In finance, according to Damodaran (2002), risk refers to the likelihood that an investor will receive a return on an investment that is different from the return expected to make. Risk is not only the bad outcomes but also indicates the upside potential of return from a security as well.

Any investor investing money in any asset expects 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.

Investor has to keep this in mind that the actual returns can be 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 variance. Any investment's bias towards positive or negative returns is represented by the skewness of the distribution. Third, the shape of the tails of the distribution is measured by the kurtosis of the distribution; fatter tails lead to higher kurtosis. In investment terms, this represents the tendency of the price of this investment to jump (up or down from current levels) in either direction (Damodaran, 2002).

**Diversifiable and Non- diversifiable Risk**

There are many reasons that actual returns may differ from expected returns, but mainly these reasons can be grouped 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. (Damodaran, 2002).

Firm specific risk comprised a wide range of risks, starting with the risk that a firm may have misjudged the demand for a product from its customers that can be called as project risk. The risk could also arise from competitors proving to be stronger or weaker than anticipated; can be termed as competitive risk. Further risks that may affect an entire sector but are restricted to that sector; referred to sector risk.

There are other risks 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. This can be termed as market risk.

**Models Measuring Market Risk**

The first two steps of the risk analysis process are one, risk comes from the distribution of actual returns around the expected return and second, that risk should be measured from the perspective of a marginal investor who is well diversified. But after these two steps corporate finance principle part ways when it comes to measuring non-diversifiable or market risk. (Damodaran, 2002).

The standard model for measuring market risk in finance-the capital asset pricing model (CAPM). Some alternatives models have developed over the last two decades.

## 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). This section 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 assts. 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 believe they can find undervalued assets and thus choose not to hold those assets that they believe to be fairly or overvalued.

The capital asset pricing model assumes that there are no transactions cost, all assets are traded and investments are infinitely divisible (i.e., you can buy any fraction of a unit of the asset). It also assumes that everyone has access to the same information and that investors therefore cannot find under or overvalued assets in the market place. Making these assumptions allows investors to keep diversifying without additional cost. At the limit, their portfolios will not only include every traded asset in the market but will have identical weights on risky assets. The fact that this diversified portfolio includes all traded assets in the market is the reason it is called the market portfolio.

## Investor Portfolios in the CAPM

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.

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.

## Measuring the Market Risk of an Individual Asset

In the CAPM world, where all investors hold the market portfolio, the risk to an investor of an individual asset will be risk that this asset adds on to the market portfolio.

Variance prior to asset i being added = $\sigma_m^2$

Variance after asset i is added

$= \sigma_m^2 = w_i^2\sigma_i^2 + (1-w_i)^2\sigma_m^2 + 2w_i(1-w_i)Cov_{im}$

Risk measure is standardized 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;

Beta of an asset i = $\frac{Covariance\ of\ asset\ i\ with\ Market\ Portfolio}{Variance\ of\ the\ Market\ Portfolio} = \frac{Cov_{im}}{\sigma_m^2}$

Since the covariance of the market portfolio with itself is its variance, 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 I and assets that are less riskier than average will have betas that are less than I. The riskless asset will have a beta of 0.

**Getting Expected Returns**

The expected return of an asset can be written as a function of the risk-free rate and the beta of that asset.

$$E(R_i) = R_f + \beta_i\big(E(R_m) - R_f\big)$$

$E(R_i)$ = Expected Return on asset i
$R_f$ = Risk-free rate
$E(R_m)$=Expected Return on market portfolio
$\beta_i$= Beta of investment i

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.

**The Arbitrage Pricing Model**

The restrictive assumptions on transactions costs and private information on the capital asset pricing model and the model's dependence on the market portfolio have long been viewed with skepticism by both academics and practioners. Ross (1976) suggested an alternative model for measuring risk called the arbitrage pricing model (APM).

**Assumptions**
**If** investors can invest risklessly and earn more than the riskless rate, they have found an arbitrage opportunity. The premise of the arbitrage pricing model is that investors take advantage of such arbitrage opportunities**, and in** the process, eliminate them.

$$R = E(R) + m + \epsilon$$

Where R is the actual return, E (R) is the expected return, m is the market-wide component of unanticipated risk and $\epsilon$ is the firm-specific component. Thus, the actual return can be different form the expected return, either because of market risk or firm-specific actions.

**The Sources of Market-Wide Risk**

While both the capital asset pricing model and the arbitrage pricing model make a distinction between firm-specific and market-wide risk, they measure market risk differently. The CAPM assumes that market risk is captured in the market portfolio, whereas the arbitrage pricing model allows for multiple sources of market-wide risk and measures the sensitivity of investments to changes in each source. In general, the market component of unanticipated returns can be decomposed into economic factors:

R= $E(R) + m + \alpha$

R = R + $\left(\beta_j F_j + \beta_2 F_2 + \cdots + \beta_n F_n\right) + \varepsilon$

Where
$\beta_j$= Sensitivity of investment to unanticipated changes in factor j
$F_j$= Unanticipated changes in factor j

Note that the measure of an investment's sensitivity to any macro-economic factor takes the form of a beta, called a factor beta. In fact, this beta has many of the same properties as the market beta in the CAPM.

