and values of firms with international operations. If most firms in the market have significant international operations, it could well be categorized as market risk. If only a few do, it would be closer to firm-specific risk. Figure 2.3 summarizes the break down or the spectrum of firm specific and market risks.

Figure 2.3: A Break Down of Risk



Why Diversification reduces or eliminates Firm-specific Risk: An Intuitive Explanation

As an investor, you could invest your entire portfolio in one stock, say Boeing. If you do so, you are exposed to both firm specific and market risk. If, however, you expand your portfolio to include other assets or stocks, you are diversifying, and by doing so, you can reduce your exposure to firm-specific risk. There are two reasons why diversification reduces or, at the limit, eliminates firm specific risk. The first is that each investment in a diversified portfolio is a much smaller percentage of that portfolio than would be the case if you were not diversified. Thus, any action that increases or decreases the value of only that investment or a small group of investments will have only a small impact on your overall portfolio, whereas undiversified investors are much more exposed to changes in the values of the investments in their portfolios. The second reason is that the effects of firm-specific actions on the prices of individual assets in a portfolio can be either positive or negative for each asset in any period. Thus, in very large portfolios, this risk will average out to zero and will not affect the overall value of the portfolio.

In contrast, the effects of market-wide movements are likely to be in the same direction for most or all investments in a portfolio, though some assets may be affected more than others. For instance, other things being equal, an increase in interest rates will lower the values of most assets in a portfolio. Being more diversified does not eliminate this risk.

> *Highest R-squared companies*: Take a look at the 50 companies with the highest proportion of market risk using the last 5 years or weekly data.

One of the simplest ways of measuring how much risk in a firm is firm specific is to look at the proportion of the firm's price movements that are explained by the market. This is called the *R-squared* and it should range between zero and one can be stated as a percentage; it measures the proportion of the firm's risk that comes from the market. A firm with an R-squared of zero has 100% firm specific risk whereas a firm with an R-squared of 0% has no firm specific risk.

*Why is the marginal investor assumed to be diversified***?**

The argument that diversification reduces an investor's exposure to risk is clear both intuitively and statistically, but risk and return models in finance go further. The models look at risk through the eyes of the investor most likely to be trading on the investment at any point in time, i.e. the marginal investor. They argue that this investor, who sets prices for investments, is well diversified; thus, the only risk that he or she cares about is the risk added on to a diversified portfolio or market risk. This argument can be justified simply. The risk in an investment will always be perceived to be higher for an undiversified investor than for a diversified one, since the latter does not shoulder any firm-specific risk and the former does. If both investors have the same expectations about future earnings and cash flows on an asset, the diversified investor will be willing to pay a higher price for that asset because of his or her perception of lower risk. Consequently, the asset, over time, will end up being held by diversified investors.

This argument is powerful, especially in markets where assets can be traded easily and at low cost. Thus, it works well for a stock traded in the United States, since investors can become diversified at fairly low cost. In addition, a significant proportion of the trading in US stocks is done by institutional investors, who tend to be well diversified. It becomes a more difficult argument to sustain when assets cannot be easily traded, or the costs of trading are high. In these markets, the marginal investor may well be undiversified and firm-specific risk may therefore continue to matter when looking at individual investments. For instance, real estate in most countries is still held by investors who are undiversified and have the bulk of their wealth tied up in these investments.

III. Models Measuring Market Risk

While most risk and return models in use in finance agree on the first two steps of the risk analysis process, i.e., that risk comes from the distribution of actual returns around the expected return and that risk should be measured from the perspective of a marginal investor who is well diversified, they part ways when it comes to measuring non-diversifiable or market risk. In this section, we will discuss the different models that exist in finance for measuring market risk and why they differ. We will begin with what still is the standard model for measuring market risk in finance – the capital asset pricing model (CAPM) – and then discuss the alternatives to this model that have developed over the last two decades. While we will emphasize the differences, we will also look at what they have in common.

A. The Capital Asset Pricing Model (CAPM)

The risk and return model that has been in use the longest and is still the standard in most real world analyses is the capital asset pricing model (CAPM). In this section, we will examine the assumptions made by the model and the measures of market risk that emerge from these assumptions.

Assumptions

While diversification reduces the exposure of investors to firm specific risk, most investors limit their diversification to holding only a few assets. Even large mutual funds rarely hold more than a few hundred stocks and many of them hold as few as ten to twenty. There are two reasons why investors stop diversifying. One is that an investor or mutual fund manager can obtain most of the benefits of diversification from a relatively small portfolio, because the marginal benefits of diversification become smaller as the portfolio gets more diversified. Consequently, these benefits may not cover the marginal costs of diversification, which include transactions and monitoring costs. Another reason for limiting diversification is that many investors (and funds) believe they can find under valued assets and thus choose not to hold those assets that they believe to be fairly or over valued.

The capital asset pricing model assumes that there are no transactions costs and that all assets are traded. It also assumes that everyone has access to the same information and that investors therefore cannot find under or over valued assets in the market place. Making these assumptions allows investors to keep diversifying without additional cost. At the limit, each investor's will include every traded asset in the market held in proportion to its market value. The fact that this diversified portfolio includes all traded assets in the market is the reason it is called the *market portfolio*, which should not be a surprising result, given the benefits of diversification and the absence of transactions costs in the capital asset pricing model. If diversification reduces exposure to firm-specific risk and there are no costs associated with adding more assets to the portfolio, the logical limit to diversification is to hold a small proportion of every traded asset in the market. If this seems abstract, consider the market portfolio to be an extremely well diversified mutual fund that holds stocks and real assets, and treasury bills as the riskless asset. In the CAPM, all investors will hold combinations of treasury bills and the same mutual fund[2].

