Risk and Return: Estimating Cost of Capital

The process:

- Estimate parameters for the risk-return model.
- Estimate cost of equity.
- Estimate cost of capital using capital structure (leverage) information.

The cost of equity can be estimated using the

- Dividend Growth Model (studied earlier),
- Capital Asset Pricing Model (CAPM).

$$E(R_i) = R_f + \beta_i \left[E(R_M) - R_f \right]$$

Inputs to the CAPM are:

- The current risk-free rate,
- The expected return on the market index, and
- The beta of the asset being analyzed.
- Hence the equation is *actually* estimated as follows:

$$E(R_i) = R_f + \beta_i \left[\text{Market Risk Premium} \right]$$

Estimation issues:

- What is the correct risk-free rate to use in the model?
- How should we measure the risk premium to be used in calculating the expected return on the market index?
- How should we estimate beta?

Estimating Risk-free Rates

Two approaches:

- Use a short-term Govt. security rate (usually the 3-month T-bill rate).
- Use a long-term Govt. bond rate (usually the 30-yr bond rate).

Which one should be used?

- Match-up the horizon of the project or asset being analyzed with the maturity of the risk-free asset.
- Managers looking at long-term projects should use the long-term Govt. bond rate.
- If the investment horizon is short (under 1 year), then use the short-term T-bill rate.

Example: Pepsi Cola Corp. has a beta of 1.16. What is their cost of equity, if the expected return on the market is 13% (3-month T-bill rate is 5%, 30-yr T-bond rate is 6.4%)

Using the short-term rate:
Cost of equity = 5% + 1.16(13%-5%) = 14.28%

Using the long-term rate:
Cost of equity = 6.4% +1.16(13%-6.4%)=14.06%

Will the cost of equity from a long-term perspective always be lower than that from a short-term perspective? Why or why not?

Estimating Risk Premium

- Defined as the difference between average returns on stocks and average returns on risk-free securities over the measurement period.
- Generally based on historical data.

Two issues:
- How long should the measurement period be?
- Should arithmetic or geometric averages be used to compute the risk premium?

Length of the measurement period:
- In practice, people use at least 10 years of data.
- Should use the longest possible period, if there are no trends in the premium.
- Much of the data on US stocks is available from 1926 onwards.
- Often, data from 1926 till now is used.

Arithmetic or Geometric averages?
- Arithmetic mean is the average of the annual returns for the period under consideration.
- Geometric mean is the compounded annual return over the same period.

Example:

Year	Price	Return
0	50	
1	100	100%
2	60	-40%

Arithmetic average return = [100%+(-40%)] / 2 = 30%
Geometric average return = $\sqrt{(2x0.6)}$ - 1 = 0.0954 (9.54%)

- There can be dramatic differences in premiums based on the averaging method!
- Arithmetic mean is argued as being more consistent with the mean-variance framework of CAPM and a better predictor of premiums in the next period.
- Geometric mean accounts for compounding, and is argued to be a better predictor of the average premium in the long run.
- Geometric mean generally yields lower premium estimates.
- Since expected returns are compounded over long periods of time, the geometric mean provided a better estimate of the risk premium.
- In the US, the premium has been about 3.82% from 1970-1990.
- European markets have had lower premiums, while Britain has had higher (6.25%).

What determines the size of the risk premium?

- More *volatile economies* have higher risk premiums (e.g., emerging markets, with high-growth high-risk economies - like South America, Russia).
- *Political risk and instability* leads to higher premiums - various rating agencies publish these surveys (e.g. Iraq would have high premiums!)
- Market structure affects risks in stocks - for economies where listed companies are large, diversified and stable (e.g., Germany and Switzerland), risk premiums are lower. In the US and UK, many smaller and riskier companies are also listed, thereby increasing the premium for investing in stocks.

Estimating Beta

The conceptual way:

- Previously, beta was defined by $\beta_i = \dfrac{Cov(R_i, R_M)}{\sigma^2(R_M)}$
- Using historical returns for a market index and the stock being analyzed, we can estimate beta.

Example: A stock had the following returns over the last 5 years, as compared to the return on the S&P 500 index. What is an estimate of the stock's beta?