**The Effects of Diversification**

$$\boldsymbol{R_f = (w_1 R_1 + w_2 R_2 + .. + w_n R_n) + \left(w_1 R_{1,1} + w_2 R_{1,2} + .. + W_n R_{1,n}\right) F_1 + \left(w_2 R_{2,1} + w_2 R_{2,2} + .. + W_n R_{2,n}\right) F_2 \ \ldots}$$

**Where**

$w_j$ = Portfolio weight on asset j
$R_j$ = Expected return on asset j
$\beta_{i,j}$ = **Beta on factor i for asset j**

**The expected return on an asset can be written as**

**E (R) =** $\boldsymbol{R_f + \beta_1\left[E(R_1) - R_f\right] + \beta_2\left[E(R_2) - R_f\right] + \cdots + \beta_n\left[E(R_n) - R_f\right]}$

**Where**

$\boldsymbol{R_f}$ **= Expected return on a zero-beta portfolio**

$E(R_j)$ **= Expected return on a portfolio with a factor beta of 1 for factor j and zero for all other factors.**

**The APM in Practice**

The arbitrage pricing model requires estimates of each the factor betas and factor risk premiums in addition to the riskless rate. In practice, these are usually estimated using historical data on asset returns and a 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 measure 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.

**C. 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.

**Deriving a Multi-Factor Model**

Chen, Roll, and Ross (1986) suggested 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) =** $R_f + +\beta_{GNP}\left[E(R_{GNP}) - R_f\right] + \beta_1\left[E(R_1) - R_f\right] + \cdots + \beta_\partial\left[E(R_\partial) - R_f\right]$

**Where**

$\beta_{GNP}$= Beta relative to changes in industrial productio**n**

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

$\beta_1$= Beta relative to changes in inflation

$E(R_1)$= Expected return on a portfolio with a beta of one on the inflation factor and zero on all other factor

Using the wrong factor or missing a significant factor in a multi-factor model can lead to inferior estimates of expected return.

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. (Damodaran, 2002).

## D. 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. Proponents of these models argue that if some investments earn consistently higher returns that other investments, they must be riskier. Consequently, we could look at the characteristics that these high-return investments have in common and consider these characteristics to be indirect measures or proxies for market risk.

Fama and French (1992), 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 ratio 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 (1992) suggested that these measures to 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 $\frac{BV}{MV}$

Where

MV = Market Value of Equity

$\frac{BV}{MV}$ = 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 Comparative Analysis of Risk and Return Models

All the risk and return models assume that only market risk is rewarded and they derive the expected return as a function of measures of this risk. The CAPM has the advantage of being a simpler model to estimate and to use, but it will underperform the richer APM when an investment is sensitive to economic factors not well represented in the market index. Roll (1977) 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. 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 Mendleson (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.

Weston and Copeland (1992) 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.

## Model of Default RISK

General risk and return models for equity which evaluate the effects of market risk on expected return, models of default risk measure the consequences of firm-specific default risk on promised return (Damodaran, 2002). 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 a two variable. 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. Firms that generate high cash flows relative to their financial obligations should have lower default risk than firm that generate low cash flows relative to their financial obligations. Thus, firms with significant existing investment, which generate relatively high cash flow, will have lower default risk than firms that do not.

In addition to the magnitude of firm's cash flows, the default risk is also affected by the volatility in these cash flows. The stability there is in cash flows the lower the default risk in the firm. Firms that operate in predictable and stable business will have lower default risk than will other similar firms that operate in cyclical or volatile businesses.

## Determinants of Bond Ratings

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.

Financial Ratios used to measure Default Risk

| Ratio | |
|---|---|
| Pretax Interest Coverage | $\frac{Pretax\ Income\ Continuing\ Operations + Interest\ Expense}{Gross\ Interest}$ |
| EBITDA Interest Coverage | $\frac{EBITDA}{Gross\ Interest}$ |
| Fund From Operations /Total Debt | $\frac{Net\ Income\ from\ Continuing\ Operations + Depreciation}{Total\ Debt}$ |
| Free Operating Cash flow /Total Deb | $\frac{(Fund\ from\ operations - Capital\ Expenditure - Change\ in\ working\ capital)}{Total\ Debt}$ |
| Pretax Return on Permanent Capital | $\frac{[(Pretax\ Income\ from\ Continuing\ Operations + Interest\ Expenses]}{[Average\ of\ Beginning\ of\ the\ year\ and\ End\ of\ the\ year\ of\ long\ and\ short\ term\ debt, minority\ interest\ and\ shareholders\ Equity]}$ |
| Operating Income/ Sales | $\frac{[Sales - COGS(before\ depreciation) - Selling\ Expenses - Administrative\ Expenses - R\ and\ D\ Expenses]}{Sales}$ |
| Long Term Debt / Capital | $\frac{Long\ Term\ Debt}{Long\ Term\ Debt + Equity}$ |
| Debt/ Capitalization | $\frac{Total\ Debt}{Total\ Debt + Equity}$ |

Source: Standard and Poors (in Damodaran, 2002)

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