



Understanding Risk

Aswath Damodaran

What is Risk?

- Risk, in traditional terms, is viewed as a ‘negative’. Webster’s dictionary, for instance, defines risk as “exposing to danger or hazard”. The Chinese symbols for risk, reproduced below, give a much better description of risk

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.

Equity Risk

■ An equity investment in a business (private or public) entitles you to residual earnings and cashflows. In other words, you are not promised an interest rate but earn whatever is left over after you pay off other investors.

■ Models that try to measure equity risk share some common characteristics. They define

- Risk in terms of variance in actual returns around expected returns
- Measure risk through the eyes of the marginal investor in equity (rather than the average investor). The marginal investor is an investor who owns a large portion of the equity and trades frequently. For most publicly traded firms, the marginal investor is likely to be well diversified.

I. The Capital Asset Pricing Model

■ The capital asset pricing model is the oldest and still the most widely used model for risk in the investment world.

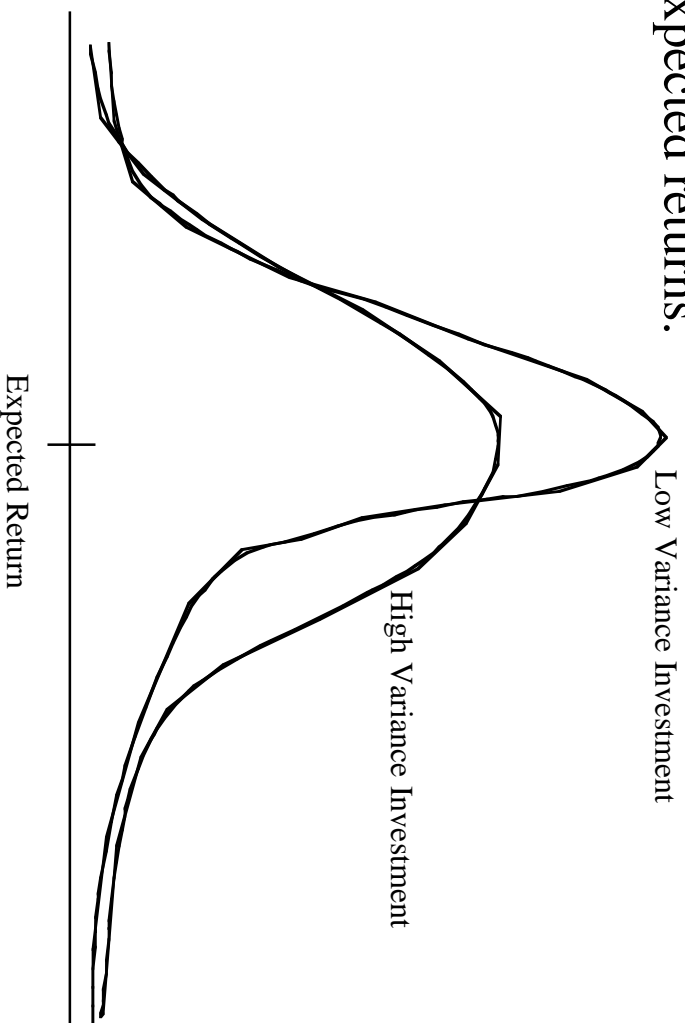
■ It is derived in four steps:

- Uses variance as a measure of risk
- Specifies that a portion of variance can be diversified away, and that is only the non-diversifiable portion that is rewarded.
- Measures the non-diversifiable risk with beta, which is standardized around one.
- Translates beta into expected return -

