CHAPTER 3

THE PRICE OF RISK: ESTIMATING DISCOUNT RATES

To value a firm, you need to estimate its costs of equity and capital. In this chapter, you first consider what each of these is supposed to measure, explore a simple model for the costs and then examine the special problems associated with estimating each for technology firms.

The cost of equity is the rate of return that investors in a firm's equity expect to make on their investments. Since publicly traded firms usually have thousands of investors, the cost of equity is usually measured from the perspective of the marginal investors in the firm – the investors most likely to be trading on the firm's stock. The models used to estimate the cost of equity attempt to measure the risk added by an investment to the marginal investor's portfolio and usually require a riskless rate and an average market risk premium or premiums to arrive at the cost of equity.

The cost of debt is the current rate at which a firm can borrow, adjusted for any tax benefits associated with borrowing. Firms with higher default risk should have higher costs of debt than firms with lower default risk.

Technology firms present a particular challenge when it comes to estimating cost of equity. Conventional approaches to estimating equity risk that are based upon stock prices flounder given the limited and volatile price history exhibited by many of these firms. While more mature technology firms are predominantly financed with equity, some younger technology firms, especially start-up ventures, do carry substantial amounts of debt. Attaching a cost of debt to the borrowings can become difficult, because these firms are often not rated, lose money and borrow from banks.

Cost of Equity

The cost of equity is the rate of return that investors in a firm's equity expect to make. In this section, you see why equity risk should be measured from the perspective of

the marginal investor in a firm's equity, examine alternative models for measuring the cost of equity, and then consider how best to estimate the cost of equity for technology firms

Risk and Return Models

To estimate the cost of equity, you need to develop first a measure or measures of risk, and then use those measures of risk to arrive at expected returns on equity investments. You begin with a short examination of the different risk and return models that are often used to estimate the cost of equity, and the common elements and differences across these models. You then learn how to use these models to estimate the cost of equity for technology firms.

Common Elements across Risk and Return Models

While there are several accepted risk and return models in finance, they all share some common views about risk. First, they all define risk in terms of variance in actual returns around an expected return; thus, an investment is riskless when actual returns are always equal to the expected return.

Second, they all argue that risk has to be measured from the perspective of the marginal investor in an asset, and that this marginal investor is *well diversified*. Therefore, the argument goes, it is only the risk that an investment adds on to a diversified portfolio that should be measured and compensated. In fact, it is this view of risk that leads risk models to break the risk in any investment into two components. There is a firm-specific component that measures risk that relates only to that investment or to a few investments like it, and a market component that contains risk that affects a large subset or all investments. It is the latter risk that is not diversifiable and should be rewarded.

Competing Models

While all risk and return models agree on this fairly crucial distinction, they part ways when it comes to how measure this market risk.

- The *capital asset pricing model*, with its assumptions that there are no transactions cost or private information, concludes that the marginal investor hold a portfolio that includes every traded asset in the market, and that the risk of any investment is the risk added on to this "market portfolio." This risk is measured with a market beta, leading to an expected return of:

  Expected Return = Riskfree Rate + β_{jM} (Risk Premium on Market Portfolio)

  Thus, the cost of equity in the capital asset pricing model is a function of three inputs – the riskless rate, the risk premium on the market portfolio and the beta of the equity investments being assessed.

- The *arbitrage pricing model*, which is built on the assumption that assets should be priced to prevent arbitrage, concludes that there can be multiple sources of market risk, and that the betas relative to each of these sources measures the expected return. Thus, the expected return is:

$$\text{Expected Return} = \text{Riskfree Rate} + \sum_{j=1}^{j=k} \beta_j (\text{Risk Premium}_j)$$

  where β_j = Beta of investment relative to factor j

  Risk Premium_j = Risk Premium for factor j

  In the arbitrage pricing model, the cost of equity is determined by the riskless rate, the risk premiums for each of the factors in the model and the betas of an asset relative to each factor. The factors remain unnamed and are estimated using a statistical technique called factor analysis.

- *Multi-factor models*, which specify macro economic variables as these factors take the same form as the arbitrage pricing model, with multiple betas and risk premiums:

$$\text{Expected Return} = \text{Riskfree Rate} + \sum_{j=1}^{j=k} \beta_j (\text{Risk Premium}_j)$$

where β_j = Beta of investment relative to macro economic factor j

Risk Premium_j = Risk Premium for macro economic factor j

The cost of equity for a firm in a multi-factor model depends upon the riskless rate, the risk premiums for each of the macro-economic factors and the betas for an investment, relative to each macro-economic factor.

- *Regression models* that relate the actual returns on stocks to observable and measurable firm characteristics, such as market capitalization, are the final approach to estimate the costs of equity for firms. In this approach, the regression equation is first estimated using historical data, and then used to obtain the costs of equity for individual firms.

Which model should you use for technology firms?

Given these choices, which, if any, of these models should you use to estimate the cost of equity for technology firms? The first, and perhaps most significant, problem in applying these models to valuing technology firms may lie in their perspective on risk. The assumption that the marginal investor in a stock, i.e., the investor most likely to be trading on the stock, is a well-diversified entity may be a difficult one to sustain for technology firms because of the following reasons:

1. Since most technology firms are young, and the original owners continue to operate as top managers, the proportion of stock held by the top managers at these firms is much higher than it is in other firms. Larry Ellison at Oracle, Bill Gates at Microsoft and Jeff Bezos at Amazon.com all continue to hold large percentages of their firms' stock.

2. For the smaller technology firms, there is another problem. The marginal investor may be an individual who is not well diversified. In fact, the marginal investor may well be a day trader whose time horizon can be measured in minutes rather than years.

How would altering the marginal investors' characteristics change the way you measure risk? Instead of considering only the risk that cannot be diversified away (which is what the betas measure), you should be looking at total risk in investments if the investor is not diversified.

Should you, therefore, abandon traditional risk and return models when looking at technology firms? Not necessarily. Even though the largest holder of stock in many technology firms is the owner/founder, there is little trading that occurs on this holding. In fact, in stocks like Oracle and Microsoft, the bulk of the trading is still done by institutional investors in the stock. This would indicate that the marginal investors, especially in the more liquid and widely traded technology stocks, are diversified institutional investors. When looking at less liquid technology stocks, held and traded primarily by individuals, you should be more cautious about using the conventional measures of risk.

If you do assume that it is, in fact, appropriate to value technology stocks using the perspective of a well diversified investors, should you use the capital asset pricing model, the arbitrage pricing model or the multi-factor model? The capital asset pricing model may be the most widely used model in valuation practice, but it does contain some significant dangers for technology stocks, especially if the market betas are estimated in the conventional way.[1] Empirical tests of the model indicate that these betas underestimate the risk in small-capitalization stocks, relative to large capitalization stocks. In addition, stocks with high price-earnings ratios seem to earn lower returns than

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[1] The conventional approach, which is described in the next section, estimates the beta for a stock by running a regression of stock returns against a market index.

those predicted by the capital asset pricing model over long periods. What are the alternatives? One is to use the arbitrage pricing or multi-factor models. While these models have the potential to better capture the risk or investing in technology firms, they require even more historical data than the capital asset pricing model. Another is to abandon the conventional approach to estimating market betas in the capital asset pricing model, and consider ways of adapting the estimation process to better measure the risk of technology stocks. The next section makes a case that the latter approach offers more promise.

Estimation Issues

All risk and return models require three sets of inputs. The first is the riskfree rate, the second is the appropriate risk premium or premiums for the factor or factors in the model and the third is the beta or betas of the investment being analyzed.

I. Riskless Rate

A riskless asset is one for which the investor knows the expected returns with certainty. Consequently, for an investment to be riskless over a specified time period (time horizon), two conditions have to be met –

- There is *no default risk*, which generally implies that the security has to be issued by the government. Not all governments are viewed as default free, and this does create a practical problem in obtaining riskless rates in some markets.
- There is *no uncertainty about reinvestment rates*, which implies that there are no cash flows prior to the end of your time horizon, since these cash flows have to be reinvested at rates that are unknown today.

Short Term versus Long Term Rates

Should you use a short-term or a long-term government bond rate as a riskless rate? The answer depends upon when your cash flows come due. Assume, for instance, that you are analyzing a five-year project, and you need a 5-year riskless rate. A six-month treasury bill is not riskless for a five-year time horizon, since there is reinvestment risk at the end of each six-month period. In fact, neither is a five-year government bond with coupons, since the coupons have to be reinvested, at the rates prevailing at that time, every six months for the next 5 years. Only a 5-year zero-coupon government bond fulfils these conditions – it has no default risk and there are no cash flows prior to the end of the 5^{th} year.

Thus, the riskless rate is the rate on a zero coupon government bond matching the time horizon of the cash flow being analyzed; here, since the only cash flow is the principal on the bond coming due at maturity, there is neither default nor reinvestment risk. In theory, this translates into using different riskless rates for each cash flow on an investment - the 1 year zero coupon rate for the cash flow in year 1, the 2-year zero coupon rate for the cash flow in year 2, and so on.

Matching each cash flow with a different riskless rate can be tedious, especially in the context of a valuation, where the cash flows are often spread over ten years or more. A simpler, though less precise, solution will suffice. You could estimate the weighted average of when the cash flows come due by computing a duration for the cash flows in the valuation. In fact, extending a measure of duration often used in the context of bonds, you can estimate the duration of the cash flows in a valuation to be:

$$\text{Duration of cash flows} = \frac{\sum_{t=1}^{t=\infty} t * \frac{CF_t}{(1+r)^t}}{\sum_{t=1}^{t=\infty} \frac{CF_t}{(1+r)^t}}$$

Where CF_t is the cash flow in year t and r is the discount rate (cost of capital, if valuing a firm). Once the duration of the cash flows have been estimated, you can then use a government bond with equivalent duration to derive a riskless rate. Since the cash flows

on technology stocks tend to be weighted towards the later years (and are often negative in the earlier years), they will have a longer duration, and this would suggest that longer-term government bond rates should be used as riskless rates when valuing these stocks.

II. Risk premium

The risk premium is clearly a significant input in all the asset pricing models. In the following section, you begin by examining the fundamental determinants of risk premiums, and then you look at practical approaches to estimating these premiums.

