Cost of Capital (represents risk)

Cost of Equity Capital

- From the shareholders' perspective, the expected return is the cost of equity capital

$$E(R_i) = R_f + \beta_i (E(R_M) - R_f)$$

$E(R_i)$ is the return needed to make the investment = the discount rate = opportunity cost.

- To estimate the cost of equity capital, we need to calculate the equity beta. Theoretically, this calculation is straightforward

$$\beta_i = \frac{Cov(R_i, R_M)}{Var(R_M)}$$

β_i is measuring the relevant risk. if $\beta_i > 1$ then the stock or asset adds risk to the portfolio. We need to estimate β_i for each firm.

The following problems may arise in practice:

1. Betas may vary over time

Beta based on history but the firms beta may vary from period to period. Older data may no longer be relevant. Firm may have implemented changes, market position may have changed. So a beta based on historical returns may have a bias in the estimation. If a firm has an actual beta of 1.5 between 1990 and 1995 and an actual beta of 3.5 between 1996 and 2000, using the past ten years to calculate the beta will give something in the middle, 2.5, which is not a true reflection of the current beta, 3.5. This method of measurement does not consider that beta varies over time.

2. The sample size may be inadequate

Small sample sizes mean less accurate observation, will have a lot of "noise" in the result. Need a balance between accurate sample size and relevant information. Investors usually use a sample size of 5 years (once a month for 5 years = 60 samples). This is the period used in reports of financial journals.

3. Betas are influenced by changing financial leverage and business risk

The properties of the firm are always changing. The amount of risk increases with the amount of debt.

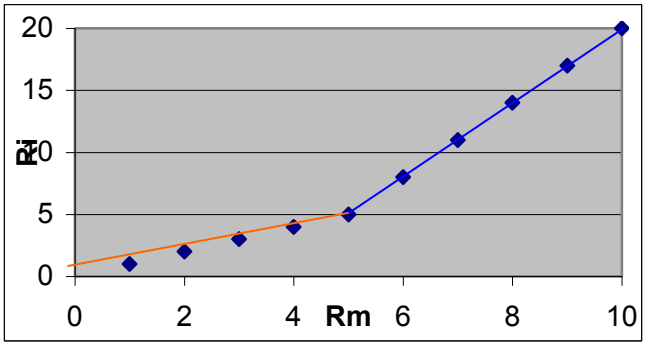
4. The equity of the firm is not publicly traded

In this case there will not be any historical data. Can you find a similarly situated firm and substitute their beta?

- Solutions: there are no perfect solutions; we are seeking to reduce the problem

• Problems 1 and 2 can be mitigated by more sophisticated statistical techniques

Our model generates a linear estimation, there are other statistical techniques which allow for a changing beta over time.



• Problem 3 can be reduced by adjusting for changes in business and financial risk

Adjusting the beta, we will see this ahead.

• Problem 4 can be solved by looking at average beta estimates of comparable firms

Firms with similar properties and which are exposed to similar risk. **Industry**, **Size**, and **Market-to-Book Ratio** are good match points. If the firm is not traded look at the equity of the last transaction, for instance the sale of the business or buyout of a partner.

Estimating the Cost of Capital

This example continues through the following pages and illustrates the above points.

- You work for Continental Airlines. Continental is considering expanding service to a new market that is currently served by a single regional airline. Our goal is to calculate Continental's Cost of Capital.

- You have estimated cash flows for this decision, but you **need a discount rate for your NPV calculation**. As a starting point, you need to calculate Continental's cost of capital.

We will use the **CAPM** formula to estimate the cost of capital. Continental is publicly traded so we calculate beta from historical returns. We will use regression to calculate beta.

Step1: Estimating Continental Equity Beta

- The first step in estimating a discount rate is to **determine the systematic risk, beta**. Since Continental is a publicly traded company, we can use historical stock returns to calculate its equity beta

- To estimate an equity beta, estimate a **market model regression**

$$R_{i,t} = \alpha_i + \beta_i R_{M,t} + \varepsilon_{i,t}$$

Alpha is the intercept of the regression line (of slope beta) with the y axis.
Epsilon is the expected residual return.

Find beta using regression and $\frac{Cov()}{Var()}$. Then find the regression of the stocks return ($R_{i,T}$) against the market return ($R_{M,t}$). This is the above equation and is called market model regression.

