Equity Securities

TOPIC 3: ESTIMATING RISK PARAMETERS

Student learning outcomes

3.1 Demonstrate the use of the capital asset pricing model (CAPM), the Fama–French model (FFM), the Pastor–Stambaugh model (PSM), macroeconomic multifactor models, and the build-up method (for example, bond yield plus risk premium) for estimating the required return on an equity investment.

3.2 Discuss beta estimation for public companies, thinly traded public companies, and non-public companies.

3.3 Analyse the strengths and weaknesses of methods used to estimate the required return on an equity investment.

Student learning outcomes

3.4 Discuss international considerations in required return estimation.

3.5 Explain and calculate the weighted average cost of capital for a company.

3.6 Evaluate the appropriateness of using a particular rate of return as a discount rate, given a description of the cash flow to be discounted and other relevant facts.

References

- **Pinto J.E., E. Henry, T.R. Robinson and D.D. Stowe. (2010).** Equity Asset Valuation. (2nd edition) John Wiley & Sons: New Jersey. Chapter 2. Pages 57 – 78.

Introduction

- Valuation models generally hypothesise that:
  - Non-systematic risk can be eliminated through diversification
  - Investors will only be rewarded for bearing non-diversifiable, or systematic, risk
  - The main difference between them is how they measure this risk
- An equities analyst can choose from a variety of different methods to estimate required return on equity, including:
  - The CAPM
  - A multifactor model such as:
    - The Fama-French model (FFM)
    - The Pastor-Stambaugh model (PSM)
    - A macroeconomic factor model (MFM)
  - A build-up method, such as bond yield plus risk premium method

Outcome 3.1

Capital Asset Pricing Model

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

- As discussed in Week 2, the CAPM says that the expected return is equal to the risk-free rate plus a risk premium
- The risk premium is based on market risk factors, which are captured by the market risk premium
- Estimation of the market risk premium was also discussed in Topic 2
- The market risk premium is then multiplied by the stock's sensitivity to market risk factors (i.e. its beta) to find the risk premium for the stock

Outcome 3.1

Expected return – CAPM

- The risk-free rate is 5%
- The beta for an asset is 1.20
- The market risk premium is 4.5%

- **What is the required return for the asset according to the CAPM?**

Outcome 31

Multi-factor models

- The CAPM is relatively simple, and very popular
- However, there has long been a view that the systematic risk driving returns includes factors *other than* a broad measure of market risk
- Multi-factor models which incorporate other risk factors are often referred to arbitrage pricing theory (APT) models (because they are based on the theory that identical assets should trade for the same price)
- The general formula for a multi-factor model is

$$E(R_i) = R_f + \sum_{j=1}^{k} \beta_{i,j}\left[E(R_j) - R_f\right]$$

where $\beta_{i,j}$ is the factor beta and $\left[E(R_j) - R_f\right]$ is the factor risk premium

Outcome 31

The Fama-French model (FFM)

- In 1993, Eugene Fama and Kenneth French addressed the perceived weakness of the CAPM with a 3-factor model
- The factors are:
  - RMRF, standing for RM – RF, the return on a market value-weighted equity index in excess of the one-month T-bill rate
  - SMB (small minus big), a size factor equal to the average return on small-cap portfolios minus the average return on large-cap portfolios
  - HML (high minus low), the average return on high book-to-market portfolios ("value" shares) minus the average return on low book-to-market ("growth" shares) portfolios

Outcome 31

The Pastor-Stambaugh model (PSM)

- This is an extension to the Fama-French model
- It adds a fourth risk factor, LIQ, representing the difference between returns on low liquidity stocks and returns on high liquidity stocks

Macroeconomics factor models (MFM)

- In these models the factors are economic variables
- An example is the BIRR model, which has 5 factors:
  - Confidence risk
  - Inflation risk
  - Market timing risk
  - Time horizon risk
  - Business cycle risk

Outcome 31

Build-up methods

- A "build-up" approach is often appropriate for estimating the return on a private business
- It is based on *building up* the expected return based on the risk-free plus a set of risk premiums
- These risk premiums
  - Are initially based on comparable publicly-traded companies
  - Usually include a small-firm premium (because private companies are usually smaller than public companies)
  - May also include a firm-specific premium which captures non-systematic risk (on the basis that risk related to a private company cannot be easily diversified away)