What is the risk premium supposed to measure?

The risk premium measures the "extra return" that would be demanded by investors for shifting their money from a riskless investment to an average risk investment. It should be a function of how risk averse investors are, and how risky they perceive stocks (and other risky investments) to be, relative to a riskless investment. Since each investor in a market is likely to have a different assessment of an acceptable premium, the premium is a weighted average of these individual premiums, where the weights are based upon the wealth the investor brings to the market. Wealthier investors will have their risk premiums weighted more than investors with less wealth.

Estimating Risk Premiums

You look now at two ways to estimate the risk premium in the capital asset pricing model. One is to look at the past and estimate the premium earned by risky investments (stocks) over riskless investments (government bonds); this is called the **historical premium**. The other is to use the premium extracted by looking at how markets price risky assets today; this is called an **implied premium**.

1. Historical Risk Premiums

The most common approach to estimating the risk premium is to base it on historical data. In the arbitrage pricing model and multi- factor models, the raw data on which the premiums are based are historical data on asset prices over very long time periods. In the CAPM, the premium is estimated by looking at the difference between average returns on stocks and average returns on riskless securities over an extended period of history.

In most cases, you follow these steps to find historical risk premiums. First, you define a time period for the estimation, which can range as far back as 1926 for U.S. data[2]. Then, you calculate the average returns on stocks and average returns on a riskless security over the period. Finally, you calculate the difference between the returns on stocks and the riskless return and use it as a risk premium to predict future returns. When you use historical premiums, you implicitly assume that the risk aversion of investors has not changed across time, and that the relative riskiness of the risky portfolio (stocks) has not changed over time, either.

In calculating the average returns over past periods, a measurement question arises: Should you use arithmetic or geometric averages to compute the risk premium? The arithmetic mean is the average of the annual returns for the period under consideration, whereas the geometric mean is the compounded annual return over the same period. The following example demonstrates the difference –

Year	Price	Return
0	50	

[2] The most widely used database, from Ibbotson Associates, has returns going back to 1926. Jeremy Siegel, at Wharton, recently presented data going back to the early 1800s.

1	100	100%
2	60	-40%

The arithmetic average return over the two years is 30%, while the geometric average is only 9.54% ($1.2^{0.5}$-1=1.0954). Those who use the arithmetic average premium argue that it is much more consistent with the framework[3] of the CAPM, and a better predictor of the risk premium in the next period. The geometric mean is justified on the grounds that it takes into account compounding, and that it is a better predictor of the average premium in the long term. There can be substantial differences in risk premiums based on the choices made at this stage, as illustrated in Table 3.1. The data in the table are based on historical data on stock, treasury bill and treasury bond returns and provide estimates of historical risk premiums:

Table 3.1: Historical Risk Premiums for the U.S. Market

	Stocks – Treasury Bills		*Stocks – Treasury Bonds*	
	Arithmetic	*Geometric*	*Arithmetic*	*Geometric*
1928-1999	8.73%	6.96%	7.63%	6.05%
1962-1999	6.97%	5.89%	6.06%	5.36%
1990-1999	13.29%	16.12%	10.97%	13.16%

Source: Federal Reserve

As you can see, the historical premiums can vary widely depending upon whether you go back to 1928, 1962 or 1990, whether you use T.Bills or T.Bonds as the riskless rate, and

[3] The CAPM is built on the premise of expected returns being averages, and risk being measured with variance. Since the variance is estimated around the arithmetic average, and not the geometric average, it may seem logical to stay with arithmetic averages to estimate risk premiums.

whether you use arithmetic or geometric average premiums[4]. Although it is impossible to prove one premium right and the others wrong, you are on safer ground assuming that::

- *Longer term premiums* , since stock returns are volatile and shorter time periods can provide premiums with large standard errors. For instance, the premium extracted from 25 years of data will have a standard error[5] of about 4-5%.
- *Long term bond rates as riskless rates*, since your time horizons in corporate financial analysis tend to be long term, and you use the treasury bond rate as your riskless rate.
- *Geometric average premiums*, since arithmetic average premiums overstate the expected returns over long periods[6]. The geometric mean yields lower premium estimates than does the arithmetic mean, and provides a more appropriate estimate for longer time horizons[7]. On this issue, however, there is significant disagreement.

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[4] Booth (1999) examines both nominal and real equity risk premiums from 1871 to 1997. While the nominal equity returns have clearly changed over time, he concludes that the real equity return has been about 9% over than period. He suggests adding the expected inflation rate to this number to estimated the expected return on equity.

[5] Assuming that returns in individual years are independent, the standard error of a 25-year estimate can be calculated by dividing the annual standard deviation in stock prices in the US (about 25%) by the square root of the number of years (25=5), yielding a standard error of 5% (25%/5) in the estimate

[6] When you look at markets like the United States that have survived for 70 years without significant breaks, you are looking at the exception. To provide a contrast, consider the other stock markets one could have invested in 1926; many of these markets did not survive and an investor would have lost much of his or her wealth.

[7] Part of the reason for the large difference between arithmetic and geometric premium is the serial correlation in stock returns – good years have tended to be followed by bad years, and vice versa.

Ibbotson Associates argues for the arithmetic average premium, noting that it is the best estimate of the premium for the next period. Indro and Lee (1997) compare arithmetic and geometric premiums, find them both wanting, and argue for a weighted average, with the weight on the geometric premium increasing with the time horizon.

These biases would lead you closer to 6.05% which is the geometric average premium for stocks over treasury bonds from 1928 to 1999, if you use historical premiums. In using this premium, however, you are assuming that there are no trends in the risk premium, and that investors today demand similar premiums to those that they used to demand two, four or six decades ago. Given the changes that have occurred in the markets and in the investor base over the last century, you should have serious concerns about using this premium, especially in the context of valuation.

 *histret.xls*: There is a dataset on the web that summarizes historical returns on stocks, T.Bonds and T.Bills going back to 1926.

2. Implied Equity Premiums

A second approach to estimating risk premiums does not require surveys or historical data but does assume that the overall market prices stocks correctly. Consider, for instance, a very simple valuation model for stocks:

$$\text{Value} = \frac{\text{Expected Dividends Next Period}}{(\text{Required Return on Equity} - \text{Expected Growth Rate})}$$

This is the present value of dividends growing at a constant rate forever, developed in chapter 5. Three of the four inputs in this model can be estimated from publicly available information - the current level of the market (value), the expected dividends next period

and the expected growth rate in earnings and dividends in the long term. The only unknown is the required return on equity; when you solve for it, you get an implied expected return on stocks. Subtracting out the riskless rate yields an implied equity risk premium.

To illustrate the estimation of implied equity risk premiums, assume that the current level of the S&P 500 Index is 900. Assume also that the expected dividends on the index next year will be 2% of current stock prices (this is called the dividend yield), and that the expected growth rate in earnings and dividends in the long term is 7%. Solving for the required return on equity yields the following:

$$900 = (.02*900) /(r - .07)$$

Solving for r,

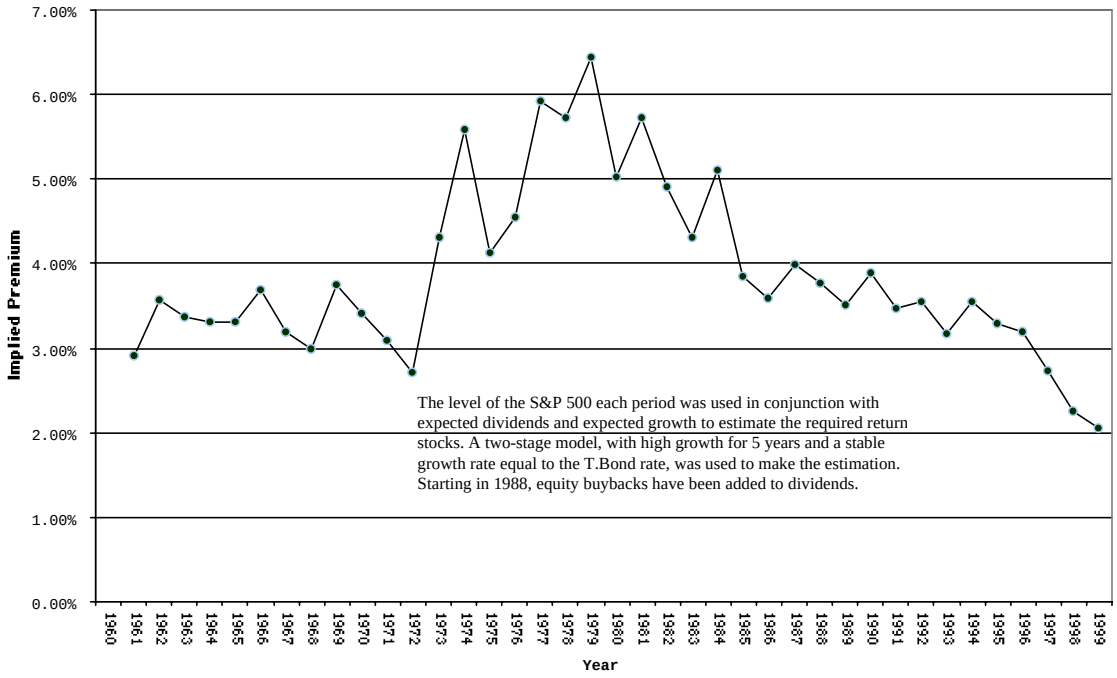
$$r = (18+63)/900 = 9\%$$

If the current riskless rate is 6%, this yields a risk premium of 3%.

The advantage of this approach is that it is market-driven and current, and does not require any historical data. It is, however, bounded by whether the valuation model used is the right one, and by whether the inputs to that model are available and reliable. For instance, in the above example, the use of dividends as the cash flow to equity investors and the assumption of constant growth might lead to an implied risk premium that is too low. Finally, the implied risk premium is based upon the assumption that the market is correctly priced.