The basic method of measuring company beta is to estimate $\beta_{i,t} = \frac{\text{Cov}(R_{i,t}, R_{M,t})}{\text{Var}(R_{M,t})}$

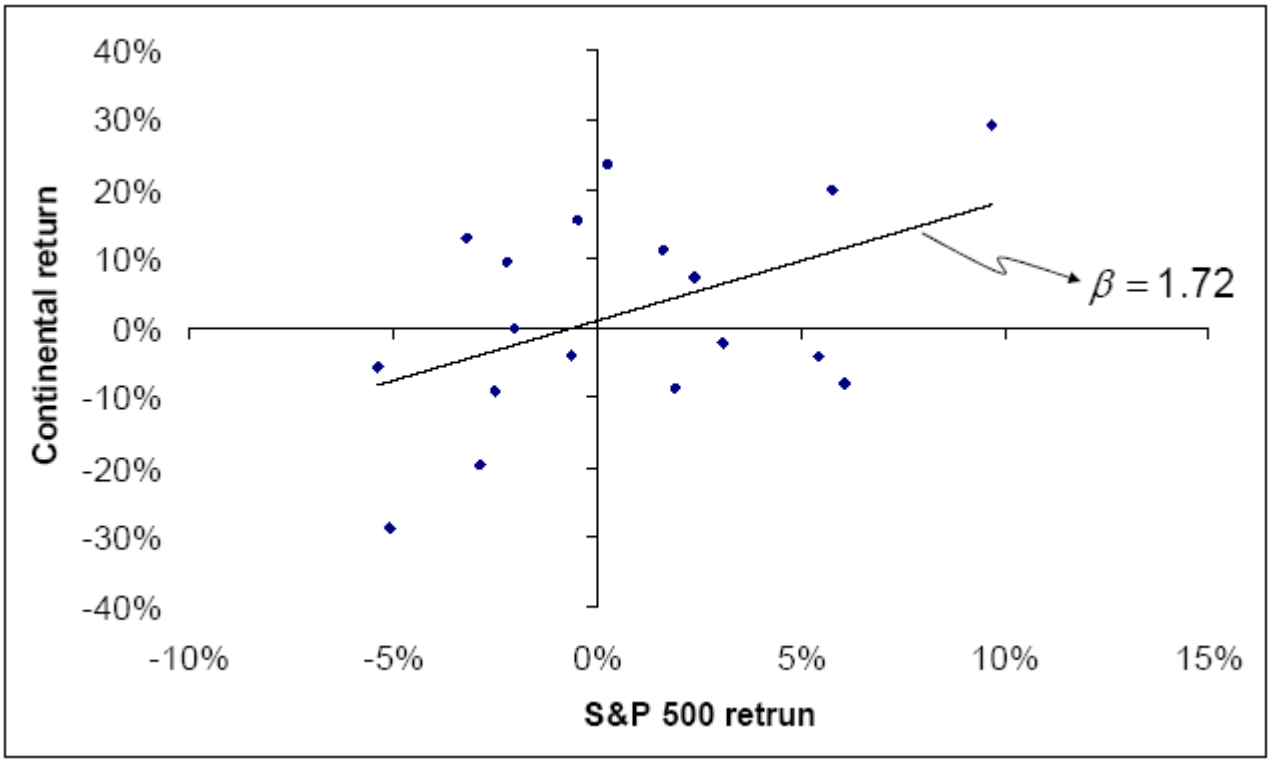
using t = 1, 2, …, T observations.

Sample data for Continental and S&P 500 Index

Date	S&P 500 return	Continental return
May-99	-2.50%	-9.12%
Jun-99	5.44%	-4.14%
Jul-99	-3.20%	12.96%
Aug-99	-0.63%	-3.97%
Sep-99	-2.86%	-19.76%
Oct-99	0.25%	23.66%
Nov-99	1.92%	-8.64%
Dec-99	5.77%	19.93%
Jan-00	-5.09%	-28.73%
Feb-00	-2.01%	0.00%
Mar-00	9.67%	29.25%
Apr-00	3.08%	-2.14%
May-00	-2.19%	9.53%
Jun-00	2.39%	7.28%
Jul-00	1.63%	11.17%
Aug-00	6.07%	-7.90%
Sep-00	-5.35%	-5.58%
Oct-00	-0.49%	15.54%

The S&P 500 is an index fund of the 500 largest US companies. It's return can be considered the return of the market (very close). We use the above table to find the regression of Continental and then it's beta.