Outcome 31

Bond yield plus risk premium

- This can be a quick way to estimate return for a company with publicly-issued debt
- Using this approach, the estimated return is equal to the yield to maturity (YTM) on the company's long-term debt plus a risk premium (to compensate for the additional risk of equity compared to debt)
- In U.S. markets, the typical risk premium added is 3 to 4%, based on experience

Outcome 3.2

Beta

- In valuation models generally, beta is used to measure the exposure of an individual investment to a risk factor
- In the CAPM it measures the exposure of the investment to market risk – which includes all risk factors affecting the market portfolio
- It measures the market risk that an investment adds to a well-diversified portfolio

Outcome 3.2

Beta

- When using the CAPM in practice:
  - The risk-free rate is usually represented by a government security such as Treasury bills or Treasury bonds
  - The market return is usually based on a broad value-weighted equity market index, such as the S&P 500 (in the US) or the ASX 200 (in Australia)
- The most difficult step in using the CAPM is estimating the beta for a stock
- There are generally three approaches that can be used:
  - Regression analysis using historical market prices
  - Decomposing the beta to reflect the fundamentals of the firm
  - Using accounting data

Outcome 3.2

Historical market betas

- This is the most common method used
- The historical returns of an asset are regressed against the returns of the market index
- The regression equations takes the following form:

$$R_i = \alpha + \beta \times R_m$$

Slope of the regression = beta of the stock

Intercept from the regression

Outcome 3.2

Historical market betas

- The intercept can be used to measure the performance of the asset over the regression period
- According to the CAPM:

  $R_i = R_f + \beta(R_m - R_f) = R_i(1-\beta) + \beta \times R_m$
- Comparing this with the regression equation, $R_i = \alpha + \beta \times R_m$, if the asset performs according to the CAPM:

  $\alpha = R_f(1-\beta)$

  or the excess return is equal to $\alpha - R_f(1-\beta)$
- If the alpha from the regression exceeds $R_f(1 - \beta)$ (i.e. excess return is positive) the stock has performed better than predicted by the CAPM

Outcome 3.2

Historical market betas

- The beta derived from the regression is equal to:

  $Cov(R_i, R_m) / \sigma_m^2$
- Statistical tests can help to determine the accuracy and reliability of the beta estimate
  - R^2 provides an estimate of the proportion of stock's risk which is attributable to market risk
  - The standard error measures the error in the beta estimate (i.e. how far each observation is from the value predicted by the model)

Outcome 3.2

Historical market betas

- Boeing Company (BA) is one of the largest aerospace and defense companies in the world and has been listed on the NYSE for decades
- You are interested in calculating a value for BA's common stock, as at the end of 2000, for which you require a discount rate
- Assume the risk-free rate is 5% and the equity premium is 5.5%
- The stock price as at the end of 2000 is US$66.00 and the current annual dividend is US$0.56
- **Calculate the required rate of return for BA.**

Outcome 3.2

Historical market betas

- Estimation issues:
  - The longer the **sample period**, the more representative the sample
  - The shorter the sample period, the more current the estimate
  - The shorter the **return interval**, the greater exposure the sample has to an infrequent trading-induced downward bias in the estimate
  - This is because if there is no trading in a given interval, the return over that interval is zero
  - The choice of an international **benchmark index** increases the relevance to international investors
- Emerging markets with fewer stocks are more senstive to the choices made in relation to these issues

Outcome 3.2

Historical market betas

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Outcome 3.2

Historical market betas

- A regression is often not a very accurate way to estimate the beta of a firm as a measure of its market risk
  - There are often high standard errors, even for mature companies in mature markets, such as Boeing
  - Significant differences in betas calculated based on different return intervals increases the uncertainty as to the true beta
  - Thinly-traded stocks and stocks in emerging markets are particularly sensitive to the choice of estimate parameters
  - Private companies do not have the market data required to calculate a beta using regression

Outcome 3.2

Fundamental betas

- The beta of a firm is determined by:
  - The type and mix of businesses the firm operates
    - The more cyclical or discretionary the demand for the firm's products, the higher the beta
  - The operational leverage of the firm
    - The higher the fixed-to-variable cost ratio, the higher the beta
  - The financial leverage of the firm
    - The higher the debt-to-equity ratio, the higher the beta
- If all of the firm's market risk is borne by the shareholders and debt has a beta of zero, then