The contrast between the implied risk premium and the historical premiums is best illustrated by graphing out the implied premiums in the S&P 500 going back to 1960 in Figure 3.1:

Figure 3.1: Implied Premium for US Equity I



Each year, you can estimate expected dividends and expected growth[8], and use the level of the index at the end of the year to estimate implied equity premiums. Note that implied equity risk premiums are consistently lower than the historical premiums estimated in Table 3.1. The implied premium has also decreased over time.[9] At the beginning of 2000, for instance, the implied equity risk premium was about 2%, well below the historical premium of 6.05%.

histimpl.xls: This dataset on the web shows the inputs used to calculate the premium in each year for the U.S. market.

[8] From 1980 on, analyst projections of growth as the input on growth were used. Earlier, forecast expected growth based upon growth in the previous five years was used.

 *implprem.xls*: This spreadsheet allows you to estimate the implied equity premium in a market.

Risk Premiums to Use in Valuing Technology Stocks

When valuing technology stocks what risk premium should you use to estimate the cost of equity? The choice between historical and implied premiums should not be based upon what types of stocks you are valuing but on what you believe about markets. If you believe that markets are, on average, right, you should use implied equity risk premiums in all your valuations. If, on the other hand, you believe that markets collectively can become under or over valued, and that there is a tendency to revert back to historical norms, you should use historical risk premiums. There are dangers associated with each approach.

If you decide to use historical risk premiums in valuation, in periods such as the current one (when implied premiums are much lower than historical premiums), you will tend to find more stocks to be over valued than under valued. This is because large risk premiums lead to higher discount rates (than those being assessed by the market currently) and lower present values. This effect is exacerbated for technology stocks, in general, and new technology stocks, in particular, because their payoffs in terms of cash flows occur way out in the future. If, on the other hand, you decide to use the implied equity risk premium, and the market overall is overvalued, you will tend to overvalue stocks as well, and technology stocks more than others.

Is there an intermediate solution? Yes. The average implied equity risk premium between 1970 and 1999 is approximately 4%. By using this premium, you are assuming

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[9] Pettit (1999) provides several reasons why equity risk premiums today are lower than they have been historically and argues for a 5% risk premium.

that while markets might have been overvalued in some of these years, and undervalued in others, it has been on average right over this period.

Finally, why don't you use a technology stock risk premium to value technology stocks? In the standard models of risk and return that you will be applying, the risk premium is the premium that marginal investors demand for investing in the average risk investment. Thus, it should remain the same for all assets. What will change across assets is your assessment of the risk of these assets (estimated as a beta or betas).

Country Risk Premiums

Of the five companies that you will be valuing, Rediff.com poses a unique challenge. Rediff is an internet portal directed at the Indian market. While the sheer size of this market may be one of the more attractive parts of investing in Rediff, there is additional exposure to risk from an emerging market in this firm that does not exist, at least to a similar extent, when investing in Yahoo! or Amazon. Should there be an additional risk premium added on to Rediff's cost of equity to reflect its emerging market status? Yes, and you should estimate it in two steps.

First, you derive a measure of India's country risk. To arrive at this measure, you begin with a country rating, which measures the default risk perceived in the country's bonds. The country rating for India in June 2000 was Ba2, and the default spread for Ba2 rated bonds over the U.S. treasury bond was approximately 3%[10]. Second, you estimate an additional equity risk premium for India by measuring how much more volatile the Indian equity market is than its bond market. Using 1998-99 data, you could estimate the annualized standard deviation in the Sensex (Indian equity index) to be 31.82% and the

[10] India does not have any dollar-denominated bonds that are traded. The dollar-denominated bonds issued by other Ba2 rated countries was used to estimate the spread over the U.S. treasury bond rate.

annualized standard deviation in the Indian 10-year government bond to be 14.90%[11]. The country risk premium for India can then be estimated as follows:

$$\text{Country risk premium for India} = \text{Default spread for Country} * \frac{\sigma_{\text{Equity}}}{\sigma_{\text{Government Bond}}}$$

$$= 3.00\% * (31.82\%/14.90\%) = 6.43\%$$

This is added on to the risk premium of 4% estimated for a mature equity market, estimated in the last part.[12]

How will this risk premium show up in Rediff's cost of equity? To make this judgment, you have to estimate Rediff's exposure to this risk and this requires an analysis of what it is that determines this risk and how best to measure in. In the next section, you turn to this measurement question.

III. Betas

The beta or betas that measure risk in models of risk in finance have two basic characteristics that you need to keep in mind during estimation. The first is that they measure the *risk added on to a diversified portfolio*, rather than total risk. Thus, it is entirely possible for an investment to be high risk, in terms of individual risk, but to be low risk, in terms of market risk. The second characteristic that all betas share is that *they measure the relative risk* of an asset, and, thus, are standardized around one. The market-capitalization weighted average beta across all investments, in the capital asset pricing model, should be equal to one. In any multi-factor model, each beta should have the same property.

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[11] Weekly returns over 100 weeks ending July 7, 2000 were used to make both estimates.

[12] For a more extensive discussion of country risk premiums, see my paper on estimating risk premiums on my web site:

http://www.stern.nyu.edu/~adamodar/New_Home_Page/papers.html

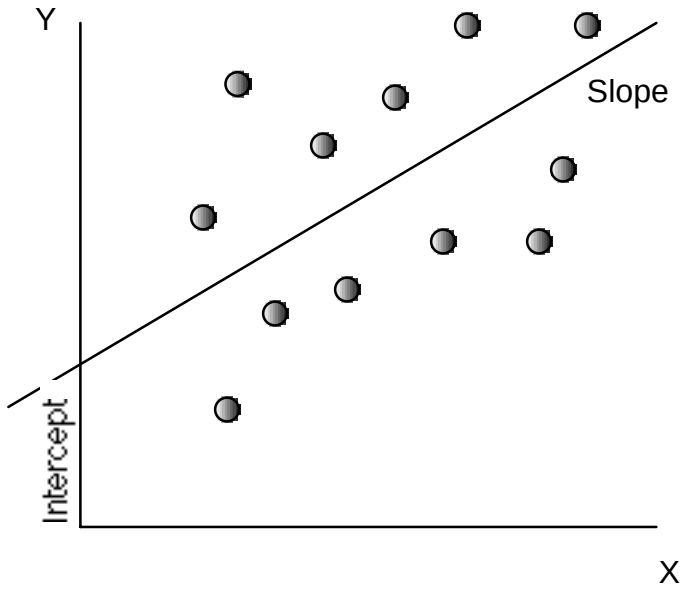
Keeping in mind these characteristics, you would like the beta you estimate for an asset to measure the risk added on by that asset to a diversified portfolio. This, of course, raises interesting follow-up questions. When you talk about diversified portfolios, are you referring to a portfolio diversified into just equity or should you include other asset classes? Should you look at diversifying only domestically or should you look globally? In the CAPM, for instance, with no transactions costs, the diversified portfolio includes all asset classes and is globally diversified. If there are transactions costs and barriers to global investment, the market portfolio may not include all asset classes or be as globally diversified. You can try an alternate route to answering these questions. In coming up with a diversified portfolio, you should take the perspective of the marginal investor in the market. The extent to which that marginal investor is diversified should determine the composition of the index to use in estimating betas.

In the section that follows, you consider two approaches to estimating betas. The first is the regression approach, where historical stock returns are used to compute the beta of a stock. The other is the bottom-up approach, where you estimate the beta by breaking a firm down into individual businesses, and estimating the betas of these businesses.

I. The Regression (or Top-down) Approach

The textbook description of beta estimation is simple. The beta for an asset can be estimated by regressing the returns on any asset against returns on an index representing the market portfolio, over a reasonable time period, as shown in Figure 3.2.

Figure 3.2: Regression of Returns on Stock against Returns on Market Index



In this figure, the returns on the asset represent the Y variable, and the returns on the market index represent the X variable. Note that the regression equation that you obtain is as follows:

$$R_j = a + b\ R_M$$

Where R_j is the return on investment j, and R_M is the return on the market index. The slope of the regression 'b" is the beta, because it measures the risk added on by that investment to the index used to capture the market portfolio. In addition, it also fulfils the requirement that it be standardized, since the weighted average of the slope coefficients estimated for all of the securities in the index will be one.

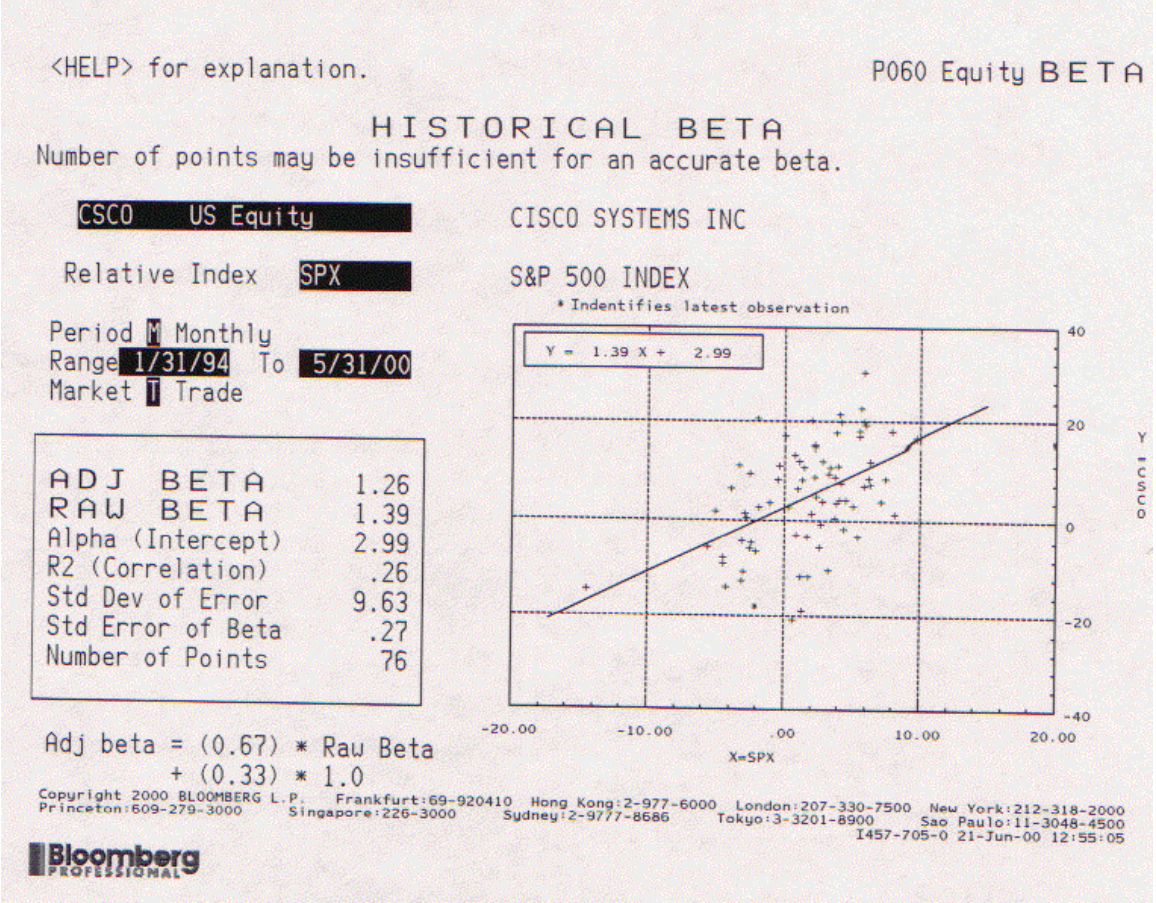
The Limitations of Regression Betas for Technology Firms

While you can use the regression approach to estimate betas for technology firms, these betas are likely to be affected by three problems that while not unique to these firms are exaggerated in their case.