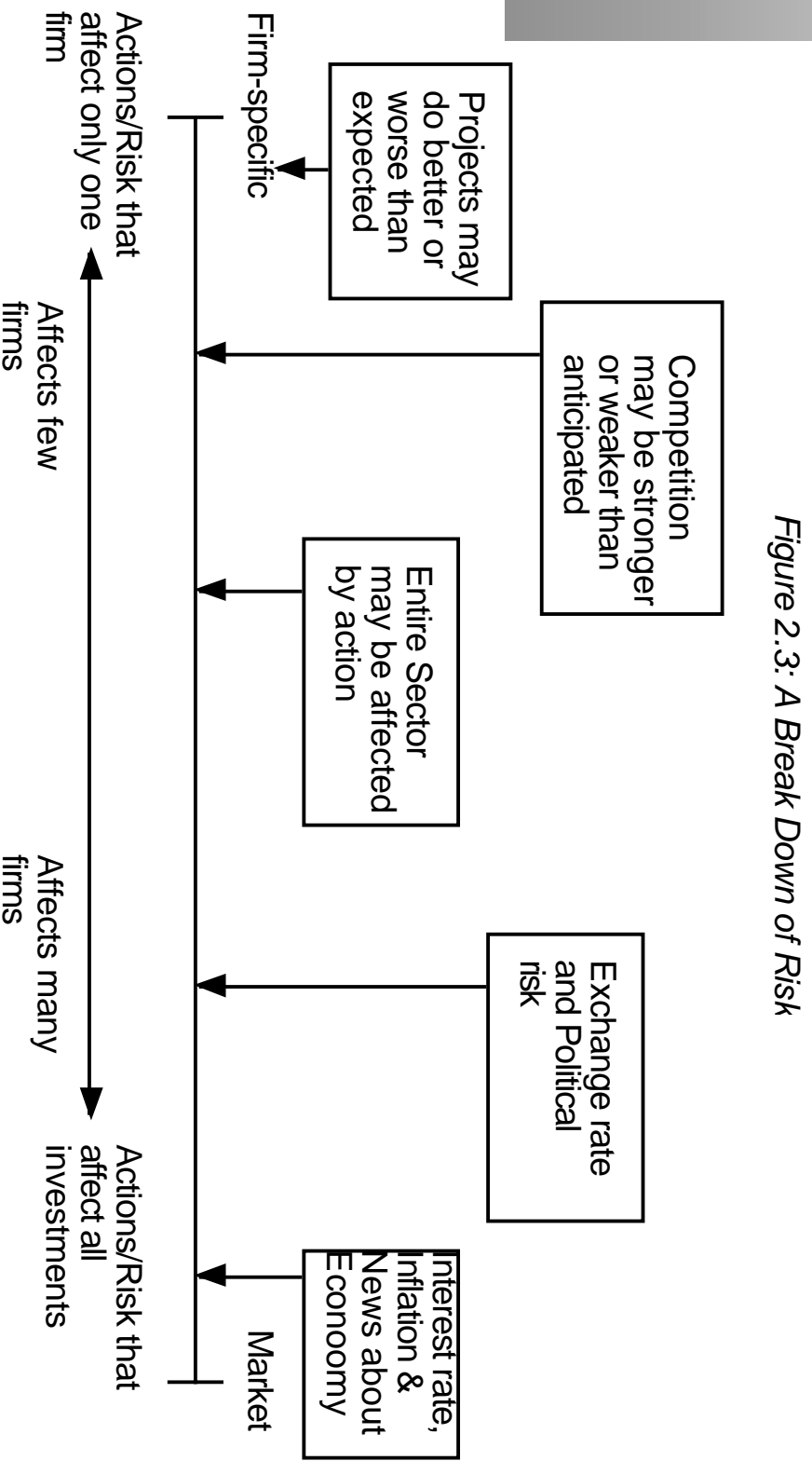
$$\text{Expected Return} = \text{Riskfree rate} + \text{Beta} * \text{Risk Premium}$$

Step 1: The Mean-Variance Framework

■ The variance on any investment measures the disparity between actual and expected returns.



Step 2: The Importance of Diversification: Risk Types



The Effects of Diversification

■ Firm-specific risk can be reduced, if not eliminated, by increasing the number of investments in your portfolio (i.e., by being diversified). Market-wide risk cannot. This can be justified on either economic or statistical grounds.