Investor Portfolios in the CAPM

If every investor in the market holds the identical market portfolio, how exactly do investors reflect their risk aversion in their investments? In the capital asset pricing model, investors adjust for their risk preferences in their allocation decision, where they decide how much to invest in a riskless asset and how much in the market portfolio. Investors who are risk averse might choose to put much or even all of their wealth in the riskless asset. Investors who want to take more risk will invest the bulk or even all of their wealth in the market portfolio. Investors, who invest all their wealth in the market portfolio and are still desirous of taking on more risk, would do so by borrowing at the riskless rate and investing more in the same market portfolio as everyone else.

These results are predicated on two additional assumptions. First, there exists a riskless asset, where the expected returns are known with certainty. Second, investors can lend and borrow at the same riskless rate to arrive at their optimal allocations. While lending at the riskless rate can be accomplished fairly simply by buying treasury bills or bonds, borrowing at the riskless rate might be more difficult to do for individuals. There are variations of the CAPM that allow these assumptions to be relaxed and still arrive at the conclusions that are consistent with the model.

[2] The significance of introducing the riskless asset into the choice mix, and the implications for portfolio choice were first noted in Sharpe (1964) and Lintner (1965). Hence, the model is sometimes called the Sharpe-Lintner model.

Measuring the Market Risk of an Individual Asset

The risk of any asset to an investor is the risk added by that asset to the investor's overall portfolio. In the CAPM world, where all investors hold the market portfolio, the risk to an investor of an individual asset will be the risk that this asset adds on to that portfolio. Intuitively, if an asset moves independently of the market portfolio, it will not add much risk to the market portfolio. In other words, most of the risk in this asset is firm-specific and can be diversified away. In contrast, if an asset tends to move up when the market portfolio moves up and down when it moves down, it will add risk to the market portfolio. This asset has more market risk and less firm-specific risk. Statistically, this added risk is measured by the *covariance* of the asset with the market portfolio.

Highest and Lowest Beta Stocks: Take a look at the 50 highest beta and 50 lowest beta stocks traded in the United States, based upon 5 years of weekly data.

The covariance is a percentage value and it is difficult to pass judgment on the relative risk of an investment by looking at this value. In other words, knowing that the covariance of Boeing with the Market Portfolio is 55% does not provide us a clue as to whether Boeing is riskier or safer than the average asset. We therefore standardize the risk measure by dividing the covariance of each asset with the market portfolio by the variance of the market portfolio. This yields a risk measure called the **beta** of the asset:

$$\text{Beta of an asset } = \frac{\text{Covariance of asset with Market Portfolio}}{\text{Variance of the Market Portfolio}}$$

The beta of the market portfolio, and by extension, the average asset in it, is one. Assets that are riskier than average (using this measure of risk) will have betas that are greater than 1 and assets that are less risky than average will have betas that are less than 1. The riskless asset will have a beta of 0.

Getting Expected Returns

Once you accept the assumptions that lead to all investors holding the market portfolio and measure the risk of an asset with beta, the return you can expect to make can be written as a function of the risk-free rate and the beta of that asset.

Expected Return on an investment = Riskfree Rate + Beta (Risk Premium for buying the average risk investment)

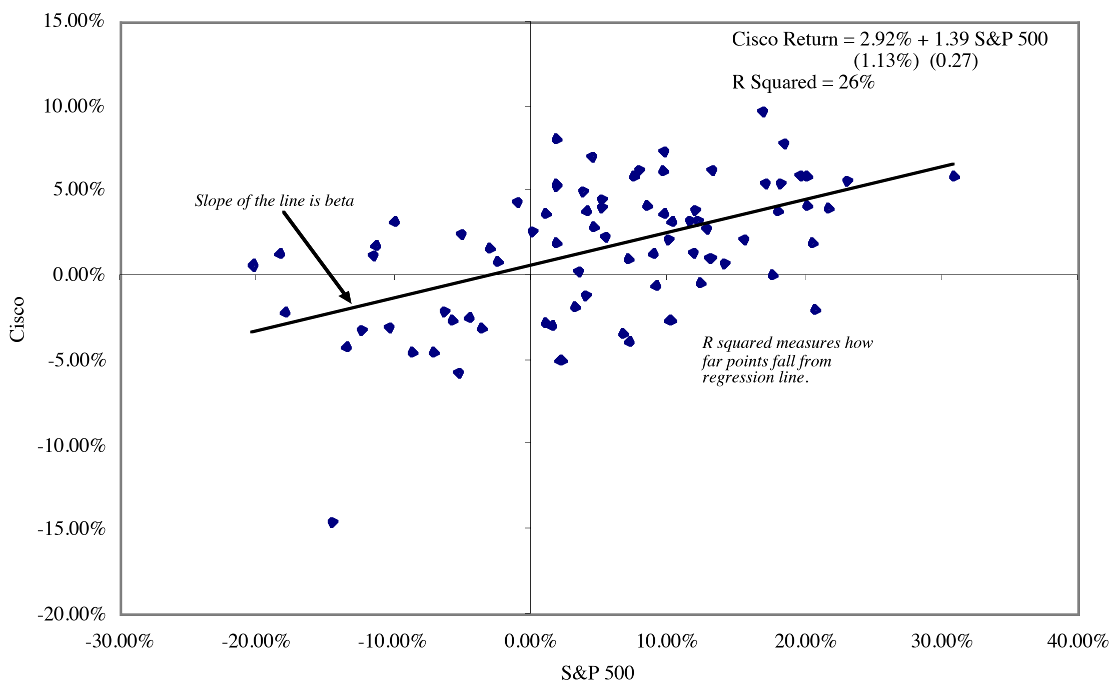
Consider the three components that go into the expected return.

a. Riskless Rate: The return you can make on a riskfree investment becomes the base from which you build expected returns. Essentially, you are assuming that if you can make 5%

investing in treasury bills or bonds, you would not settle for less than this as an expected return for investing in a riskier asset. Generally speaking, we use the interest rate on government securities to estimate the riskfree rate, assuming that such securities have no default risk. While this may be a safe assumption in the United States and other developed markets, it may be inappropriate in many emerging markets, where governments themselves are viewed as capable of defaulting. In such cases, the government bond rate will include a premium for default risk and this premium will have to be removed to arrive at a riskfree rate. [3]

b. *The beta of the investment*: The beta is the only component in this model which varies from investment to investment, with investments that add more risk to the market portfolio having higher betas. But where do betas come from? Since the beta measures the risk added to a market portfolio by an individual stock, it is usually estimated by running a regression of past returns on the stock against returns on a market index.