1. Estimation Choices and Betas

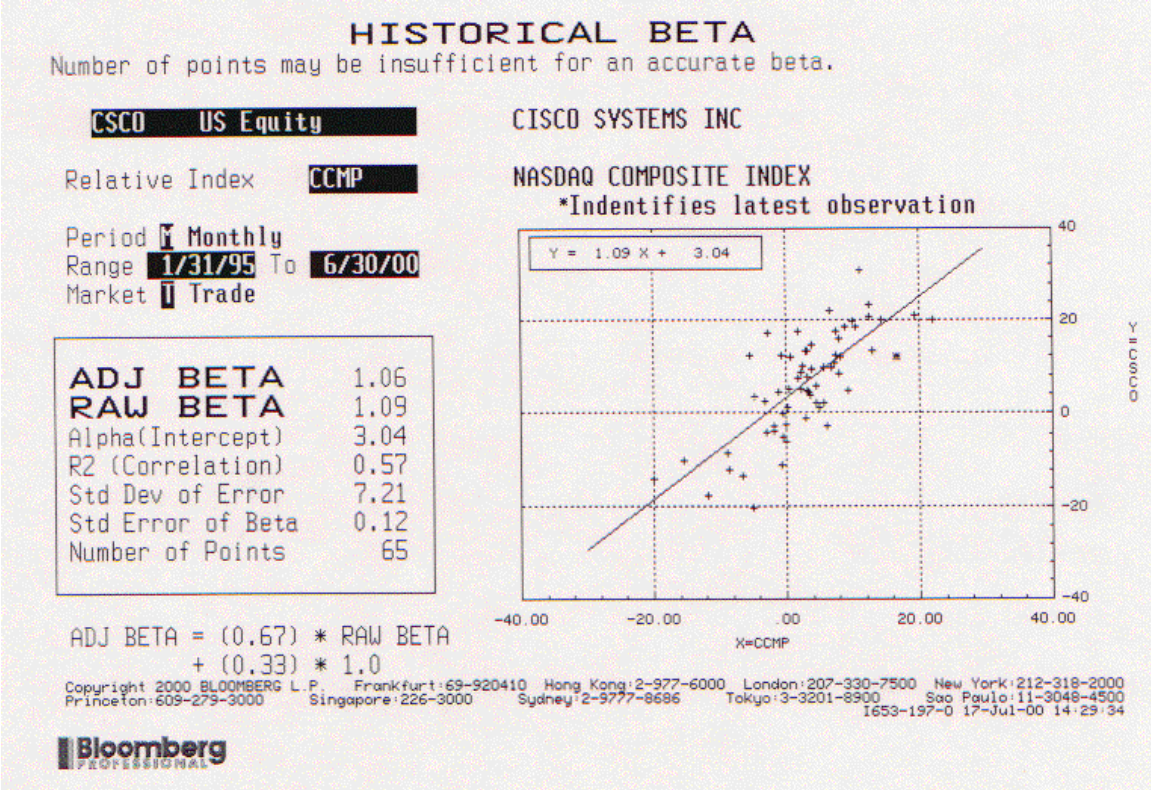
The regression betas will vary widely depending upon how the regression is set up and run. Consider the case of Cisco. You could estimate Cisco's beta relative to the S& P 500, the index most widely by beta estimation services in the United States, and get the regression shown in Figure 3.3

Figure 3.3: Beta Estimate for Cisco: S&P 500



This regression uses monthly returns over 76 months to arrive at this estimate. Alternatively, you could have estimated Cisco's beta relative to the index of the exchange on which it is traded – the NASDAQ. The regression output is shown in Figure 3.4.

Figure 3.4: Beta Estimate for Cisco: NASDAQ



Note how different the betas are with the two indices - 1.09 with the NASDAQ versus 1.39 with the S&P 500. Which one is the right index? In the capital asset pricing model, the index that comes closer to the "market portfolio," which contains all traded assets in proportion to their market value would be the better index. From that perspective, the S&P 500 would be the better choice, since it includes the 500 largest market capitalization firms in the United States. But, you could legitimately have estimated Cisco's beta against other indices such as the Wilshire 5000 (which includes far more U.S, stocks) or the Morgan Stanley Capital Index (which has a better claim as an index that represents a global market portfolio). The betas would have been very different from the betas estimated above.

The choice of index is but one of the many choices that can affect the beta estimate. There are at least two others. One is the period over which you estimate the beta. Approximately six years of history were used in the two beta estimates above, but there is no consensus on this, with some services using only 2 years of history. The other

is the return interval used to estimate returns. Monthly returns were used in the two estimates above, but daily, weekly, quarterly or annual returns could also have been used. Table 3.2 reports the beta estimate for Cisco, relative to the S&P 500, as a function of these choices.

Table 3.2: Beta Estimates for Cisco

	Daily	*Weekly*	*Monthly*	*Quarterly*
2 years	1.72	1.74	1.82	2.70
5 years	1.63	1.70	1.45	1.78

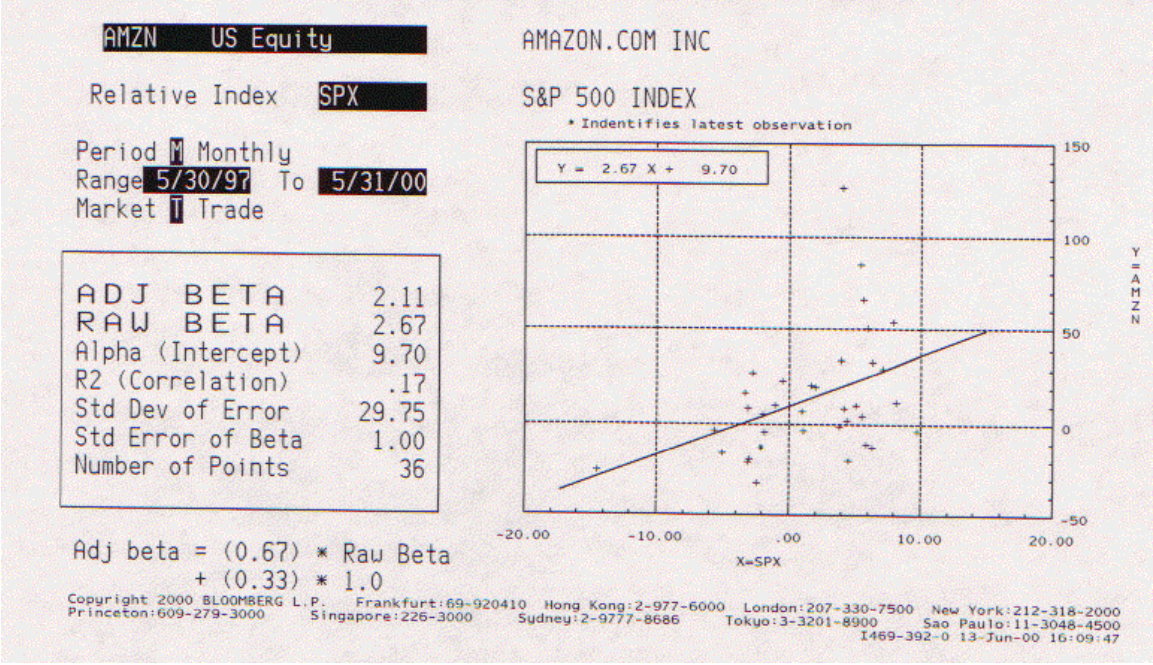
Source: Bloomberg

It should be troubling, from the perspective of valuation, that the regression technique can yield beta estimates ranging from 1.45 to 2.70.

2. The Noise Problem

The beta estimate from the regression is noisy, and the range that emerges for the beta is large. Figure 3.5 reports the beta estimate for Amazon.com. Since it has been traded only since 1997, three years of monthly returns were used to make this estimate:

Figure 3.5: Beta Estimate for Amazon.com



Source: Bloomberg The beta estimate for Amazon of 2.67 comes with a standard error of 1.00. If you assume that the beta estimate is normally distributed, this would imply that the true beta for Amazon would lie between 1.67 (2.67- one standard error) and 3.67 (2.67 + one standard error) with 67% confidence. While beta estimates for all firms come with standard errors, they tend to be much larger for technology firms, partly because of their limited histories and partly because of the volatility of their stock prices.

In fact, the beta estimate for Ariba has to be based upon less than one year of data. Rediff.com, as an initial public offering, represents the limiting case for this problem, since it has no public history. Its beta cannot be estimated using the regression approach.

3. The Problem of Firms Changing over Time

Even if a stock does not dominate the index, and the regression beta has a low standard error, there is a final problem with regression beta estimates. They are based upon historical data, and firms change over time. Technology firms change more than most since the technology evolves, revenues grow exponentially and the firm's basis product mix often changes. In addition, these firms often acquire other firms to grow. Thus, the regression reflects the firm's characteristics, on average, over the period of the estimation rather than the firm as it exists today. Again, this problem is obvious with both Amazon and Cisco. Amazon, over the four years of its history, has seen its revenues change dramatically from $16 million in 1996 to $1.6 billion in 1999. Clearly, it was a very different firm in 1999 than it was in 1996.