■ On economic grounds, diversifying and holding a larger portfolio eliminates firm-specific risk for two reasons-

- (a) Each investment is a much smaller percentage of the portfolio, muting the effect (positive or negative) on the overall portfolio.
- (b) Firm-specific actions can be either positive or negative. In a large portfolio, it is argued, these effects will average out to zero. (For every firm, where something bad happens, there will be some other firm, where something good happens.)

The Role of the Marginal Investor

- The marginal investor in a firm is the investor who is most likely to be the buyer or seller on the next trade.
- Since trading is required, the largest investor may not be the marginal investor, especially if he or she is a founder/manager of the firm (Michael Dell at Dell Computers or Bill Gates at Microsoft)
- In all risk and return models in finance, we assume that the marginal investor is well diversified.

Step 3: The Market Portfolio

- Assuming diversification costs nothing (in terms of transactions costs), and that all assets can be traded, the limit of diversification is to hold a portfolio of every single asset in the economy (in proportion to market value). This portfolio is called the market portfolio.
- Individual investors will adjust for risk, by adjusting their allocations to this market portfolio and a riskless asset (such as a T-Bill)

Preferred risk level

Allocation decision

- | | |
|--------------------|---|
| No risk | 100% in T-Bills |
| Some risk | 50% in T-Bills; 50% in Market Portfolio; |
| A little more risk | 25% in T-Bills; 75% in Market Portfolio |
| Even more risk | 100% in Market Portfolio |
| A risk hog.. | Borrow money; Invest in market portfolio; |
- Every investor holds some combination of the risk free asset and the market portfolio.

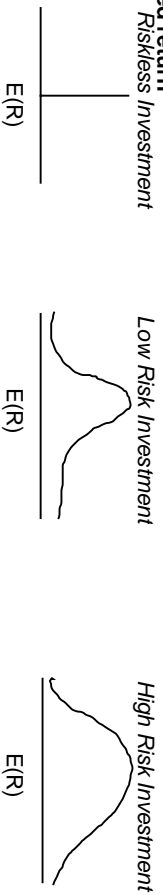
Step 4: The Risk of an Individual Asset

- The risk of any asset is the risk that it adds to the market portfolio
- Statistically, this risk can be measured by how much an asset moves with the market (called the covariance)
- Beta is a standardized measure of this covariance
- Beta is a measure of the non-diversifiable risk for any asset can be measured by the covariance of its returns with returns on a market index, which is defined to be the asset's beta.
- The cost of equity will be the required return,
$$\text{Cost of Equity} = R_f + \text{Equity Beta} * (E(R_m) - R_f)$$
where,
$$R_f = \text{Riskfree rate}$$
$$E(R_m) = \text{Expected Return on the Market Index}$$

Alternatives to the CAPM

Step 1: Defining Risk

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



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

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

Risk that affects all investments (Market Risk)

Cannot be diversified away since most assets are affected by it.

Step 3: Measuring Market Risk

The CAPM	The APM	Multi-Factor Models	Proxy Models
<p>If there is</p> <ol style="list-style-type: none"> 1. no private information 2. no transactions cost <p>the optimal diversified portfolio includes every traded asset. Everyone will hold this market portfolio</p> <p>Market Risk = Risk added by any investment to the market portfolio:</p>	<p>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.</p> <p>Market Risk = Risk exposures of any asset to market factors</p>	<p>Multi-Factor Models</p> <p>Since market risk affects most or all investments, it must come from macro economic factors.</p> <p>Market Risk = Risk exposures of any asset to macro economic factors.</p>	<p>Proxy Models</p> <p>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.</p> <p>Market Risk = Captured by the Proxy Variable(s)</p>
<p>Beta of asset relative to Market portfolio (from a regression)</p>	<p>Betas of asset relative to unspecified market factors (from a factor analysis)</p>	<p>Betas of assets relative to specified macro economic factors (from a regression)</p>	<p>Equation relating returns to proxy variables (from a regression)</p>

Inputs required to use the CAPM -

- (a) the current risk-free rate
- (b) the expected market risk premium (the premium expected for investing in risky assets over the riskless asset)
- (c) the beta of the asset being analyzed.