Figure 2.4: Beta Estimate for Cisco: S&P 500



[3] Consider, for example, a government bond issued by the Brazilian government. Denominated in Brazilian Real, this bond has an interest rate of 17%. The Brazilian government is viewed as having default risk on this bond and is rated BB by Standard and Poor's. If we subtract the typical default spread earned by BB rated country bonds (about 5%) from 17%, we end up with a riskless rate in Brazilian Real of 12%.

The slope of the regression captures how sensitive a stock is to market movements and is the beta of the stock. In the regression above, for instance, the beta of Cisco would be 1.39. There are, however, two problems with regression betas. One is that the beta comes with estimation error – the standard error in the estimate is 0.27. Thus, the true beta for Cisco could be anywhere from .85 to 1.93 – this range is estimated by adding and subtracting two standard errors to the beta estimate. The other is that firms change over time and we are looking backwards rather than looking forwards. A better way to estimate betas is to look at the average beta for publicly traded firms in the business or businesses Cisco operates in. While these betas come from regressions as well, the average beta is always more precise than any one firm's beta estimate.

Risk Premium for the United States: Take a look at the equity risk premium implied in the U.S. stock market from 1960 through the most recent year.

c. *The risk premium for buying the average risk investment*: You can view this as the premium you would demand for investing in equities as a class as opposed to the riskless investment. Thus, if you require a return of 9% for investing in equities and the treasury bond rate is 5%, your risk premium is 4%. There are again two ways in which you can estimate this risk premium. One is to look at the past and look at the typical premium you would have earned investing in stocks as opposed to a riskless investment. This number is called a historical premium and yields about 5-7% for the United States. The other is to look at how stocks are priced today and to estimate the premium that investors must be demanding. This is called an implied premium and yields a value of about 4% for U.S. stocks in early 2002.

Bringing it all together, you could use the capital asset pricing model to estimate the expected return on a stock for Cisco for the future (assuming a treasury bond rate of 5%, the regression beta of 1.39 and a risk premium of 4%):

Expected return on Cisco = T. Bond Rate + Beta * Risk Premium

= 5% + 1.39 (4%) = 10.56%

What does this number imply? It does not mean that you will earn 10.56% every year from risk, but it does provide a benchmark that you will have to meet and beat if you are considering Cisco as an investment. For Cisco to be a good investment, you would have to expect it to make more than 10.56% as an annual return in the future.

In summary, in the capital asset pricing model, all the market risk is captured in the beta, measured relative to a market portfolio, which at least in theory should include all traded assets in the market place held in proportion to their market value.

Betas for Other Investments

Most services report betas for publicly traded stocks, but there is no reason why the concept cannot be extended to other investments. You could compute the beta of real estate, gold or even fine art as an investment, just as you computed the beta for Cisco. While analysts have done this and concluded that both real estate and gold are low beta investments (though not necessarily low variance investments), we would add a few cautionary notes. The first is that it is difficult to get traded prices on some alternative investments on a continuous basis. [4] The second is that many analysts continue to use the stock index as their measure of the market portfolio. Since the market portfolio in the capital asset pricing model is supposed to include all traded assets, this likely to give you betas that are biased downwards for non-equity investments.

If you modify the market portfolio to include other traded asset classes and compute betas for alternative investments, you may even find some that have negative betas. While, on the face of it, this may seem absurd, you can get negative betas for investments that reduce the risk (rather than add on to risk) of the market portfolio. Essentially, these investments act as insurance against some large component of market risk, going up as other investments in the portfolio go down. This is the reason why some analysts claim that gold as an investment should have a negative beta, because it tends to do well when inflation increases whereas financial investments are hurt.

B. Alternatives to the Capital Asset Pricing Model

The restrictive assumptions on transactions costs and private information in the capital asset pricing model and the model's dependence on the market portfolio have long been viewed with skepticism by both academics and practitioners. There are three alternatives to the CAPM that have been developed over time:

1. Arbitrage Pricing Model: To understand the arbitrage pricing model, we need to begin with a definition of arbitrage. The basic idea is a simple one. Two portfolios or assets with the same exposure to market risk should be priced to earn exactly the same expected returns. If they are not, you could buy the less expensive portfolio, sell the more expensive portfolio, have no risk exposure and earn a return that exceeds the riskless rate. This is arbitrage. If you assume that arbitrage is not possible and that investors are diversified, you can show that the expected return on an investment should be a function of its exposure to market risk. While this statement mirrors what was stated in the capital asset pricing model,

---

[4] Analysts have tried to get around this problem by using the prices of real estate investment trusts which are traded, but they represent a small fraction of all real estate investments.

the arbitrage pricing model does not make the restrictive assumptions about transactions costs and private information that lead to the conclusion that one beta can capture an investment's entire exposure to market risk. Instead, in the arbitrage pricing model, you can have multiples sources of market risk and different exposures to each (betas) and your expected return on an investment can be written as:

Expected return = Riskfree rate + Beta for factor 1 (Risk premium for factor 1) + Beta for factor 2 (Risk premium for factor 2)….+ Beta for factor n (Risk premium for factor n)

The practical questions then become knowing how many factors there are that determine expected returns and what the betas for each investment are against these factors. The arbitrage model estimates both by examining historical data on stock returns for common patterns (since market risk affects most stocks) and estimating each stock's exposure to these patterns in a process called factor analysis. A factor analysis provides two output measures:

1. It specifies the number of common factors that affected the historical return data
2. It measures the beta of each investment relative to each of the common factors and provides an estimate of the actual risk premium earned by each factor.