II. Bottom-up Betas

The beta of a firm might be estimated from a regression, but it is determined by fundamental decisions that a firm takes on where to invest, what type of cost structure it plans to maintain and how much debt it takes on. The alternative approach to beta

estimation considers these fundamentals and is the bottom-up approach to beta estimation. To understand this approach, you can begin be considering the fundamentals that determine betas and then provide a framework for estimating bottom-up betas.

Determinants of Betas

The beta of a firm is determined by three variables -(1) the type of business(es) the firm is in, (2) the degree of operating leverage in the firm and (3) the firm's financial leverage. While much of the discussion in this section is couched in terms of CAPM betas, the same analysis can be applied to the betas estimated in the APM and the multi-factor model as well.

1. *Type of Business*

Since betas measure the risk of a firm relative to a market index, the more sensitive a business is to market conditions, the higher is its beta. Thus, other things remaining equal, cyclical firms can be expected to have higher betas than non-cyclical firms. Other things remaining equal, then, companies involved in housing and automobiles, two sectors of the economy which are very sensitive to economic conditions, will have higher betas than companies which are in food processing and tobacco, which are relatively insensitive to business cycles.

Building on this point, you can see that the degree to which a product’s purchase is discretionary affects the beta of the firm manufacturing the product. “Discretionary” refers to the capacity of customers of the firm to delay, defer or not buy the product or service, if their income drops. Technology firms that produce products that are non-discretionary to their customers should have lower betas than technology firms that produce discretionary products. For instance, you would expect a firm that manufactures expensive add-ons for computers to have a higher beta than a firm that manufactures

computers, and a firm that produces computer games to have a higher beta than a firm that produces virus protection programs.

There is also a link between a firm's growth potential and the discretionary nature of its products. If a significant portion of a firm's value comes from expected future growth, you would expect it to have a higher beta than a firm that gets most of its value from existing assets. This is because a high-growth firm has to attract new customers to its products or get existing customers to use more of its products, and the extent to either occurs may depend upon how well customers are doing.

b. Degree of Operating Leverage

The degree of operating leverage is a function of the cost structure of a firm, and is usually defined in terms of the relationship between fixed costs and total costs. A firm that has high operating leverage (i.e., high fixed costs relative to total costs), will also have higher variability in earnings before interest and taxes (EBIT) than would a firm producing a similar product with low operating leverage. Other things remaining equal, the higher variance in operating income will lead to a higher beta for the firm with high operating leverage.

While operating leverage affects betas, it is difficult to measure the operating leverage of a firm, at least from the outside, since fixed and variable costs are often aggregated in income statements. It is possible to get an approximate measure of the operating leverage of a firm by looking at changes in operating income as a function of changes in sales.

Degree of Operating leverage = % Change in Operating Profit / % Change in Sales

For firms with high operating leverage, operating income should change more than proportionately, when sales change.

What is the relevance for technology firms? Many new technology firms have significant fixed costs associated with setting up infrastructure and developing new products. Once these costs have been incurred, however, the variable costs are often low. America Online, for instance, faces very little additional costs when it adds a new subscriber, having used its resources to develop a communication network in prior years. For firms like Cisco and Microsoft, research and development expenses can be viewed as a fixed costs, since the failure to do research can be disastrous for future growth. These high fixed costs should lead to higher betas for technology firms. Furthermore, since there are economies of scale associated with size, you would expect smaller technology firms to have much higher betas than larger technology firms.

c. Degree of Financial Leverage

Other things remaining equal, an increase in financial leverage will increase the equity beta of a firm. Intuitively, the obligated payments on debt increase the variance in net income, with higher leverage increasing income during good times and decreasing income during economic downturns. If all of the firm's risk are borne by the stockholders (i.e., the beta of debt is zero)[13], and debt has a tax benefit to the firm, then,

$$\beta_L = \beta_u \ (1 + (1-t) (D/E))$$

where

[13] If debt has market risk (i.e., its beta is greater than zero), this formula can be modified to take it into account. If the beta of debt is β_D , the beta of equity can be written as:

β_L = Levered Beta for equity in the firm

β_u = Unlevered beta of the firm (i.e., the beta of the firm without any debt)

t = Corporate tax rate

D/E = Debt/Equity Ratio

The unlevered beta of a firm is determined by the types of the businesses in which it operates and its operating leverage. Thus, the equity beta of a company is determined both by the riskiness of the business it operates in, as well as the amount of financial leverage risk it has taken on.

Technology firms tend to be lightly levered. Thus, very seldom can debt be fingered as the culprit when a firm has a high beta. Given the high risk inherent in their underlying businesses, technology firms tend to have high unlevered betas. Borrowing money will only exaggerate the impact of leverage and push the betas of these firms to even higher levels.

 This spreadsheet allows you to estimate the unlevered beta for a firm and compute the betas as a function of the leverage of the firm.

Estimating Bottom-up Betas

Breaking down betas into their business, operating leverage, and financial leverage components provides you with an alternative way of estimating betas, where you do not need past prices on an individual firm or asset to estimate its beta.

To develop this alternative approach, you need to introduce an additional feature that betas possess that proves invaluable. The beta of two assets put together is a

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$\beta_L = \beta_u (1+(1-t)(D/E)) - \beta_D (D/E)$

weighted average of the individual asset betas, with the weights based upon market value. Consequently, the beta for a firm is a weighted average of the betas of all of different businesses it is in. Thus, the bottom-up beta for a firm, asset or project can be estimated as follows.

(1) *Identify the business or businesses* that make up the firm, asset or project.

(2) *Estimate the unlevered beta(s) for the business or businesses that the firm is involved in*. The simplest approach uses these unlevered betas directly, without adjusting for any differences between the firm being analyzed and the average firm in the sector. When you do this you implicitly assume that all firms in a sector have the same operating leverage. Given that smaller firms tend to have a greater proportion of fixed costs than larger firm, a more discriminating approach requires that you do one of the following:

- Assume that market capitalization and operating leverage are correlated, and use the *unlevered beta of firms with similar market capitalization* in estimating the unlevered beta.
- Calculate the *operating leverage of the division or firm being analyzed and compare it to the operating leverage of comparable firms*. If the firm being analyzed has a higher proportion of fixed costs than the comparable firms, the unlevered beta should be adjusted upwards (downwards).

(3) To calculate the unlevered beta for the firm, *take a weighted average of the unlevered betas*, using the estimated values of the different businesses that the firm is involved in. If the values are not available, use a reasonable proxy such as operating income or revenues.

(4) *Calculate the leverage for the firm*, using market values if available. If not, use the target leverage specified by the management of the firm or industry-typical debt ratios.

(5) *Estimate the levered beta* for the firm (and each of its businesses) using the unlevered beta from step 3 and the leverage from step 4.

Advantages of Bottom-up Betas

This approach provides much better beta estimate for firms for three reasons. The first is that you estimate the unlevered betas, by sector, by averaging across regression betas. While regression betas are noisy and have large standard errors, averaging across regression betas reduces the noise in the estimate. In fact, the standard error of the average beta can be approximated as follows:

$$\text{Standard Error}_{\text{Average Beta}} = \frac{\text{Average Standard Error}_{\text{Beta Estimate}}}{\sqrt{n}}$$

where n is the number of firms in the sector. To illustrate, consider the software sector. The average standard error for betas estimates in this sector is 0.50, and that there are 225 firms in the sector. The standard error of the average beta estimate can then be estimated as follows:

$$\text{Standard Error}_{\text{Average Software Beta}} = \frac{\text{Average Standard Error}_{\text{Beta Estimate}}}{\sqrt{n}} = \frac{0.50}{\sqrt{225}} = 0.03$$

The second advantage is that the beta estimates reflect the firm as it exists today, since it is computed based upon current weightings for different businesses. In fact, expected changes in business mix can be reflected in beta estimates quite easily with bottom-up betas. The final advantage is that the levered beta is computed using the current financial leverage of the firm, rather than the average leverage over the period of the regression. Thus, the beta can be estimated more accurately for firms that have changed their debt/equity ratio in recent periods.

 This data set on the web has updated betas and unlevered betas by business sector in the United States.

Illustration 3.1: Estimating Bottom-up Betas

The betas for the firms in the analysis can be estimated using the bottom up approach and the average betas for the sectors in which each of the firms operate.

1. Bottom Up Beta for Cisco

To estimate Cisco's bottom-up beta, it is assumed that Cisco is in a single business (telecomm services) and the following firms could be viewed as comparable firms.[14]

Company Name	*Beta*	*Market Cap $ (Mil)*	*Total Debt $ (Mil)*
3Com Corp.	1.35	$ 16,620.70	$ 45.00
ADC Telecom.	1.40	$ 21,498.00	$ 46.20
Alcatel ADR	0.90	$ 336,934.70	$ 4,793.90
Ciena Corp.	1.70	$ 18,395.90	$ -
Comverse Technology	1.45	$ 13,499.20	$ 301.10
E-TEK Dynamics		$ 15,517.00	$ 28.90
JDS Uniphase	1.60	$ 65,566.00	$ -
Lucent Technologies	1.30	$ 201,173.20	$ 7,026.00
Nortel Networks	1.40	$ 164,284.30	$ 1,665.00
Tellabs, Inc.	1.75	$ 28,664.50	$ 2.80
Average	1.43		

Source: Value Line

The average levered beta for the comparable firms is 1.43. The debt to equity ratio is computed for the comparable firms, using the cumulated market value of equity

[14] Morningstar.com's categorization of comparable firms is used to develop this list.