The Riskfree Rate and Time Horizon

- On a riskfree asset, the actual return is equal to the expected return.
- Therefore, there is no variance around the expected return.
- For an investment to be riskfree, i.e., to have an actual return be equal to the expected return, two conditions have to be met –
 - There has to be no default risk, which generally implies that the security has to be issued by the government. Note, however, that not all governments can be viewed as default free.
 - There can be no uncertainty about reinvestment rates, which implies that it is a zero coupon security with the same maturity as the cash flow being analyzed.

Riskfree Rate in Practice

- The riskfree rate is the rate on a zero coupon government bond matching the time horizon of the cash flow being analyzed.
- Theoretically, this translates into using different riskfree rates for each cash flow - the 1 year zero coupon rate for the cash flow in year 2, the 2-year zero coupon rate for the cash flow in year 2 ...
- Practically speaking, if there is substantial uncertainty about expected cash flows, the present value effect of using time varying riskfree rates is small enough that it may not be worth it.

The Bottom Line on Riskfree Rates

- Using a long term government rate (even on a coupon bond) as the riskfree rate on all of the cash flows in a long term analysis will yield a close approximation of the true value.

- For short term analysis, it is entirely appropriate to use a short term government security rate as the riskfree rate.

Measurement of the risk premium

- The risk premium is the premium that investors demand for investing in an average risk investment, relative to the riskfree rate.
- As a general proposition, this premium should be
 - greater than zero
 - increase with the risk aversion of the investors in that market
 - increase with the riskiness of the “average” risk investment

What is your risk premium?

- Assume that stocks are the only risky assets and that you are offered two investment options:
 - a riskless investment (say a Government Security), on which you can make 5%
 - a mutual fund of all stocks, on which the returns are uncertain

How much of an expected return would you demand to shift your money from the riskless asset to the mutual fund?

- Less than 5%
- Between 5 - 7%
- Between 7 - 9%
- Between 9 - 11%
- Between 11 - 13%
- More than 13%

Risk Aversion and Risk Premiums

- If this were the capital market line, the risk premium would be a weighted average of the risk premiums demanded by each and every investor.
- The weights will be determined by the magnitude of wealth that each investor has. Thus, Warren Buffett's risk aversion counts more towards determining the "equilibrium" premium than yours' and mine.
- As investors become more risk averse, you would expect the "equilibrium" premium to increase.

Risk Premiums do change..

Go back to the previous example. Assume now that you are making the same choice but that you are making it in the aftermath of a stock market crash (it has dropped 25% in the last month). Would you change your answer?

- I would demand a larger premium
- I would demand a smaller premium
- I would demand the same premium

Estimating Risk Premiums in Practice

- Survey investors on their desired risk premiums and use the average premium from these surveys.
- Assume that the actual premium delivered over long time periods is equal to the expected premium - i.e., use historical data
- Estimate the implied premium in today's asset prices.

The Survey Approach

- Surveying all investors in a market place is impractical.
- However, you can survey a few investors (especially the larger investors) and use these results. In practice, this translates into surveys of money managers' expectations of expected returns on stocks over the next year.
- The limitations of this approach are:
 - there are no constraints on reasonability (the survey could produce negative risk premiums or risk premiums of 50%)
 - they are extremely volatile
 - they tend to be short term; even the longest surveys do not go beyond one year

The Historical Premium Approach

- This is the default approach used by most to arrive at the premium to use in the model
- In most cases, this approach does the following
 - it defines a time period for the estimation (1926-Present, 1962-Present...)
 - it calculates average returns on a stock index during the period
 - it calculates average returns on a riskless security over the period
 - it calculates the difference between the two
 - and uses it as a premium looking forward
- The limitations of this approach are:
 - it assumes that the risk aversion of investors has not changed in a systematic way across time. (The risk aversion may change from year to year, but it reverts back to historical averages)
 - it assumes that the riskiness of the “risky” portfolio (stock index) has not changed in a systematic way across time.