The factor analysis does not, however, identify the factors in economic terms – the factors remain factor 1, factor etc. In summary, in the arbitrage pricing model, the market risk is measured relative to multiple unspecified macroeconomic variables, with the sensitivity of the investment relative to each factor being measured by a beta. The number of factors, the factor betas and factor risk premiums can all be estimated using the factor analysis.

2. Multi-factor Models for risk and return: The arbitrage pricing model's failure to identify the factors specifically in the model may be a statistical strength, but it is an intuitive weakness. The solution seems simple: Replace the unidentified statistical factors with specific economic factors and the resultant model should have an economic basis while still retaining much of the strength of the arbitrage pricing model. That is precisely what multi-factor models try to do. Multi-factor models generally are determined by historical data, rather than economic modeling. Once the number of factors has been identified in the arbitrage pricing model, their behavior over time can be extracted from the data. The behavior of the unnamed factors over time can then be compared to the behavior of macroeconomic variables over that same period to see whether any of the variables is correlated, over time, with the identified factors.

For instance, Chen, Roll, and Ross (1986) suggest that the following macroeconomic variables are highly correlated with the factors that come out of factor analysis: industrial production, changes in default premium, shifts in the term structure, unanticipated inflation, and changes in the real rate of return. These variables can then be correlated with returns to come up with a model of expected returns, with firm-specific betas calculated relative to each variable.

$$E(R) = R_f + \beta_{GNP}\left[E(R_{GNP}) - R_f\right] + \beta_I\left[E(R_I) - R_f\right] + \ldots + \beta_\partial\left[E(R_\partial) - R_f\right]$$

where

β_{GNP} = Beta relative to changes in industrial production

$E(R_{GNP})$ = Expected return on a portfolio with a beta of one on the industrial production factor and zero on all other factors

β_I = Beta relative to changes in inflation

$E(R_I)$ = Expected return on a portfolio with a beta of one on the inflation factor and zero on all other factors

The costs of going from the arbitrage pricing model to a macroeconomic multi-factor model can be traced directly to the errors that can be made in identifying the factors. The economic factors in the model can change over time, as will the risk premia associated with each one. For instance, oil price changes were a significant economic factor driving expected returns in the 1970s but are not as significant in other time periods. Using the wrong factor or missing a significant factor in a multi-factor model can lead to inferior estimates of expected return.

In summary, multi-factor models, like the arbitrage pricing model, assume that market risk can be captured best using multiple macro economic factors and betas relative to each. Unlike the arbitrage pricing model, multi factor models do attempt to identify the macro economic factors that drive market risk.

3. Regression or Proxy Models: All the models described so far begin by defining market risk in broad terms and then developing models that might best measure this market risk. All of them, however, extract their measures of market risk (betas) by looking at historical data. There is a final class of risk and return models that start with the returns and try to explain differences in returns across stocks over long time periods using characteristics such as a firm's market value or price multiples[5]. Proponents of these models argue that if some investments earn consistently higher returns than other investments, they must be riskier. Consequently, we could look at the characteristics that these high-return investments

---

[5] A price multiple is obtained by dividing the market price by its earnings or its book value. Studies indicate that stocks that have low price to earnings multiples or low price to book value multiples earn higher returns than other stocks.

have in common and consider these characteristics to be indirect measures or proxies for market risk.

Fama and French, in a highly influential study of the capital asset pricing model in the early 1990s, noted that actual returns between 1963 and 1990 have been highly correlated with book to price ratios[6] and size. High return investments, over this period, tended to be investments in companies with low market capitalization and high book to price ratios. Fama and French suggested that these measures be used as proxies for risk and report the following regression for monthly returns on stocks on the NYSE:

$$R_t = 1.77\% - 0.11\ln(MV) + 0.35\ln\left(\frac{BV}{MV}\right)$$

where

MV = Market Value of Equity

BV/MV = Book Value of Equity / Market Value of Equity

The values for market value of equity and book-price ratios for individual firms, when plugged into this regression, should yield expected monthly returns.

. A Composite of the CAPM and Proxy Models: Three Factor Models

The capital asset pricing model relates the expected return on an investment to its beta against a market portfolio. The proxy models find that there are other variables such as market capitalization and price to book ratios explain returns better than betas. There are composite models that attempt to blend the two and estimated expected returns as a function of betas, market capitalization and price to book ratios. These are also called factor models.

Will these composite models work better than the CAPM? Of course! Should we therefore use them instead of the CAPM? The answer is that it depends on what you are trying to do. If you are trying to explain the past performance of portfolio managers, it may make sense to use composite models, since failing to do so will make portfolio managers who invest in small cap stocks look much better than portfolio managers who invest in large cap stocks. If you are trying to estimate expected returns for the future, to make judgments on where to invest your money, you should be careful about going down this road, since it seems designed to lead the conclusion that everything is fairly priced. Consider why. If there are pockets of the market which are systematically mispriced – say small cap stocks with low price to book ratios – you want to buy these stocks and you will using a conventional risk and return model. If you use a composite model and include market capitalization and price to book ratios as factors, these same stocks will look fairly valued.

---

[6] The book to price ratio is the ratio of the book value of equity to the market value of equity.

A Comparative Analysis of Risk and Return Models

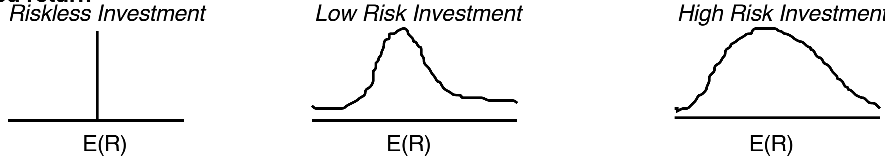
Figure 2.5 summarizes all the risk and return models in finance, noting their similarities in the first two steps and the differences in the way they define market risk.