Scatter plot for Continental and S&P 500 Index



Each data point is the return of Continental against the S&P 500 for a particular month. From the regression we will find alpha and beta (intercept and slope).

$$R_i = \alpha + \beta R_M + \varepsilon \qquad \hat{\beta} = \frac{\mathrm{Cov}(R_i, R_M)}{\mathrm{Var}(R_M)} \qquad \mathrm{Cov}(x, y) = \sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})P_i$$

When using historical data there is no basis to assign a higher probably to one observation over another. So we assign the probability of $\frac{1}{n}$ to each data point. Thus…

$$\mathrm{Cov}(x, y) = \frac{1}{n}\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y}) \qquad \text{and} \qquad \mathrm{Var}(R_M) = \frac{1}{n}\sum_{i=1}^{n}(R_i - \bar{R}_M)^2$$

These expressions lead to the beta hat result above. The Cov/Var solution for beta will give the same result as solving the regression.

Measurement error in beta

- Since beta is estimated from historical data, it is measured with some error

- Estimating a beta for similar firms (for example, firms in the same industry) can help reduce some of the measurement error in beta

- In this problem, we might want to examine the betas for other national airlines to see if our beta estimate for Continental is comparable to the betas of similar firms

Compare the beta we calculate with that of similar firms. Look at what is going on in that particular industry. Calculate the beta of these other firms, compare to ours. A gross difference may indicate errors.

The range of beta is typically between 0 and 3. Beta > 3 is very rare.

National Airline Equity Betas

Airline	Beta
US Airways	1.37
American	2.13
Delta	0.87
Northwest	1.61
United	1.12
Average	1.42

Continental's beta is 1,72. Should we use the industry beta in our plans? We see that there is a relatively large spread which is a red light! The 1.52 comes from more data (so maybe it's more accurate?) but it comes from data with a large spread. Which beta should we use? Recalculate removing the outliers but we will still end up around 1.4. Consider that these firms are not identical to Continental. Both values, 1.72 and 1.42 are viable, there is no exactly correct answer. Must use judgment.

Each project is different and each has it's own independent beta relating it's correlation to the market. Now what if the project Continental is considering if not a project in line with it's typical business model? If the project is representative of the firms business it may be a good idea to use the firms beta. If the project is not representative of the firms business calculate a new beta for the project. These alternative projects will require a calculation of their own beta, they will involve different risks and different covariance with the market.

If the project is non-representative of the firms business it is not advisable to use the firms general beta.

Project vs. company betas

- We have estimated the beta of Continental, but should we use that beta to determine the discount rate of the project?

- By using the Continental equity beta to calculate a discount rate for our project, we are implicitly assuming that the new project has the same market risk as the company as a whole

- For our scale-expansion project, this is probably not a bad assumption

- For other projects it might be a very bad assumption

- Suppose you thought that expanding into a low volume airline market had market risk that was similar to the risk of a regional airline rather than the risk of Continental

- In this case you should ignore the beta of Continental and estimate the beta of a typical regional airline.

Continental is a national airline but they are considering a regional project. What is the risk in the regional airline business? Look at the regional firms, calculate their beta to use as a measure of the risk in the regional business.

Regional Airline Equity Betas

Betas of publically traded regional airlines.

Airline	Beta
Atlas Air	1.64
Mesa Air	1.78
Midwest	0.89
Comair	2.04
Average	1.59

A final decision on beta

- We now have at least three choices for beta

- Continental's beta 1.72 (more conservative, higher cost of capital)
- Regional airlines' average beta 1.59 (less conservative, lower cost of capital)
- National airlines' average beta 1.42

- **The final choice of beta requires some judgment**

Here we must make a decision. Consider things like regional companies coming into a small market are not the same as the smaller companies operating there. Will have different cost structures. Things like that.

β here is our Discount Rate of the project. It will be going into the denominator of our NPV calculation. It is the **Cost of Capital**.

Faced with this decision we might consider that the regional airline beta of **1.59** is about in the middle of the other two, appealing. The judgment we use in making the decision should be based in part on the numbers we are presented with.

Consider that when we noticed a difference between the beta of Continental and the average of other national airlines we set out to calculate the beta of regional airlines hoping to find a sounding of the real value for this specific project. Now we have 1.59, right about in the middle, and we ask ourselves, how far can we really go wrong with this number? So 1.59 seems like a good decision. Plus, our regional result coming in right between the others gives us some confidence that our calculations are good. However there are still advantages and disadvantages to this decision. There will always be more research you could do but may not have all that time.