Historical Average Premiums for the United States

	<i>Arithmetic average</i>		<i>Geometric Average</i>	
Historical Period	T. Bills	T. Bonds	T. Bills	T. Bonds
1928-2001	8.09%	6.84%	6.21%	5.17%
1962-2001	5.89%	4.68%	4.74%	3.90%
1991-2001	10.62%	6.90%	9.44%	6.17%

What is the right premium?

- Go back as far as you can. Otherwise, the standard error in the estimate will be large.
- Be consistent in your use of a riskfree rate.
- Use arithmetic premiums for one-year estimates of costs of equity and geometric premiums for estimates of long term costs of equity.

What about historical premiums for other markets?

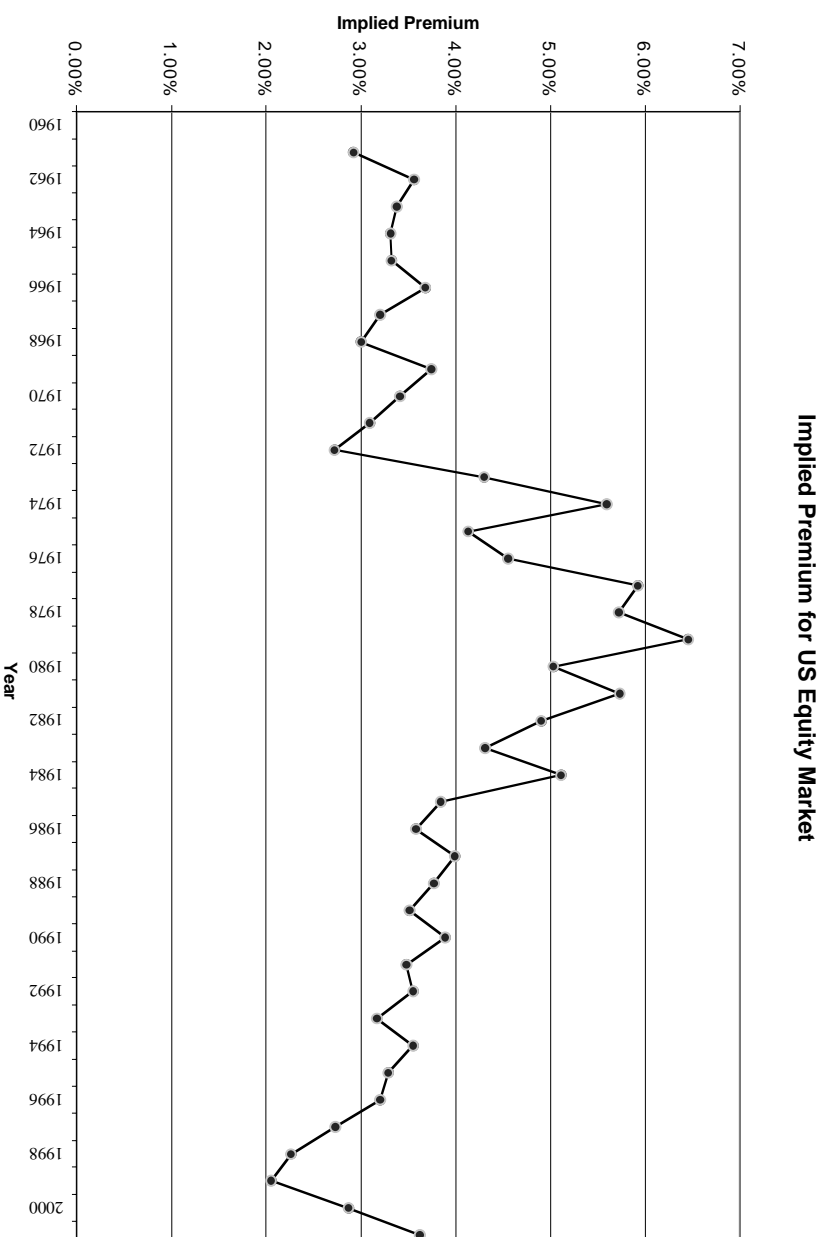
- Historical data for markets outside the United States tends to be sketchy and unreliable.
- Ibbotson, for instance, estimates the following premiums for major markets from 1970-1996