Figure 2.5: Risk and Return Models in Finance

Step 1: Defining Risk

The risk in an investment can be measured by the variance in actual returns around an expected return

Riskless Investment | *Low Risk Investment* | *High Risk Investment*



Step 2: Differentiating between Rewarded and Unrewarded Risk

Risk that is specific to investment (Firm Specific)
Can be diversified away in a diversified portfolio
1. each investment is a small proportion of portfolio
2. risk averages out across investments in portfolio

Risk that affects all investments (Market Risk)
Cannot be diversified away since most assets are affected by it.

The marginal investor is assumed to hold a "diversified" portfolio. Thus, only market risk will be rewarded and priced.

Step 3: Measuring Market Risk

The CAPM	**The APM**	**Multi-Factor Models**	**Proxy Models**
If there is 1. no private information 2. no transactions cost the optimal diversified portfolio includes every traded asset. Everyone will hold this <u>market portfolio</u> **Market Risk = Risk added by any investment to the market portfolio:**	If there are no arbitrage opportunities then the market risk of any asset must be captured by betas relative to factors that affect all investments. **Market Risk = Risk exposures of any asset to market factors**	Since market risk affects most or all investments, it must come from macro economic factors. **Market Risk = Risk exposures of any asset to macro economic factors.**	In an efficient market, differences in returns across long periods must be due to market risk differences. Looking for variables correlated with returns should then give us proxies for this risk. **Market Risk = Captured by the Proxy Variable(s)**
Beta of asset relative to Market portfolio (from a regression)	Betas of asset relative to unspecified market factors (from a factor analysis)	Betas of assets relative to specified macro economic factors (from a regression)	Equation relating returns to proxy variables (from a regression)

As noted in Figure 2.5, all the risk and return models developed in this chapter make some assumptions in common. They all assume that only market risk is rewarded and they derive the expected return as a function of measures of this risk. The capital asset pricing model makes the most restrictive assumptions about how markets work but arrives at the simplest model, with only one factor driving risk and requiring estimation. The arbitrage pricing model makes fewer assumptions but arrives at a more complicated model, at least in terms of the parameters that require estimation. The capital asset pricing model can be considered a specialized case of the arbitrage pricing model, where there is only one underlying factor and it is completely measured by the market index. In general, the CAPM has the advantage of being a simpler model to estimate and to use, but it will underperform the richer multi-factor models when an investment is sensitive to economic factors not well represented in the market index. For instance, oil company stocks, which derive most of their risk from oil price movements, tend to have low CAPM betas and low expected returns. An arbitrage pricing model, where one of the factors may measure oil and other commodity price movements, will yield a better estimate of risk and higher expected return for these firms[7].

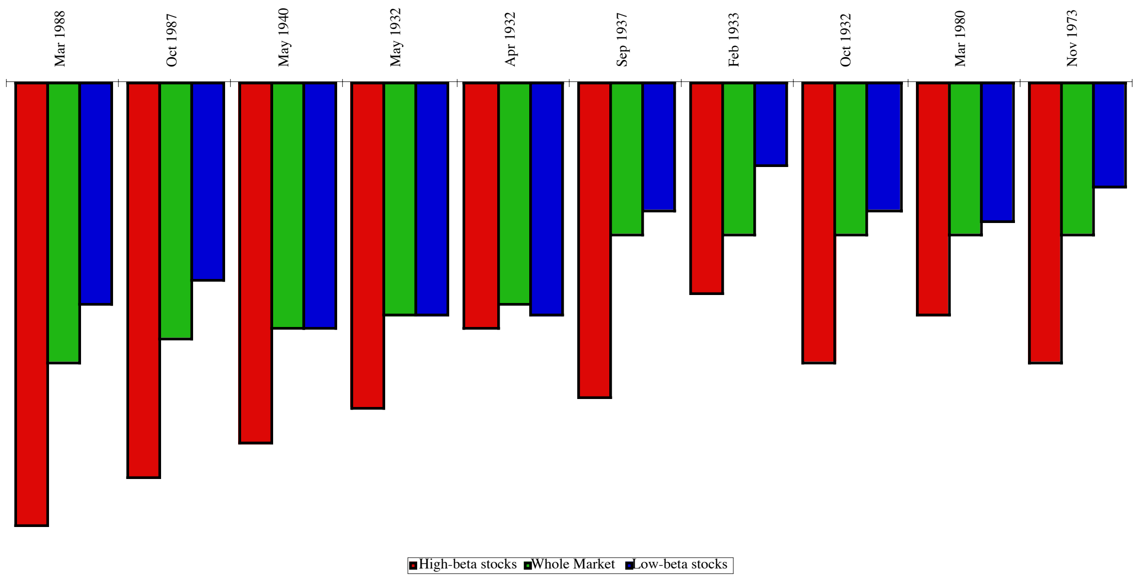
Which of these models works the best? Is beta a good proxy for risk and is it correlated with expected returns? The answers to these questions have been debated widely in the last two decades. The first tests of the CAPM suggested that betas and returns were positively related, though other measures of risk (such as variance) continued to explain differences in actual returns. This discrepancy was attributed to limitations in the testing techniques. In 1977, Roll, in a seminal critique of the model's tests, suggested that since the market portfolio could never be observed, the CAPM could never be tested, and all tests of the CAPM were therefore joint tests of both the model and the market portfolio used in the tests. In other words, all that any test of the CAPM could show was that the model worked (or did not) given the proxy used for the market portfolio. It could therefore be argued that in any empirical test that claimed to reject the CAPM, the rejection could be of the proxy used for the market portfolio rather than of the model itself. Roll noted that there was no way to ever prove that the CAPM worked and thus no empirical basis for using the model.

Fama and French (1992) examined the relationship between betas and returns between 1963 and 1990 and concluded that there is no relationship. These results have been contested on three fronts. First, Amihud, Christensen, and Mendelson (1992), used the same data, performed different statistical tests and showed that differences in betas did, in fact, explain differences in returns during the time period. Second, Kothari and Shanken (1995) estimated betas using annual data, instead of the shorter intervals used in many tests, and concluded that betas do explain a significant proportion of the differences in returns across investments. Third, Chan and Lakonishok (1993) looked at a much longer time series of returns from 1926 to 1991 and found that the positive relationship between betas and returns broke down only in the period after 1982. They also find that betas are a useful guide to risk in extreme market conditions, with the riskiest firms (the 10% with highest betas) performing far worse than the market as a whole, in the ten worst months for the market between 1926 and 1991 (See Figure 2.6).