Now that we have selected a value for beta …

Step 2: Estimate the Required Rate of Return on Equity

Using the beta we have decided upon

- The CAPM tells us that

$$E(R_i) = R_f + \beta_i (E(R_M) - R_f)$$

- We have estimated beta, to calculate the required rate of return **we still need to know** the **risk-free rate (R_f)** and the **market risk premium ($E(R_M) - R_f$)**

Risk-free rate

- The current risk-free rate can be observed directly by looking at the return on a risk-free government bond

- The rate on a 3-months Treasury is 3.7%, and the rate on a 10-year Treasury is 4.7% Different rates based on term. We may want to compare the term of the project to the term of the risk free rate we selected (but this method is not perfect). The 3 month to 10 year range of terms have more investors in the market, they are more likely to represent the market rate accurately. Another possibility is to take the average of several terms…

- Let's use the average for this example, 4.2%.

Market risk premium

- The market risk premium is an expected value that cannot be observed directly

- We can use historical data on the market risk premium to estimate this expected value – the consensus seems to be close to 8%

This is the same 8% that has been shown to be the rate required by investors to make the jump from risk-free investing to risk based investing. So if we select 4.2% for risk free and 8% for risk premium we can calculate

$$E(R_M) = 4.2\% + 8\% = 12.2\%$$

Required return on equity

- Putting these results together gives us a required return on equity for Continental

$$E(R_i) = R_f + \beta_i(E(R_M) - R_f) \quad = .042 + 1.6(12.2 - .042) = 17\%$$

(Note that this $E(R_i)$ = 17% is the R_E below (return on equity))
Here we have found that **17% is the cost of capital of the equity** (discount rate). We calculated the 17% based on data which came from the stock returns of the firm (compared to the market) so we have only looked at equity.

Note that Beta came from the stock returns, from the EQUITY in the company. So this is the cost of capital of Continental's EQUITY. If the project is only financed by equity this is the complete solution. But **firms usually finance using a combination of debt and equity**. So far we have only found the cost of capital of one asset, the stock. But we want to find the cost of capital of the **total assets** (this is called **The Cost of Capital of the Firm**).

Step 3: The effects of leverage

- We have estimated Continental required return on equity to be 17%. However, what we really want to know is Continental's **required return on investment**, or **return on assets.**

The required return on equity will be higher than the Required Return on Assets because of the effects of leverage.

Why is this true? This is the same as saying that the cost of capital of the debt will be lower than the cost of capital of the equity. Cost of capital reflects risk. Risk is beta (beta is the relevant risk here, not variance or standard deviation). So we know that the stock will react stronger than the bond to a change in the return of the market. So the price of the bond has a lower covariance with the stock market, the price of stock will have higher covariance with the stock market. The bond has lower covariance with the market (which is the relevant risk) and thus lower risk.

Financial Manager faces two questions: in what to invest and how to finance the investment? What project to take and how to finance, with equity or with debt?

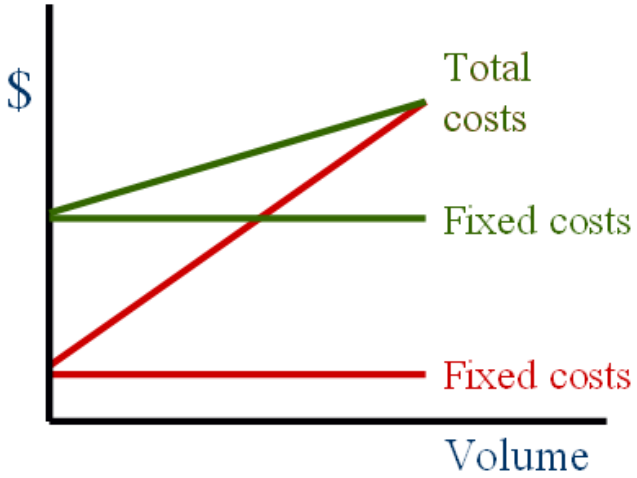
- For simplicity, the following analysis assumes no taxes

Bonds are used to finance which in turn raises the leverage on the company. Equity has a positive correlation to the market. If the bond has a low covariance to the market it will have lower risk.

Operating Leverage

- The degree of operating leverage measures how sensitive a firm (or project) is to its fixed costs.
- Operating leverage increases as fixed costs rise and variable costs fall.
- Operating leverage magnifies the effect of cyclicity on beta.
- The degree of operating leverage is given by:

$$DOL = \frac{\Delta \text{EBIT}}{EBIT} \times \frac{\text{Sales}}{\Delta \text{ Sales}}$$



Operating leverage increases as fixed costs rise and variable costs fall.