<i>Country</i>	<i>Stock return</i>	<i>Bond Return</i>	<i>Equity Risk Premium</i>
Australia	8.47%	6.99%	1.48%
France	11.51%	9.17%	2.34%
Germany	11.30%	12.10%	-0.80%
Italy	5.49%	7.84%	-2.35%
Japan	15.73%	12.69%	3.04%
Mexico	11.88%	10.71%	1.17%
Singapore	15.48%	6.45%	9.03%
Spain	8.22%	7.91%	0.31%
Switzerland	13.49%	10.11%	3.38%
UK	12.42%	7.81%	4.61%

Implied Equity Premiums

- If we use a basic discounted cash flow model, we can estimate the implied risk premium from the current level of stock prices.
- For instance, if stock prices are determined by the simple Gordon Growth Model:
 - Value = Expected Dividends next year/ (Required Returns on Stocks - Expected Growth Rate)
 - Plugging in the current level of the index, the dividends on the index and expected growth rate will yield a “implied” expected return on stocks. Subtracting out the riskfree rate will yield the implied premium.
- The problems with this approach are:
 - the discounted cash flow model used to value the stock index has to be the right one.
 - the inputs on dividends and expected growth have to be correct
 - it implicitly assumes that the market is currently correctly valued

Implied Premiums in the US

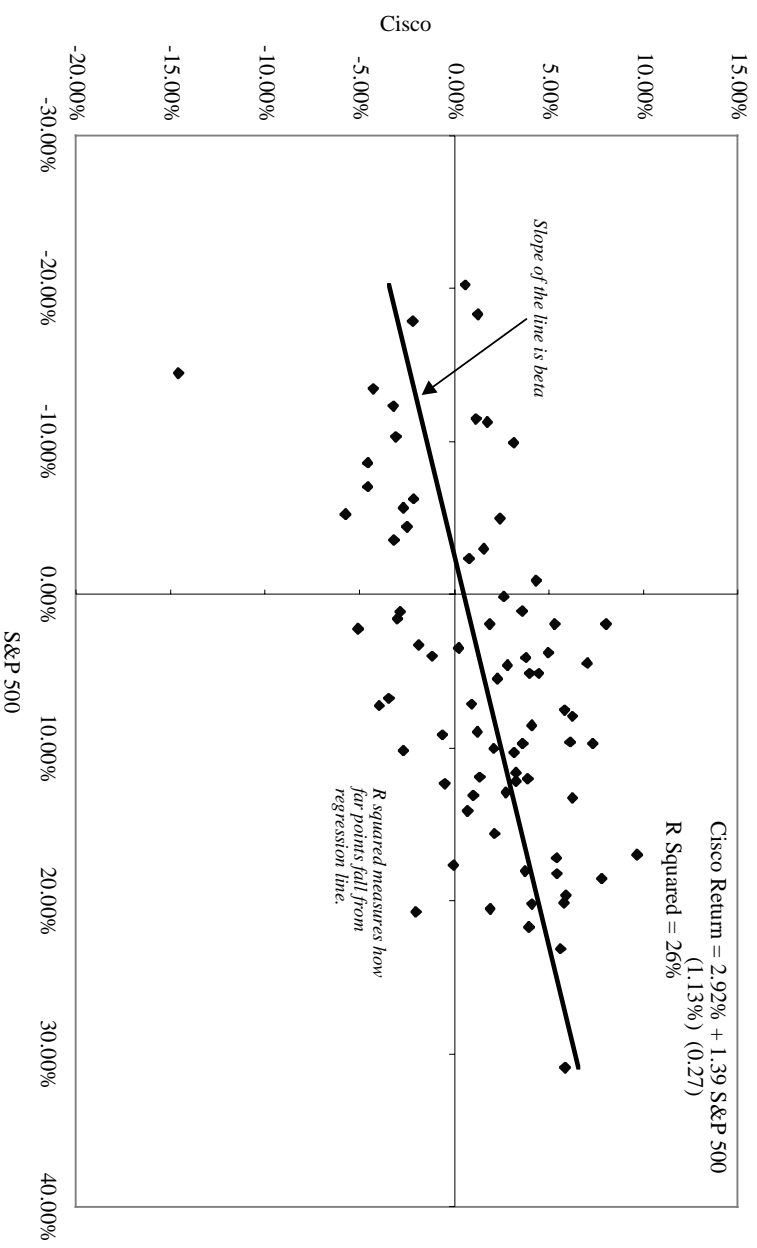


Firm Specific and Market Risk

- The R squared (R^2) of the regression provides an estimate of the proportion of the risk (variance) of a firm that can be attributed to market risk;
- The balance ($1 - R^2$) can be attributed to firm specific risk.

Beta Estimate: Cisco

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



Estimating Expected Returns for Cisco

- Cisco's Beta = 1.39
- Riskfree Rate = 5.00% (Long term Government Bond rate)