($8821,54) and the cumulated market value of debt ($13,909) of the firms.[15] This average value is less affected by extreme values for the debt to equity ratio that individual firms may possess. The unlevered beta can then be estimated as follows:[16]

Unlevered Beta = 1.43/ (1+(1-0.3056)*(13909/882154)) = 1.412

This beta is affected by the fact that these firms have cash on their balance sheets, since cash has a beta of zero. The proportion of firm value (market value of equity plus debt) that was cash is computed to be 1.41%, and an unlevered beta for the business is estimated as follows:[17]

Unlevered beta (cleansed of cash) = Unlevered Beta / (1 – Cash/ Firm Value)

= 1.412/(1-.0141) = 1.43

To estimate Cisco's bottom-up beta, Cisco' market values of equity and debt are used:

Market Value of Equity = $ 64.88/share * 6890 million = $ 446,989 million

Estimated Market Value of Debt = $ 0

Bottom-up Beta for Cisco = 1.43

Note that this will be the beta that you use to value Cisco's operating assets. The cash is viewed as a separate asset that is added on to the value of the operating assets.

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[15] There are two measurement alternatives. One is to compute the unlevered beta for each firm and to average the unlevered betas. The other is to compute the debt to equity ratio for each firm and take the average debt to equity ratio.

[16] The average effective tax rate for the comparable firms of 30.56% is used to estimate the unlevered beta

[17] I do this because cash balances can be different for different firms in the same business.

2. Bottom Up Betas for Ariba , Amazon.com and Rediff.com

Ariba and Amazon.com are considered internet firms but they operate in businesses where they compete with more conventional firms (brick and mortar, so to speak). For instance, Amazon.com can be considered a specialty retailer that delivers its products online, just as Ariba can be considered a firm that provides business services that operates on the internet. To estimate Ariba and Amazon.com's betas, therefore, you can look at two groups of comparable firms. First, you can look at internet firms as a group, and estimate the betas for firms that offer business services online (for Ariba) and for internet retailers (for Amazon). Second, you can estimate the betas of firms in the businesses that Ariba and Amazon.com operate in – business services and specialty retailing. Table 3.3 summarizes the estimates of the unlevered betas for each group:

Table 3.3:Unlevered Beta Estimates for Sectors

In business	*Ariba*	*Amazon.com*
Internet firms	1.78	1.61
Conventional firms	1.18	1.01

Source: Value Line

To value these firms, it is assumed that Ariba and Amazon are currently viewed by investors as internet firms first and business service or retail firms second, and the betas for internet firms are used as their betas for the next 5 years. As both firms become larger, the fact they deliver their products and services online will become secondary and their primary businesses will come to the fore. Consequently, the betas will be moved towards those of conventional firms after year 5.[18] Since Amazon does have debt outstanding, the

[18] You adjust betas from year 6 through 10 to move them from internet levels to conventional levels.

levered beta for the next 5 years to is estimated to be 1.74, based upon its market value of equity (at the time of the analysis) of $17.26 billion and the market value of debt of $1.345 billion.

Amazon's levered beta = 1.61 (1 + (1-.00) (1.345/17.26)) = 1.74

Azero percent tax rate is used, since Amazon is losing money and has considerable net operating losses to carry forward.

For Rediff.com, you face a tougher decision. The firm operates an internet portal and, thus, would not have existed prior to the online boom, but it does make its money in conventional ways – from other firms advertising on its site. Portals try to attract customers by providing content or services (such as search engines) for free, and charge for advertising based upon the number visitors they attract. Fundamentally, therefore, they do not differ from newspapers and magazines, which base their advertising rates on circulation and readership. As with Ariba and Amazon, you begin by using the average beta for internet portals that are publicly traded as the beta for Rediff,com; the average beta of these firms in 2000 was 1.90. You then move the beta of Rediff.com towards the average for publishing and newspaper firms as the firm matures; the average beta for these firms in 2000 was 1.07. There is the real possibility that Rediff could evolve into a different kind of online business, becoming an online exchange or expanding into online retailing. Since all of these businesses currently have high betas (1.7-1.9), it should not make a significant difference in the near-term cost of equity.

3. Bottom-up Beta for Motorola

Unlike Cisco, Ariba and Amazon.com, Motorola operates in two different businesses – telecomm equipment and semiconductors. Since the beta for Motorola is a weighted

average of the betas of these two businesses, you first have to compute the weights to attach to each business. In theory, the weights should be market value weights, but the divisions are not traded. You have three choices. You could use the operating income that Motorola reports for each business to weight them. While this approach has intuitive appeal, it can lead to negative weights for any business that is currently generating negative operation income. Alternatively, you could use the revenues generated by each business to weight them. While this approach is simple and the weights are always positive, you are implicitly assuming that the margins are equal across businesses. In the third approach, you estimate the revenues in each business first, and then multiply them by the average Value/Sales ratio prevalent in publicly traded firms in that business to estimate an approximate value for each business. You then use these values to weight the businesses:

Table 3.4: Motorola : Bottom-up Beta

Segment	*Revenues*	*Value/Sales*	*Estimated Value*	*Proportion*	*Unlevered Beta*
Telecom Equipment	$ 28,472.00	6.69	$ 190,478	71.76%	1.09
Semiconductors	$ 7,370.00	10.17	$ 74,953	28.24%	1.32
Motorola	$ 35,842.00		Bottom-up Unlevered beta =		1.1563

Source: Motorola 10-K

The equity beta can then be estimated using the current financial leverage for Motorola as a firm. Combining the market value of equity of $ 73.306 billion and the value of debt of $ 4.583 billion, and using a 35% tax rate for the firm, you arrive at the current beta for Motorola.

Equity Beta for Motorola = 1.1563(1+(1-.35)(4.583/73.306)) = 1.203

IV. Estimating the Cost of Equity

Having estimated the riskless rate, the risk premium(s) and the beta(s), you can now estimate the expected return from investing in equity at any firm. In the CAPM, this expected return can be written as:

Expected Return = Riskless Rate + Beta * Expected Risk Premium

where the riskless rate would be the rate on a long-term government bond, the beta would be either the historical, fundamental or accounting betas described above, and the risk premium would be either the historical premium or an implied premium.

In the arbitrage pricing and multi-factor model, the expected return would be written as follows:

$$\text{Expected Return} = \text{Riskless Rate} + \sum_{j-1}^{j=n} \beta_j * \text{Risk Premium}_j$$

where the riskless rate is the long term government bond rate, β_j is the beta relative to factor j, estimated using historical data or fundamentals, and Risk Premium_j is the risk premium relative to factor j, estimated using historical data.

The expected return on an equity investment in a firm, given its risk, has implications for both equity investors in the firm and the managers of the firm. For equity investors, it is the rate they need to earn to be compensated for the risk they have taken in investing in the equity of the firm. If, after analyzing an investment, they conclude they cannot make this return, they would not buy this investment; alternatively, if they decide they can make a higher return, they would make the investment. For managers in the firm, the return investors need to make to break even on their equity investments becomes the return they have to try to deliver to these investors. In other words, this is the cost of equity to the firm.

Illustration 3.2: Estimating the Cost of Equity

In the following analysis, you estimate the cost of equity for the firms you are valuing, using the CAPM. In doing so, you use the bottom-up betas since they reflect best the true riskiness of these firms. Table 3.5 summarizes these estimates:

Table 3.5: Cost of Equity Calculations(for next 5 years)

	Motorola	*Cisco*	*Amazon*	*Ariba*	*Rediff*
Bottom-up Unlevered Beta	1.1563	1.43	1.61	1.78	1.90
Bottom-up Beta	1.203	1.43	1.74	1.78	1.90
Riskless Rate	6.00%	6.00%	6.00%	6.00%	6.00%
Risk Premium	4.00%	4.00%	4.00%	4.00%	10.43%
Cost of Equity	10.81%	11.72%	12.77%	13.12%	25.82%

Note that the riskless rate and risk premium are the same for each of the first four firms. The only input that varies across these firms is the beta, with the higher beta stocks having higher costs of equity than the lower beta firms. The risk premium for Rediff.com is higher because it includes the country risk premium of 6.43% for India, leading to a much higher cost of equity for the firm. The cost of equity is estimated in U.S. dollar terms to reflect the fact that the initial public offering was in the United States.[19]

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[19] The dollar cost of equity can be converted into an Indian rupee cost of equity fairly easily by taking into account the difference in inflation rates in the two countries. For instance, using expected inflation rates of 6% for India and 3% in the United States, you can estimate the rupee cost of equity for Rediff.com as follows:

Cost of equity (in Rs) = $(1 + \$ \text{ Cost of equity}_4)\ (1+\text{Inflation rate}_{India})/(1+ \text{Inflation rate}_{US}) -1$

$= 1.2582\ (1.06/1.03) -1= 29.49\%$

V. Risk, Cost of Equity and Private Firms

Implicit in the use of beta as a measure of risk is the assumption that the marginal investor in equity is a well diversified investor. While this is a defensible assumption when analyzing publicly traded firms, it becomes much more difficult to sustain for private firms. The owner of a private firm generally has the bulk of his or her wealth invested in the business. Consequently, he or she cares about the total risk in the business, rather than just the market risk.

There are three ways of estimating the cost of equity for a private firm, with undiversified owners:

1. Assume that the business is run with the near-term objective of selling to a large publicly traded firm, or making an initial public offering; this is often the case with young technology firms. In such a case, it is reasonable to use the market beta and cost of equity that comes from it.
2. Add a premium to the cost of equity to reflect the higher risk created by the owner's inability to diversify. (This may help explain the high returns some venture capitalists demand on their equity investments in fledgling businesses)
3. Adjust the beta to reflect total risk rather than market risk. This adjustment is a relatively simple one, since the R squared of the regression measures the proportion of the risk that is market risk.

$$\text{Total Beta} = \text{Market Beta} / \quad R \text{ squared}$$

In the case of Rediff.com, where the market beta is 1.90 and the average R-squared of the comparable publicly traded firms is 16%, this would lead to a total beta estimate of 4.75, resulting in a cost of equity of 55.54% for Rediff.com as a private firm. However, the cost

of equity you use to value the initial public offering is based upon the market beta, since the potential investors in the initial public offering are likely to be well diversified.

What if you were a venture capitalist analyzing an equity investment in a private firm? The cost of equity you would use will fall somewhere between the cost of equity that you estimate based upon the market beta and the cost of equity you obtain from a total beta, depending upon how diversified the venture capitalist is. Most venture capitalists are diversified across firms in a sector – i.e., they are sector focused – but not diversified across sectors. Consequently, their costs of equity will be higher than those estimated using a market beta.