FI

Financial Leverage and Beta

- Operating leverage refers to the sensitivity to the firm's fixed costs of *production*.
- Financial leverage is the sensitivity of a firm's fixed costs of *financing*.
- The relationship between the betas of the firm's debt, equity, and assets is given by:

$$\beta_{Asset} = \frac{\text{Debt}}{\text{Debt} + \text{Equity}} \times \beta_{Debt} + \frac{\text{Equity}}{\text{Debt} + \text{Equity}} \times \beta_{Equity}$$

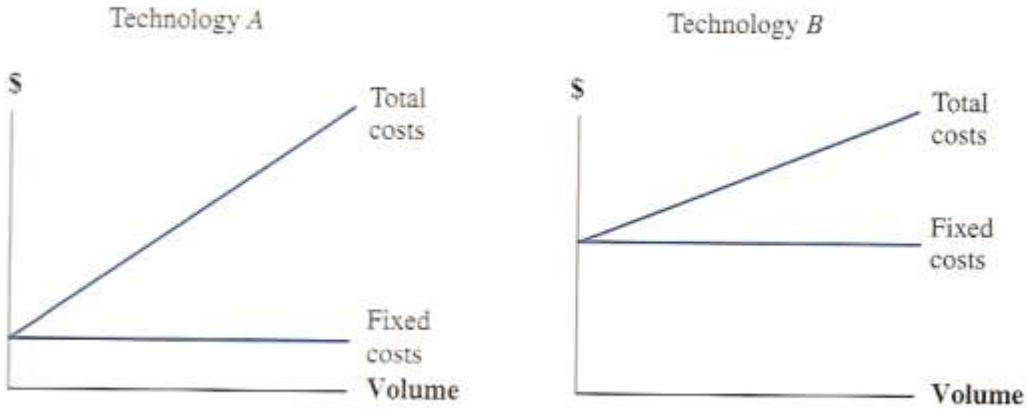
- Financial leverage always increases the equity beta relative to the asset beta.

Consider a firm that can choose either technology *A* or technology *B* when making a particular product. The relevant differences between the two technologies are displayed below:

Technology *A*	Technology *B*
Fixed cost: $1,000/year	Fixed cost: $2,000/year
Variable cost: $8/unit	Variable cost: $6/unit
Price: $10/unit	Price: $10/unit
Contribution margin: $2 ($10 − $8)	Contribution margin: $4 ($10 − $6)

Technology *A* has lower fixed costs and higher variable costs than does technology *B*. Perhaps technology *A* involves less mechanization than does *B*. Or, the equipment in *A* may be leased whereas the equipment in *B* must be purchased. Alternatively, perhaps technology *A* involves few employees but many subcontractors, whereas *B* involves only highly skilled employees who must be retained in bad times. Because technology *B* has both lower variable costs and higher fixed costs, we say that it has higher **operating leverage.**[5]

Figure 12.5 graphs the costs under both technologies. The slope of each total-cost line represents variable costs under a single technology. The slope of *A*'s line is steeper, indicating greater variable costs



Technology *A* has higher variable costs and lower fixed costs than does technology *B*. Technology *B* has higher operating leverage.

Continental as a Portfolio of Debt and Equity

Here we assume no taxes though we will discuss soon

- Think of the value of Continental as a portfolio of two assets, debt and equity

VALUE OR FIRM = EQUITY + DEBT

Want to find V, the cost of capital of the firm.

The cost of capital is the expected return on the firm. The expected value of a portfolio is the weighted average of the expected value of the individual assets. Same is true here…

The expected return of the firm (cost of capital) will be the weighted average of the cost of capital of the individual assets, equity and debt.

- Then, Continental required return on assets, or the **Weighted Average Cost of Capital (WACC)**, is equal to the weighted average of the return on equity and the return on debt, where the portfolio weights are given by E/V and D/V where V = Equity + Debt.

$$WACC = R_A = \frac{E}{V} R_E + \frac{D}{V} R_D$$

Where R_A is the Expected Return on Total Assets. How firms finance projects can be seen on the **Balance Sheet**, the **Debt-to-Asset Ratio**.

Continental as a Portfolio of Debt and Equity

- The financial structure of Continental is given in its balance sheet. Suppose that the **Debt-to-Asset Ratio** of Continental is 40%, this means that 40% of the assets are financed by debt and 60% are financed by equity. (debt/[asset + debt] = 40% and equity/[asset + debt] = 60%, so that the sum is one).