- Risk Premium = 5.17% (Approximate historical premium)
- Expected Return = 5.00% + 1.39 (5.17%) = 12.19%

Use to a Potential Investor in Cisco

As a potential investor in Cisco, what does this expected return of 12.19% tell you?

- This is the return that I can expect to make in the long term on Cisco, if the stock is correctly priced and the CAPM is the right model for risk,
- This is the return that I need to make on Cisco in the long term to break even on my investment in the stock
- Both

Assume now that you are an active investor and that your research suggests that an investment in Cisco will yield 25% a year for the next 5 years. Based upon the expected return of 12.19%, you would

- Buy the stock
- Sell the stock

What is debt?

- General Rule: Debt generally has the following characteristics:
 - Commitment to make fixed payments in the future
 - The fixed payments are tax deductible
 - Failure to make the payments can lead to either default or loss of control of the firm to the party to whom payments are due.
- As a consequence, debt should include
 - Any interest-bearing liability, whether short term or long term.
 - Any lease obligation, whether operating or capital.

Measuring Bond Risk: Default Risk

- When you buy a bond, you are promised a fixed payment (the interest rate on the bond). The best case scenario for you is that you receive that fixed payment. The worse case scenarios have a much wider range, with the worst case scenario being that you do not receive any of your promised cash flows.
- Since the potential for upside is limited and for downside is very large, we measure risk in bonds by looking at the downside or default risk.