Year	Home Depot's return	S&P 500 return
1	-15%	-10%
2	3%	15%
3	12%	8%
4	58%	30%
5	44%	22%

here, s.d.(R_M) = 13.62% (i.e., Var(R_M) = 0.01856)
Cov(R_i, R_M) = 0.03346

hence, β = 0.03346 / 0.01856 = 1.8

Estimating beta the real-world way:

- CAPM can be written as a one-factor model:

$$R_i = R_f + \beta \lfloor R_M - R_f \rfloor$$
$$= R_f(1-\beta) + \beta R_M$$
$$\Rightarrow R_i = a + bR_M$$

- This is a linear regression of stock returns (R_i) against market returns (R_M).
- The slope of this regression is the beta of the stock.
- The intercept of this regression provides a simple measure of the performance of the stock relative to CAPM, during the regression period:

$$\text{If} \quad a > R_f(1-\beta), \quad \text{stock did better than expected}$$
$$a = R_f(1-\beta), \quad \text{stock did as well as expected}$$
$$a < R_f(1-\beta), \quad \text{stock did worse than expected}$$

- The difference between *a* and $R_f(1-\beta)$ is called *Jensen's alpha*; it provides a measure of whether the asset under- or out-performed the market on a risk-adjusted basis.
- The R-squared (R^2)of this regression provides an estimate of the proportion of risk that can be attributed to market wide factors (*systematic risk*) - the balance ($1-R^2$) can be attributed to firm-specific risk (*unsystematic risk*).

Is high R-squared good? As an analyst, would you recommend investors with limited funds to buy high R-squared stocks?

Example: Estimating beta for Intel (1989-94)

- We can compute monthly returns to a stockholder in Intel as follows:

$$Stock\ return_{Intel,\,j} = \frac{price_{Intel,\,j} - price_{\mathrm{int}\,el,\,j-1} + dividends_j}{price_{Intel,\,j-1}}$$

- Monthly returns on the market index (S&P 500)are given by:

$$market\ return_{Intel,\,j} = \frac{index_j - index_{j-1}}{index_{j-1}} + Dividend\ Yield_j$$

- Regress the monthly time series of Intel's stock returns on the market's return.
- The slope of this regression comes to 1.39, which is Intel's beta, during 1989-94.
- The intercept of this regression is 2.09%.
- Since the returns are monthly, the risk-free rate on a monthly basis averaged 0.4% during 1989-94.
- We can, therefore, compute the Jensen's alpha, to measure Intel's performance relative to the market:

$$Jensen's\ \alpha = Intercept - R_f(1-\beta) = 2.09\% - 0.4\%(1-1.39) = 2.25\%$$

- Hence, Intel performed 2.25% better than expected, based on CAPM, on a monthly basis (1989-94). This results in an annualized excess return of 30.6%.
- The R-squared of the regression was 22.9%, implying that 22.9% of the risk in Intel comes from market-wide sources, and the balance (77.1%) comes from firm-specific components (this component is diversifiable, hence unrewarded in CAPM).

Estimation issues in the beta regression:

- *Length of estimation period* (Value Line and S&P use 5 years of data, Bloomberg uses 2 years) - longer period provides more data, but the firm's risk characteristics may not remain stable over longer periods.
- *Return Interval* - Using daily or intraday data increases observations, but induces bias due to non-trading days (if stock is not traded frequently, the returns on nontraded days would be zero, thereby biasing the beta downwards). E.g., for America Online (1990-94), the beta is 1.8 using monthly returns, but 1.2 using daily returns (*which one is more reliable, and why?*).
- *Choice of market index* - standard practice is to estimate betas relative to the index of the market in which the stock trades (US stocks relative to NYSE Composite, British stocks relative to the FTSE, Japanese stocks relative to the Nikkei, etc.). But it may not be appropriate for international or cross-border investors.
- *Statistical issues* - whether betas should be adjusted to reflect the likelihood of estimation errors and biases. These techniques are most useful when daily returns are used; less useful for longer return intervals.

When the betas of stocks listed on overseas markets are estimated against the NYSE Composite instead of their local indices, are the betas likely to increase or decrease? Which beta would you use and why?

The Determinants of Beta

- *The cyclical nature of business* - the more sensitive a business is to market conditions, higher is its beta. E.g., housing firms have higher betas than food processing companies.
- *Degree of Operating Leverage* - ratio of %change in operating profits to %change in sales (defines the relationship between fixed costs and total costs - high fixed costs implies high Operating Leverage). High Operating Leverage implies a higher variability in earnings, hence higher beta for the firm.
- *Degree of Financial Leverage (debt/equity ratio)*
  - higher debt implies higher *obligated* payments,
  - hence, in bad times, the income goes *down* more; in good times, the income goes *up* more.
  - so more debt increases the variance in net income, increasing the *equity beta* (what we estimate using stock returns) of the firm.