- We now have all the inputs to calculate Continental cost of capital (or return on assets) except for R_D , Continental's **Cost of Debt**, or **Borrowing Rate**

- **We can often estimate the cost of debt (R_D) by observing the YTM of the firm's debt**. If YTM figures are not available use coupon rate, it's the best you can do.

For most firms, R_D can be approximated by the coupon rate on the firm's recently issued bonds.

The cost of capital of the debt is usually lower than the cost of capital of the equity. Assume for Continental that the coupon rate on recently issued bonds is 7%.

We now have all the values we need to complete the WACC calculation…

Continental as a portfolio of debt and equity

- The weighted average cost of capital of Continental is (V = E + D):

$$WACC = R_A = \frac{E}{V} R_E + \frac{D}{V} R_D$$

WACC = .6*.17 + .4*.07 = 13%

The point is how we overcome the defects in the model/theory. We need to pay attention to things which may effect our estimation. We need to use good judgment in some cases. Each case is different. We need a good feeling of the estimation we come up with (beta), have reasons why you went with a certain decision number wise).

Exam: need to know things like YTM and NPV.

Practice questions

12.1 12.3 12.4 12.7

Risk, Cost of Capital, and Capital Budgeting

The purpose of Chapter 12 is to apply the risk and return concepts discussed in the previous two chapters to capital budgeting. The chapter describes how to estimate beta using the returns on an asset and the market portfolio. On a qualitative level, the chapter describes how a firms operating leverage, financial leverage, and the cyclical nature of its revenues help determine the systematic risk, beta, of the firm. The notion of an asset beta is introduced, and how financial leverage affects the firm's equity beta. Firm versus project discount, or hurdle, rates is discussed, and finally the firm's weighted average cost of capital is defined.

The key concepts presented in Chapter 12 are outlined below.

- Cost of equity capital
- Estimating beta
    - real world betas
    - stability of beta
    - using an industry beta
- Determinants of beta
    - cyclicality of revenues
    - operating leverage
    - financial leverage
- Asset beta
- Firm versus project hurdle rates
- Weighted average cost of capital
- Reducing the cost of capital

Chapter Summary

Earlier chapters on capital budgeting assumed that projects generate riskless cash flows. The appropriate discount rate in that case is the riskless interest rate. Of course, most cash flows from realworld capital-budgeting projects are risky. This chapter discusses the discount rate when cash flows are risky.

1. A firm with excess cash can either pay a dividend or make a capital expenditure. Because stockholders can reinvest the dividend in risky financial assets, the expected return on a capitalbudgeting project should be at least as great as the expected return on a financial asset of comparable risk.

2. The expected return on any asset is dependent upon its beta. Thus,we showed how to estimate the beta of a stock. The appropriate procedure employs regression analysis on historical returns.
3. We considered the case of a project whose beta risk was equal to that of the firm. If the firm is unlevered, the discount rate on the project is equal to

$$R_F + \beta \times (\overline{R}_M - R_F)$$

   where R_M is the expected return on the market portfolio and R_F is the risk-free rate. In words, the discount rate on the project is equal to the CAPM's estimate of the expected return on the security.

4. If the project's beta differs from that of the firm, the discount rate should be based on the project's beta. The project's beta can generally be estimated by determining the average beta of the project's industry.
5. The beta of a company is a function of a number of factors. Perhaps the three most important are
   - Cyclicality of revenues
   - Operating leverage
   - Financial leverage
6. Sometimes one cannot use the average beta of the project's industry as an estimate of the beta of the project. For example, a new project may not fall neatly into any existing industry. In this case, one can estimate the project's beta by considering the project's cyclicality of revenues and its operating leverage. This approach is qualitative in nature.
7. If a firm uses debt, the discount rate to use is the r_{WACC}. In order to calculate r_{WACC}, the cost of equity and the cost of debt applicable to a project must be estimated. If the project is similar to the firm, the cost of equity can be estimated using the SML for the firm's equity. Conceptually, a dividend-growth model could be used as well, though it is likely to be far less accurate in practice.
8. A number of academics have argued that expected returns are negatively related to liquidity, where high liquidity is equivalent to low costs of trading. These scholars have further suggested that firms can reduce their cost of capital by lowering these trading costs. Practical suggestions include stock splits, more complete dissemination of information, and more effective assistance to security analysts.