Determinants of Default Risk

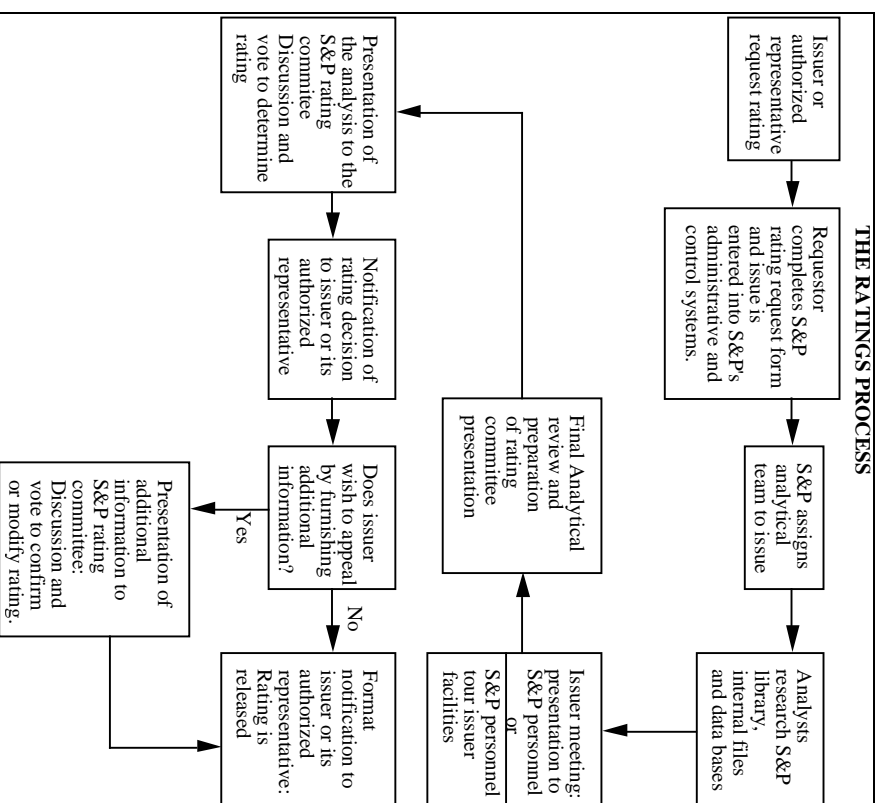
- *Capacity to generate cashflows from operations*: The larger the cashflows that you generate from operations, the lower your default risk should be.
- *Volatility in these cashflows*: The more predictable your cashflows are, the lower your default risk should be.
- *Fixed Commitments*: The larger your commitments (interest and principal payments), relative to your operating cashflows, the greater is your default risk.

Measuring Default Risk

- *Credit Risk Scores*: For as long as institutions and individuals have been lending money, they have been using both qualitative and quantitative factors to measure the credit risk of borrowers.

- *Bond Ratings*: Publicly traded companies that desire to access the bond market (where individual investors may lack the resources and the incentives to measure default risk on their own) have been rated by ratings agencies.

The Ratings Process



Ratings and Financial Ratios

	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

From Ratings to Default Spreads

<i>Rating</i>	<i>Spread</i>
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%

Estimating the Cost of Debt

- If the firm has bonds outstanding, and the bonds are traded, the yield to maturity on a long-term, straight (no special features) bond can be used as the interest rate.
- If the firm is rated, use the rating and a typical default spread on bonds with that rating to estimate the cost of debt.
- If the firm is not rated,
 - and it has recently borrowed long term from a bank, use the interest rate on the borrowing or
 - estimate a synthetic rating for the company, and use the synthetic rating to arrive at a default spread and a cost of debt

Estimating Synthetic Ratings

- The rating for a firm can be estimated using the financial characteristics of the firm. In its simplest form, the rating can be estimated from the interest coverage ratio

$$\text{Interest Coverage Ratio} = \text{EBIT} / \text{Interest Expenses}$$

- For a firm, which has earnings before interest and taxes of \$ 3,500 million and interest expenses of \$ 700 million

$$\text{Interest Coverage Ratio} = 3,500/700 = 5.00$$

- Based upon the relationship between interest coverage ratios and ratings, we would estimate a rating of A for the firm.

Interest Coverage Ratios, Ratings and Default Spreads

If Interest Coverage Ratio is	Estimated Bond Rating	Default Spread
> 8.50	AAA	0.75%
6.50 - 8.50	AA	1.00%
5.50 - 6.50	A+	1.50%
4.25 - 5.50	A	1.80%
3.00 - 4.25	A-	2.00%
2.50 - 3.00	BBB	2.25%
2.00 - 2.50	BB	3.50%
1.75 - 2.00	B+	4.75%
1.50 - 1.75	B	6.50%
1.25 - 1.50	B-	8.00%
0.80 - 1.25	CCC	10.00%
0.65 - 0.80	CC	11.50%
0.20 - 0.65	C	12.70%
< 0.20	D	14.00%