From Cost of Equity to Cost of Capital

While equity is undoubtedly an important and indispensable ingredient of the financing mix for every business, it is but one ingredient. Many businesses finance some or much of their operations using debt or some security that is a combination of equity and debt. The costs of these sources of financing are generally different from the cost of equity, and the cost of financing for a firm should reflect their costs as well, in proportion to their use in the financing mix. Intuitively, the *cost of capital* is the weighted average of the costs of the different components of capital used by a firm to fund its operations.

Estimating the cost of capital for a technology firm is complicated by three factors:

- These firms are disproportionately dependent on equity for capital. In fact, some of these firms are entirely financed with equity.
- The firms that use public debt tend to use hybrid securities, such as convertible bonds, to raise funds.

- Smaller technology firms have bank borrowings, and are often not rated by the ratings agencies.

In this section, you consider first how best to estimate the cost of debt for technology firms and how to deal with hybrid securities in cost of capital calculations.

Calculating the Cost of Debt

The *cost of debt* measures the current cost to the firm of borrowing funds to finance projects. In general terms, it is determined by the following variables:

(1) The current level of interest rates: As the level of interest rates increases, the cost of debt for firms will also increase.

(2) The default risk of the company: As the default risk of a firm increases, the cost of borrowing money will also increase.

(3) The tax advantage associated with debt: Since interest is tax deductible, the after-tax cost of debt is a function of the tax rate. The tax benefit that accrues from paying interest makes the after-tax cost of debt lower than the pre-tax cost. Furthermore, this benefit increases as the tax rate increases.

After-tax cost of debt = Pre-tax cost of debt (1 - tax rate)

Estimating the Default Risk and Default Spread of a firm

The simplest scenario for estimating the cost of debt occurs when a firm has long term bonds outstanding that are widely traded. The market price of the bond, in conjunction with its coupon and maturity can serve to compute a yield you use as the cost of debt. For instance, this approach works for a firm like AT&T that has dozens of outstanding bonds that are liquid and trade frequently.

Many firms have bonds outstanding that do not trade on a regular basis. Since these firms are usually rated, you can estimate their costs of debt by using their ratings and associated default spreads.

Some companies choose not to get rated. Many smaller firms and most private businesses fall into this category. While ratings agencies have sprung up in many emerging markets, there are still a number of markets where companies are not rated on the basis of default risk. When there is no rating available to estimate the cost of debt, there are two alternatives:

- *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.
- *Estimate a synthetic rating*: An alternative is to play the role of a ratings agency and assign a rating to a firm based upon its financial ratios; this rating is called a *synthetic rating*. To make this assessment, you begin with rated firms and examine the financial characteristics shared by firms within each ratings class. To illustrate, table 3.6 lists the range of interest coverage ratios for riskier non-financial service firms in each S&P ratings class[20].

Table 3.6: Interest Coverage Ratios and Ratings

Interest Coverage Ratio	*Rating*
> 12.5	AAA

[20] This table was developed in early 1999, 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.

9.50 - 12.50	AA
7.50 – 9.50	A+
6.00 – 7.50	A
4.50 – 6.00	A-
3.50 – 4.50	BBB
3.00 – 3.50	BB
2.50 – 3.00	B+
2.00 - 2.50	B
1.50 – 2.00	B-
1.25 – 1.50	CCC
0.80 – 1.25	CC
0.50 – 0.80	C
< 0.65	D

Source: Compustat

Now consider Motorola. It has an interest coverage ratio of 10.54. Based on this ratio, you would assess a "synthetic rating" of AA for the firm. This approach can be expanded to allow for multiple ratios and qualitative variables, as well.

Once you have a bond rating for a firm, the cost of borrowing can be estimated by adding a default spread, based upon the rating, to the riskless rate. Allowing for a default spread of 0.50% for AA rated firms and a riskless rate of 6%, you estimate a pre-tax cost of debt of 6.50% for Motorola.

While this approach works reasonably well for firms that have established income streams, it can be difficult to get a good synthetic rating for young firms based upon current operating income. The ratings of these firms reflect expecations about the future, and the operating income can usually be expected to change dramatically over the next few years. In these cases, a synthetic rating can be estimated based upon the expected interest coverage ratio over the next few years, rather than the current interest coverage ratio.

Illustration 3.3: Estimating the Cost of Debt for Amazon

Amazon.com has $1,480.66 billion in debt outstanding. While this is a relatively small amount of debt, given its market value of equity is $17.236 billion, it is still surprising since Amazon reported an operating loss of $276 million in 1999. To estimate the cost of debt for Amazon, you could use its current bond rating of B, assigned to it by Standard and Poor. Alternatively, you could estimate the interest coverage ratio for the firm and compute a synthetic rating. With a negative operating income, the interest coverage ratio will be negative, yielding a synthetic rating of D.

How do you reconcile the two ratings (B from the ratings agency and D from the synthetic rating) and which one should you use in your analysis? The ratings agencies are clearly assuming that Amazon's operating income in future years will be higher and, thus, would justify their higher rating. To estimate an equivalent synthetic rating, you used the projections of operating income that you have for Amazon for the next 3 years, and compute an average interest coverage ratio based upon the average operating income over the next 5 years:

Average operating income (next 3 years) = $ 270 million

Interest Expenses (current) = $ 84.57 million

Interest coverage ratio = 270/84.57 = 3.19

Synthetic rating = BB

Default spread for BB rated bonds = 2.00%

Pre-tax cost of debt for Amazon.com = Riskless Rate + Default spread = 6%+2% = 8%

After-tax cost of debt for Amazon.com = 8% (since firm does not pay taxes currently)

The cost of debt for Amazon will change over time for two reasons. One aspect is that Amazon will start paying taxes in two years, and the interest expense will yield a tax savings. The other issue is that Amazon will become a larger, more stable firm over the

next few years, leading to better ratings and lower default spreads. The following table summarizes the cost of debt estimates for Amazon over the next 10 years:

Table 3.7: Pre-tax and After-tax Cost of Debt - Amazon

Year	*Cost of Debt*	*Tax Rate*	*After-tax Cost of debt*
1	8.00%	0.00%	8.00%
2	8.00%	0.00%	8.00%
3	8.00%	18.40%	6.53%
4	8.00%	35.00%	5.20%
5	8.00%	35.00%	5.20%
6	7.80%	35.00%	5.07%
7	7.75%	35.00%	5.04%
8	7.67%	35.00%	4.98%
9	7.50%	35.00%	4.88%
10	7.00%	35.00%	4.55%

Note that the after-tax cost of debt declines from 8% in year 1 of the analysis to 4.55% in year 10.[21]


ratings.xls: This spreadsheet allows you to estimate the synthetic rating and cost of debt for any firm.

Calculating the Cost of Hybrid Securities

While debt and equity represent the fundamental financing choices available for firms, there are some types of financing that share characteristics with both debt and equity. These are called *hybrid securities*. In this section, you consider how best to estimate the costs of two such securities – preferred stock and convertible stock.

Preferred Stock

Preferred stock shares some of the characteristics of debt - the preferred dividend is pre-specified at the time of the issue and is paid out before common dividend -- and

some of the characteristics of equity - the payments of preferred dividend are not tax deductible. Preferred stock is generally issued in perpetuity and the cost of preferred stock can be written as follows:

k_{ps} = Preferred Dividend per share/ Market Price per preferred share

This approach assumes the dividend is constant in dollar terms forever and that the preferred stock has no special features (convertibility, callability etc.). If such special features exist, they will have to be valued separately to estimate the cost of preferred stock. In terms of risk, preferred stock is safer than common equity, because preferred dividends are paid before dividends on common equity. It is however, riskier than debt since interest payments are made prior to preferred dividend payments. Consequently, on a pre-tax basis, it should command a higher cost than debt and a lower cost than equity.

Convertible Bonds

A **convertible bond** is a bond that can be converted into equity, at the option of the bondholder. A convertible bond can be viewed as a combination of a straight bond (debt) and a conversion option (equity). Technology firms are heavy users of convertible debt, for two reasons:

1. The conversion option on the bond increases its price and reduces the coupon rate on the bond. This allows firms with low operating cash flows to service debt payments.
2. The high volatility in stock prices that characterizes many technology firms works in their favor by increasing the value of conversion options on convertible bonds.

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[21] The tax rate is explained in fuller detail in the chapter 5.

What is the cost of a convertible bond? The simplest approach to analyzing a convertible bond is to break it down into debt and equity components and treat the components separately. There are two ways in which this break down can be accomplished:

- An option pricing model can be used to value the conversion option, which is treated as equity. The difference between the price of the convertible bond and the conversion option value is then treated as debt.
- The convertible bond can be valued as if it were a straight bond, using the stated coupon rate and maturity for the valuation, and this value is treated as debt. The difference between the convertible bond price and this value is the value of the conversion option and treated as equity.

Illustration 3.5: Breaking down a convertible bond into debt and equity components: Amazon Inc

In 1999, Amazon Inc issued convertible bonds with a coupon rate of 4.75% and a ten-year maturity. Since the firm was losing money, it was rated CCC+ by S&P and would have had to pay 11% if it had issued straight bonds at the same time. The bond were issued at a price that was 98% of par, and the total par value of the convertible bond issue was $ 1.25 billion. Each convertible bond (with a face value of $1,000) can be broken down into straight bond and conversion option components.

Straight Bond component = Value of a straight 4.75% coupon bond due in 10 years with a 11% interest rate = $ 636 (assuming semi-annual coupons)

Conversion Option = $ 980 - $ 636 = $ 344

The straight bond component of $636 is treated as debt, and has the same cost as the rest of debt. The conversion option of $ 344 is treated as equity, with the same cost of equity

as other equity issued by the firm. For the entire bond issue of $ 1.25 billion, the value of debt is $ 795 million, and the value of equity is $ 430 million.

Calculating the Weights of Debt and Equity Components

The weights assigned to equity and debt in calculating the weighted average cost of capital have to be based on market value, not book value. This is so because the cost of capital measures the cost of issuing securities – stocks as well as bonds -- to finance projects, and these securities are issued at market value, not at book value.