---

[7] Weston and Copeland used both approaches to estimate the cost of equity for oil companies in 1989 and came up with 14.4% with the CAPM and 19.1% using the arbitrage pricing model.

FIGURE 2.6: Returns and Betas: Ten Worst Months between 1926 and 1991



While the initial tests of the APM suggested that they might provide more promise in terms of explaining differences in returns, a distinction has to be drawn between the use of these models to explain differences in past returns and their use to predict expected returns in the future. The competitors to the CAPM clearly do a much better job at explaining past returns since they do not constrain themselves to one factor, as the CAPM does. This extension to multiple factors does become more of a problem when we try to project expected returns into the future, since the betas and premiums of each of these factors now have to be estimated. Because the factor premiums and betas are themselves volatile, the estimation error may eliminate the benefits that could be gained by moving from the CAPM to more complex models. The regression models that were offered as an alternative also have an estimation problem, since the variables that work best as proxies for market risk in one period (such as market capitalization) may not be the ones that work in the next period.

Ultimately, the survival of the capital asset pricing model as the default model for risk in real world applications is a testament to both its intuitive appeal and the failure of more complex models to deliver significant improvement in terms of estimating expected returns. We would argue that a judicious use of the capital asset pricing model, without an over reliance on historical data, is still the most effective way of dealing with risk in modern corporate finance.

Models of Default Risk

The risk that we have discussed hitherto in this chapter relates to cash flows on investments being different from expected cash flows. There are some investments, however, in which the cash flows are promised when the investment is made. This is the case, for instance, when you lend to a business or buy a corporate bond. However, the borrower may default on interest and principal payments on the borrowing. Generally speaking, borrowers with higher default risk should pay higher interest rates on their borrowing than those with lower default risk. This section examines the measurement of default risk and the relationship of default risk to interest rates on borrowing.

In contrast to the general risk and return models for equity, which evaluate the effects of market risk on expected returns, models of default risk measure the consequences of firm-specific default risk on promised returns. While diversification can be used to explain why firm-specific risk will not be priced into expected returns for equities, the same rationale cannot be applied to securities that have limited upside potential and much greater downside potential from firm-specific events. To see what we mean by limited upside potential, consider investing in the bond issued by a company. The coupons are fixed at the time of the issue and these coupons represent the promised cash flow on the bond. The best case scenario for you as an investor is that you receive the promised cash flows; you are not entitled to more than these cash flows even if the company is wildly successful. All other scenarios contain only bad news, though in varying degrees, with the delivered cash flows being less than the promised cash flows. Consequently, the expected return on a corporate bond is likely to reflect the firm-specific default risk of the firm issuing the bond.

The Determinants of Default Risk

The default risk of a firm is a function of two variables. The first is the firm's capacity to generate cash flows from operations and the second is its financial obligations – including interest and principal payments[8]. Firms that generate high cash flows relative to their financial obligations should have lower default risk than firms that generate low cash flows relative to their financial obligations. Thus, firms with significant existing investments, which generate relatively high cash flows, will have lower default risk than firms that do not.

In addition to the magnitude of a firm's cash flows, the default risk is also affected by the volatility in these cash flows. The more stability there is in cash flows the lower the

---

[8] Financial obligation refers to any payment that the firm has legally obligated itself to make, such as interest and principal payments. It does not include discretionary cash flows, such as dividend payments or new capital expenditures, which can be deferred or delayed, without legal consequences, though there may be economic consequences.

default risk in the firm. Firms that operate in predictable and stable businesses will have lower default risk than will other similar firms that operate in cyclical or volatile businesses.

Most models of default risk use financial ratios to measure the cash flow coverage (i.e., the magnitude of cash flows relative to obligations) and control for industry effects to evaluate the variability in cash flows.