$$\beta_{firm} = \frac{D}{D+E}\beta_{debt} + \frac{E}{D+E}\beta_{equity}$$

$$\Rightarrow \beta_{equity} = \left(1+\frac{D}{E}\right)\beta_{firm}, \qquad as\ \beta_{debt} \approx 0$$

  - β_{firm} is called the *unlevered* beta of the firm (β_U), i.e., the beta of the firm without any debt.
  - β_{equity} is the *levered* beta for equity in the firm (β_L).
  - In the presence of taxes, the levered beta is given by:

$$\beta_L = \beta_U\left[1+(1-t)(D/E)\right]$$

The properties of beta:

- Levered betas are always greater than unlevered betas in the presence of financial leverage (debt).
- If a firm has multiple divisions / businesses, its beta will be the weighted average of the betas of each business line, with the weights based on the market value of each.

European companies have stricter labor laws than US companies, making it more difficult for them to lay off employees during economic downturns. How should this affect their betas?

Example: Boeing has a beta of 0.95, a debt / equity ratio of 5%, and a tax rate of 34%. How would their beta change if their debt ratio went up to 25%? How does it affect their cost of equity, if the T-bond rate is 6.5% and the market risk premium is 5.5%?

present cost of equity = 6.5% + 0.95(5.5%) = 11.73%

unlevered beta = 0.95 / [1+(1-0.34)(0.05)] = 0.912

levered beta at 25% debt ratio = 0.912[1+(1-0.34)(0.25)]
= 1.07

Equity cost at 25% debt ratio = 6.5% + 1.07(5.5%) = 12.39%

What can you infer from this?

Weighted Average Cost of Capital (WACC)

- The weighted average of costs of different components of financing (debt, equity, and hybrids).

$$WACC = \frac{E}{D+E} k_e + \frac{D}{D+E} k_d (1-t)$$

- The debt-equity proportional weights *must* be estimated using the *market values* of equity and debt, *not* the *book values* (cost of capital measures the cost of issuing securities to finance projects, and these securities are issued at market values, not book values!).
- k_e is the cost of equity.
- k_d is the *pre-tax* cost of debt, while $k_d(1-t)$ is the after-tax cost of debt.
- The cost of debt is the *current* cost to the firm of borrowing funds to finance projects. It is *not*
  - the coupon rate on the outstanding bonds, nor
  - the rate at which the company borrowed in the past.
- The cost of debt is the *Yield-to-Maturity* on its debt.

Example: In March 1995, Pepsi Cola Corp. had a cost of equity of 13.33%, a cost of debt of 8% (pretax), and 34% tax rate. Its equity had a book value of $7.05 billion and a market value of $32 billion. The book value of debt was $9.75 billion, while the market value of debt was $10 billion. What was its WACC?

$$WACC = \frac{32}{32+10} 13.33\% + \frac{10}{32+10} 8\%(1-34\%) = 11.41\%$$

(*using book value weights gives a totally distorted WACC of 8.66%!*)

A Comprehensive Example of Risk, Return and Costs of Financing - Home Depot (again!)

- By regressing monthly returns for Home Depot on the S&P 500 index returns, over 1990-94, we get a beta of 1.38 (*hence Home Depot stock is riskier than the average market*).
- The beta estimates from different estimation services are different - Value Line reports 1.30 for Home Depot - why? (*Value Line uses weekly returns, and statistically adjusts beta for long-term biases*).
- In Jan 95, 30-yr T-bond rate was 7.5%. Using a historical risk premium of 5.5%, the expected return is:

  Expected return = 7.5% + 1.38(5.5%) = 15.09%

(*In other words, the cost of equity for Home Depot was 15.09% in Jan 95*)

- The intercept on the beta regression was 2.19%. Using an average risk-free rate of 6.5% during 1990-94, Jensen's α is 2.39% per month (32.82% excess annual return).
- The average Jensen's α for the industry was -0.02% per month. (*This suggests that Home Depot's superior performance was due entirely to firm-specific factors*)
- R-squared was 33.76%. Hence, 33.76% of the risk in Home Depot's stock comes from market-wide factors. (*This is understandable, since Home Depot's business is home improvement, which will suffer during economic recessions*)

- Home Depot had an average debt-equity ratio of 4%, so their unlevered beta comes to 1.34 (using 34% tax rate). (*So currently, bulk of their risk is due to business risk, not financial leverage - if they increase leverage to 50%, beta would go above 2*).
- Home Depot had a pre-tax cost of debt of 8.5%, and market values of debt and equity of $900 million and $20.815 billion (*stock price x # of shares*), respectively. Using a 34% tax rate, their WACC comes to 14.70%. (*This is the appropriate benchmark to use for evaluating their projects*).