There are three standard arguments against using market value, and none of them are convincing. First, there are some financial managers who argue that book value is more reliable than market value because it is not as volatile. While it is true that book value does not change as much as market value, this is more a reflection of book value's weakness rather than its strength, since the true value of the firm changes over time as both firm-specific and market information is revealed. Market value, with its volatility, is still a much better reflection of true value than is book value.[22]

Second, the defenders of book value also suggest that using book value rather than market value is a more conservative approach to estimating debt ratios. This assumes that market value debt ratios are always lower than book value debt ratios, an assumption not based on fact. Furthermore, even if the market value debt ratios are lower than the book value ratios, the cost of capital calculated using book value ratios will be lower than those calculated using market value ratios, making them less conservative estimates, not more.

To illustrate this point, consider Amazon. The firm's market value of equity of $17.26 billion and the market value of debt of $1.345 billion yield a market debt ratio of 7.81%. In contrat, using Amazon's book values for equity ($266.28 million) and debt ($1480.66 million) results in book debt ratio of 84.76%. The cost of capital can be calculated as follows –

With market value debt ratios: 12.94% (.9219) + 8% (.0781) = 12.56%

With book value debt ratios: 12.94% (.1524) + 8% (.8476) = 8.75%

Third, it is claimed that lenders will not lend on the basis of market value, but this claim again seems to be based more upon perception than fact. Any homeowner who has taken a second mortgage on a house that has appreciated in value knows that lenders do lend on the basis of market value. It is true, however, that the greater the perceived volatility in the market value of an asset, the lower is the borrowing potential on that asset.

There is one important point to be made about market values. Market prices for equity can change a great deal from period to period for technology firms. Amazon's market value of equity would have been $ 33 billion if this analysis had been done three months earlier, and the debt ratio would have been lower. The effect on the cost of capital will be muted, however, because technology firms tend to have small amounts of debt on their balance sheets. Even Amazon, which has a lot of debt for a new technology firm, has only seen its debt ratio increase from 4% to 7.81%, even as its equity market value

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[22] There are some who argue that stock prices are much more volatile than the underlying true value. Even if this argument is justified (and it has not conclusively been shown to be so), the difference between market value and true value is likely to be much smaller than the difference between book value and true value.

dropped by 50%. With a cost of equity of 12.94% and a cost of debt of 8%, the cost of capital has changed from 12.74% to 12.56% as the debt ratio has increased[23].

Estimating the Market Values of Equity and Debt

The market value of equity is generally the number of shares outstanding times the current stock price. If there other equity claims in the firm such as warrants and management option, these should also be valued and added on to the value of the equity in the firm.

The market value of debt is usually more difficult to obtain directly, since very few firms have all their debt in the form of bonds outstanding trading in the market. Many firms have non-traded debt, such as bank debt, which is specified in book value terms but not market value terms. A simple way to convert book value debt into market value debt is to treat the entire debt on the books as one coupon bond, with a coupon set equal to the interest expenses on all the debt and the maturity set equal to the face-value weighted average maturity of the debt, and then to value this coupon bond at the current cost of debt for the company. Thus, the market value of $ 1 billion in debt, with interest expenses of $ 60 million and a maturity of 6 years, when the current cost of debt is 7.5% can be estimated as follows:

$$\text{Estimated Market Value of Debt} = 60\left[\frac{(1-\frac{1}{(1.075)^6}}{.075}\right] + \frac{1,000}{(1.075)^6} = \$930$$

[23] The effect would be even smaller if you adjusted the beta for the higher debt to equity ratio that Amazon has after the drop in market value of equity.

While this will yield a market value for the debt in the balance sheet, it still ignores other commitments that a firm has made that should be categorized as debt. The most important of these is operating leases. When a lease is classified as an operating lease, the lease expenses are treated as operating expenses and the operating lease does not show up as part of the debt of the firm. When a lease is classified as a capital lease, the present value of the lease expenses is treated as debt, and interest is imputed on this amount and shown in the income statement. You could make the argument that in an operating lease, the lease payments are just as much a commitment as are lease expenses in a capital lease or interest payments on debt. Converting operating lease expenses into a debt equivalent is straightforward. The operating lease commitments in future years, which are revealed in the footnotes to the financial statements for US firms, should be discounted back at a rate that reflects their status as unsecured and fairly risky debt. As an approximation, using the firm's current pre-tax cost of borrowing as the discount rate yields a good estimate of the value of operating leases

Illustration 3.6: Difference between market value and book value debt ratios

The following table contrasts the book values of debt and equity with the market values for Cisco, Motorola, Amazon and Ariba. Rediff has no debt on its books. For the four publicly traded firms, the market value of equity is estimated using the current market price and the number of shares outstanding. For Rediff.com, you use the book value of equity, but the absence of debt makes the debt ratio zero. Cisco has no conventional debt, but Motorola, Amazon and Ariba do have debt on their books. All of these firms except for Motorola also have operating lease commitments, and these commitments are treated as debt.

You estimate the market value of debt using the book value of debt, the interest expense on the debt, the average matuirty of the debt and the pre-tax cost of debt for each firm. For Motorola, the book value of debt is $5,593 million, the interest expense on the debt is $ 305 million, the average maturity of the debt is 3.26 years and the pre-tax cost of debt is 6.50%. The estimated market value is as follows:

$$\text{Estimated MV of Motorola Debt} = 305\left[\frac{(1-\frac{1}{(1.065)^{3.26}}}{.065}\right] + \frac{5,593}{(1.065)^{3.26}} = \$5,426 \text{ million}$$

Since Motorola has no operating lease commitments, the estimated market value of Motorola's debt is $5,426 million.

Ariba has a small amount of conventional debt ($1.47 million) on its balance sheet, which is at market value. To this amount, you add the present value of operating lease commitments that Ariba has over the next 5 years, with the cost of debt of 9.25% used as the discount rate. Table 3.8 presents the debt value of operating leases.

Table 3.8: Debt Value of Operating Leases: Ariba

Year	*Lease Commitment*	*Present Value at 9.25%*
1	$ 5.10	$ 4.67
2	$ 5.20	$ 4.35
3	$ 5.29	$ 4.06
4	$ 5.40	$ 3.79
5	$ 5.42	$ 3.49
6 and beyond[24]	$ 9.78	$ 5.75
Total Present Value =		$ 26.10 million

The cumulative market value of debt for Ariba is $27.57 million.

You estimate the market values of debt and operating leases for Amazon and Cisco, using a similar approach. Table 3.9 summarizes the final estimates of value for all of the firms.

Table 3.9: Comparison of Book Value and Market Value Debt Ratios

	Motorola	*Cisco*	*Amazon*	*Ariba*	*Rediff.com*
BV of Debt	5,593	0	1481	1.47	0
BV of Equity	16,828	11,722	266	122.18	0.29
BV D/(D+E)	24.95%	0%	84.76%	1.19%	0%
MV of Equity	73,706	446,989	17,237	17,832	NA
MV of Debt	5,426	0	1345	1.47	0
PV: Leases	0	827	114	26.1	0
MV D/(D+E)	6.86%	0.18%	7.81%	0.15%	0%

 *wacccalc.xls*: This spreadsheet allows you to convert book values of debt into market values.

Estimating the Cost of Capital

Since a firm can raise its money from three sources -- equity, debt and preferred stock -- the cost of capital is defined as the weighted average of each of these costs. Thus, if E, D and PS are the market values of equity, debt and preferred stock respectively, the cost of capital can be written as follows:

$$\text{Cost of Capital} = k_e \left(E/ (D+E+PS)\right) + k_d \left(D/ (D+E+PS)\right) + k_{ps} \left(PS/ (D+E+PS)\right)$$

Illustration 3.7: Estimating Cost of Capital

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[24] The 10-K reports on the cumulated value of operating leases after year 6. In this case, you have assumed that the entire payment is in year 6. If the amount had been larger, you would have treated it as an annuity

Concluding the analysis in this chapter, you estimate the costs of capital for each of the five firms that you will be valuing.

Table 3.10: Cost of Capital Calculation

	Motorola	*Cisco*	*Amazon*	*Ariba*	*Rediff.com*
Cost of Equity	10.85%	11.72%	12.94%	13.12%	25.82%
Equity/(Debt + Equity)	93.14%	99.82%	92.19%	99.85%	100%
Cost of Debt	4.23%	4.03%	8.00%	9.25%	10.00%
Debt/(Debt + Equity)	6.86%	0.18%	7.81%	0.15%	0%
Cost of Capital	10.39%	11.71%	12.56%	13.11%	25.82%

Note that the costs of capital are close to the costs of equity for all of the firms, and almost identical to them for three. This is because equity dominates the capital structures for all of the firms, but especially the youngest - Ariba and Rediff.com.

Summary

The costs of equity and capital are fundamental inputs in discounted cash flow valuation and the estimation problems can be far greater when you look at technology firms. In this chapter, you consider the estimation issues and suggest solutions to some of the more common shortcomings.

Risk and return models for estimating the cost of equity begin with the premise that the marginal investor is well diversified and is therefore concerned only about the risk added by an investment on to a diversified portfolio. This added risk is measured differently in different models, ranging from a market beta in the capital asset pricing model to proxies such as market capitalization in proxy models. This view of risk is justified for technology firms, even though many of them continue to be closely held and

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over multiple years for computing the present value.

run by their founders. This is because institutional investors, who tend to be well diversified, tend to dominate trading in these stocks. The standard procedures for estimating risk parameters, however, have to be modified substantially both because of these firms' limited and volatile price histories and because of the changes that these firms can go through in short periods. Bottom-up betas, based upon the businesses that the firms operate in, are an alternative to regression betas and usually have lower standard error and better reflect your firm's current standing. In addition, the cost of equity should be estimated using implied, rather than historical premiums, and should be based upon long term riskless rates, rather than short term ones.

When technology firms borrow money, they often use hybrid securities such as convertible bonds. Furthermore, they are often unrated, leaving you with the task of estimating ratings based upon one or two years of history.

As a final point, it is worth noting that the costs of debt and equity, the weights on each and the resulting cost of capital will change over time for all firms, but especially so for young high-growth firms. Consequently, you need to not only estimate the current cost of capital but forecast how the costs of debt, equity and capital will change as the firm grows larger and more stable.