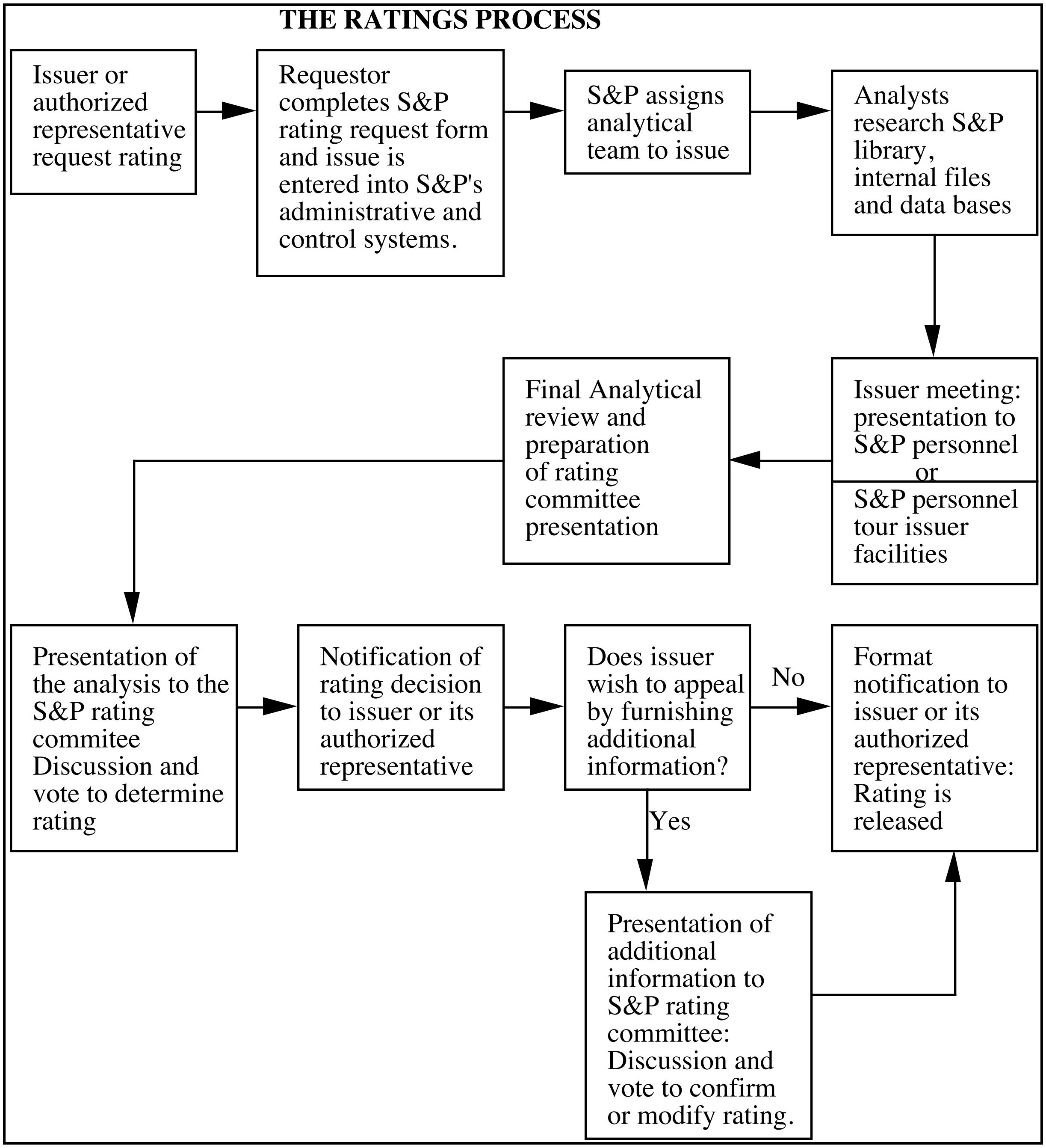
Bond Ratings and Interest rates

The most widely used measure of a firm's default risk is its bond rating, which is generally assigned by an independent ratings agency. The two best known are Standard and Poor’s and Moody’s. Thousands of companies are rated by these two agencies and their views carry significant weight with financial markets.

The Ratings Process

The process of rating a bond usually starts when the issuing company requests a rating from a bond ratings agency. The ratings agency then collects information from both publicly available sources, such as financial statements, and the company itself and makes a decision on the rating. If the company disagrees with the rating, it is given the opportunity to present additional information. This process is presented schematically for one ratings agency, Standard and Poors (S&P), in Figure 2.7.

Figure 2.7: The Ratings Process



The ratings assigned by these agencies are letter ratings. A rating of AAA from Standard and Poor's and Aaa from Moody's represents the highest rating granted to firms that are viewed as having the lowest default risk. As the default risk increases, the ratings decrease toward D for firms in default (Standard and Poor's). A rating at or above BBB by Standard and Poor's is categorized as investment grade, reflecting the view of the ratings agency that there is relatively little default risk in investing in bonds issued by these firms.

Determinants of Bond Ratings

The bond ratings assigned by ratings agencies are primarily based upon publicly available information, though private information conveyed by the firm to the rating agency does play a role. The rating assigned to a company's bonds will depend in large part on financial ratios that measure the capacity of the company to meet debt payments and generate stable and predictable cash flows. While a multitude of financial ratios exist, table 2.1 summarizes some of the key ratios used to measure default risk.

Table 2.1: Financial Ratios used to measure Default Risk

Ratio	Description
Pretax Interest Coverage	$\frac{\text{Pretax Income from Continuing Operations} + \text{Interest Expense}}{\text{Gross Interest}}$
EBITDA Interest Coverage	$\frac{\text{EBITDA}}{\text{Gross Interest}}$
Funds from Operations / Total Debt	$\frac{\text{Net Income from Continuing Operations} + \text{Depreciation}}{\text{Total Debt}}$
Free Operating Cashflow/ Total Debt	$\frac{\left(\begin{array}{l}\text{Funds from Operations - Capital Expenditures}\\ \text{-Change in Working Capital}\end{array}\right)}{\text{Total Debt}}$
Pretax Return on Permanent Capital	$\frac{\text{Pretax Income from Continuing Operations} + \text{Interest Expense}}{\left(\begin{array}{l}\text{Average of Beginning of the year and End of the year of long and}\\ \text{short term debt, minority interest and Shareholders Equity}\end{array}\right)}$
Operating Income/Sales	$\frac{\left(\begin{array}{l}\text{Sales - COGS(before depreciation) - Selling Expenses -}\\ \text{Administrative Expenses - R \& D Expenses}\end{array}\right)}{\text{Sales}}$

Long Term Debt/ Capital	$\frac{\text{Long Term Debt}}{\text{Long Term Debt} + \text{Equity}}$
Total Debt/Capitalization	$\frac{\text{Total Debt}}{\text{Total Debt} + \text{Equity}}$

Source: Standard and Poors

There is a strong relationship between the bond rating a company receives and its performance on these financial ratios. Table 2.2 provides a summary of the median ratios[9] from 1998 to 2000 for different S&P ratings classes for manufacturing firms.

Table 2.2: Financial Ratios by Bond Rating: 1998-2000

	AAA	*AA*	*A*	*BBB*	*BB*	*B*	*CCC*
EBIT interest cov. (x)	17.5	10.8	6.8	3.9	2.3	1.0	0.2
EBITDA interest cov.	21.8	14.6	9.6	6.1	3.8	2.0	1.4
Funds flow/total debt	105.8	55.8	46.1	30.5	19.2	9.4	5.8
Free oper. cash flow/total debt (%)	55.4	24.6	15.6	6.6	1.9	–4.5	-14.0
Return on capital (%)	28.2	22.9	19.9	14.0	11.7	7.2	0.5
Oper.income/sales (%)	29.2	21.3	18.3	15.3	15.4	11.2	13.6
Long-term debt/capital (%)	15.2	26.4	32.5	41.0	55.8	70.7	80.3
Total Debt/ Capital (%)	26.9	35.6	40.1	47.4	61.3	74.6	89.4
Number of firms	10	34	150	234	276	240	23

Source: Standard and Poors

Note that the pre-tax interest coverage ratio (EBIT) and the EBITDA interest coverage ratio are stated in terms of times interest earned, whereas the rest of the ratios are stated in percentage terms.

Not surprisingly, firms that generate income and cash flows significantly higher than debt payments, that are profitable and that have low debt ratios are more likely

Companies with AAA ratings: Take a look at the companies that commanded triple AAA ratings from Standard and Poor's in the most recent period.

[9] See the Standard and Poor's online site: http://www.standardandpoors.com/ratings/criteria/index.htm

to be highly rated than are firms that do not have these characteristics. There will be individual firms whose ratings are not consistent with their financial ratios, however, because the ratings agency does add subjective judgments into the final mix. Thus, a firm that performs poorly on financial ratios but is expected to improve its performance dramatically over the next period may receive a higher rating than is justified by its current financials. For most firms, however, the financial ratios should provide a reasonable basis for guessing at the bond rating.

Synthetic Ratings and Default Risk

Not all firms that borrow money have bond ratings available on them. How do you go about estimating the cost of debt for these firms? There are two choices.

- One is to look at recent borrowing history. Many firms that are not rated still borrow money from banks and other financial institutions. By looking at the most recent borrowings made by a firm, you can get a sense of the types of default spreads being charged the firm and use these spreads to come up with a cost of debt.
- The other is to estimate a synthetic rating for the firm, i.e, use the financial ratios used by the bond ratings agencies to estimate a rating for the firm. To do this you would need to begin with the rated firms and examine the financial characteristics shared by firms within each ratings class. As an example, assume that you have an unrated firm with operating earnings of $ 100 million and interest expenses of $ 20 million. You could use the interest coverage ratio of 5.00 (100/20) to estimate a bond rating of A- for this firm.[10].

Bond Ratings and Interest Rates

The interest rate on a corporate bond should be a function of its default risk, which is measured by its rating. If the rating is a good measure of the default risk, higher rated bonds should be priced to yield lower interest rates than would lower rated bonds. The difference between the interest rate on a bond with default risk and a default-free government bond is defined to be the *default spread*. Table 2.3 summarizes default spreads for 10-year bonds in S&P's different rating classes as of December 31, 2001:

Table 2.3: Default Spreads and Bond Ratings

Rating	*Spread*

[10] This rating was based upon a table that was developed in 1999 and 2000, by listing out all rated firms, with market capitalization lower than $ 2 billion, and their interest coverage ratios, and then sorting firms based upon their bond ratings. The ranges were adjusted to eliminate outliers and to prevent overlapping ranges.

AAA	0.75%
AA	1.00%
A+	1.50%
A	1.80%
A-	2.00%
BBB	2.25%
BB	3.50%
B+	4.75%
B	6.50%
B-	8.00%
CCC	10.00%
CC	11.50%
C	12.70%
D	14.00%

Source: www.bondsonline.com

These default spreads, when added to the riskless rate, yield the interest rates for bonds with the specified ratings. For instance, a D rated bond has an interest rate about 14% higher than the riskless rate. This default spread will vary by maturity of the bond and can also change from period to period, depending on economic conditions, widening during economic slowdowns and narrowing when the economy is strong.

Summary

Risk, as we define it in finance, is measured based upon deviations of actual returns on an investment from its' expected returns. There are two types of risk. The first, which we call equity risk, arises in investments where there are no promised cash flows, but there are expected cash flows. The second, default risk, arises on investments with promised cash flows.

On investments with equity risk, the risk is best measured by looking at the variance of actual returns around the expected returns, with greater variance indicating greater risk. This risk can be broken down into risk that affects one or a few investments, which we call firm specific risk, and risk that affects many investments, which we refer to as market risk. When investors diversify, they can reduce their exposure to firm specific risk. By assuming that the investors who trade at the margin are well diversified, we conclude that the risk we should be looking at with equity investments is the market risk. The different models of equity risk introduced in this chapter share this objective of measuring market risk, but they differ in the way they do it. In the capital asset pricing model, exposure to market risk is measured by a market beta, which estimates how much risk an individual investment will add to a portfolio that includes all traded assets. The arbitrage pricing model and the multi-factor model allow for multiple sources of market risk and estimate betas for an investment relative to each source. Regression or proxy models for risk look for firm characteristics, such as size, that have been correlated with high returns in the past and use these to measure market risk. In all these models, the risk measures are used to estimate the expected return on an equity investment. This expected return can be considered the cost of equity for a company.

On investments with default risk, risk is measured by the likelihood that the promised cash flows might not be delivered. Investments with higher default risk should have higher interest rates and the premium that we demand over a riskless rate is the default premium. For most US companies, default risk is measured by rating agencies in the form of a company rating; these ratings determine, in large part, the interest rates at which these firms can borrow. Even in the absence of ratings, interest rates will include a default premium that reflects the lenders' assessments of default risk. These default-risk adjusted interest rates represent the cost of borrowing or debt for a business.

Lessons for Investors

1. Your perceptions of how risky an investment may be very different from the risk perceived by the marginal investors (the large institutional investors who set prices at the margin) in an investment. The market prices assets based upon the marginal investors' perceptions of risk.
2. Since the marginal investors are usually well diversified, the only risk that is priced is the risk that cannot be diversified away in a portfolio.
3. Individual risk and return models differ on how to measure this non-diversifable risk. The capital asset pricing model tries to measure it with one beta, whereas multi-factor models try to measure it with multiple betas.
4. The measure of risk allows us to estimate an expected return on a risky investment for the future. This expected return becomes the benchmark that the investment has to beat to be a good investment.
5. For bonds, risk is measured as default or downside risk, since there is not much potential upside. Bond with higher default risk should command higher interest rates.