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

Outcome 3.2

Fundamental betas

- Bloomberg calculates the beta of BA as at the end of 2000 as being 0.57, based on monthly returns for the period 1996 – 2000
- You have calculate the average debt-to-equity ratio for Boeing over that period as being equal to 15.56%
- Assume an effective tax rate of 35%
- **Calculate Boeing's unlevered beta as at the end of 2000**
- **Calculate Boeing's levered beta if it increases its leverage to 50%**

Outcome 3.2

Fundamental betas – bottom-up betas

- Identify the industries in which the firm operates
- Identify publicly-traded firms operating in each of these industries, preferably single-business firms
- Calculate the beta of each identified firm
- Calculate the average weighted beta of each industry
- Delever the average weighted beta of each industry
  - Use the average weighted debt-to-equity ratio for the publicly-traded firms in each industry
- Calculate the unlevered beta of the firm as the weighted average of the betas calculated for each industry
- Calculate the levered beta of the firm
  - Use the market values of debt and equity for the firm

Outcome 3.2

Fundamental betas – bottom-up betas

- Advantages of bottom-up betas
  - An average regression beta has a lower standard error which, if estimation errors on individual firm betas are uncorrelated, equals:

$$se_{\text{bottom-up beta}} = \frac{\text{Average se}_{\text{comparable firms}}}{\sqrt{n \text{ firms}}}$$

  - Flexibility in allowing account to be taken for changes in the firm's business mix
  - Flexibility in allowing account to be taken for changes in the firm's financial gearing
  - This method allows betas to be calculated for private firms, divisions of firms an stocks which are newly listed

Outcome 3.2

Fundamental betas – bottom-up betas

- Calculation issues
  - The definition of "comparable firms" needs to be broad enough to allow a reasonable sample of firms for each business, so as to reduce the standard error
  - If the comparable firms are dominated by one or two large firms, using a market-weighted average may not result in reductions in the standard error (in which case it would be best to use a simple average)
  - By deleveraging the betas of comparable firms for operational leverage you can control for differences in operational leverage

$$\text{Business } \beta_L = \beta_U \left[1 + (\text{Fixedcosts} / \text{Variable costs})\right]$$

Outcome 3.2

Fundamental betas – bottom-up

- Boeing change both its business mix and financial gearing in the 1990s, debt-funding the acquisition of Rockwell and McDonnell Douglass
- As at 2000 its business was divided into two segments: Commercial aircraft and Information, space, defence systems (ISDS)
  - The market value of equity and debt are $55.2 bn & $7.85 bn
  - The corporate tax rate is 35%

Segment	Revenue	Multiple	Unlevered beta
Aircraft	$26,929m	1.12	0.91
ISDS	$18,125m	0.70	0.80

- **Calculate a bottom-up beta for Boeing as at 2000**

Outcome 3.2

Fundamental betas – bottom-up

- Boeing change both its business mix and financial gearing in the 1990s, debt-funding the acquisition of Rockwell and McDonnell Douglass
- At the time of its acquisition of MDD, the business values were as follows:

Company	β	Debt	Equity	Value
Boeing	0.95	$3,980m	$32,438m	$36,418m
MDD	0.90	$2,143m	$12,555m	$14,698m

- **Calculate a bottom-up beta for Boeing after its acquisition of MDD**

Outcome 3.2

Fundamental betas – accounting betas

- To find this beta, regress the change in earnings on a quarterly or annual basis against the changes in earnings for the market as a whole over the same period
- Advantage
  - Beta can be estimated for a division with no market price data
- Disadvantages
  - Accounting earnings tend to be smoothed; hence betas tend towards 1
  - Accounting earnings can be affected by non-operational factors; e.g. changes in accounting policy or the allocation of overheads
  - There are not sufficient data items to provide explanatory power; hence R^2 tends to be low and standard errors high

Outcome 3.3

Which beta?

- The bottom-up method is preferred for valuing publicly-listed companies
  - This allows for the estimation of beta taking account of proposed changes to the business mix and financial gearing of the company
  - It uses average betas across a large number of companies, reducing the noise associated with individual firm betas
  - It allows for the calculation of beta by area of business for a firm

Outcome 3.4

International issues

- An international investor is concerned with returns stated in terms of his own currency
- In theory, exchange rate gains and losses should be offset by changes in the risk-free rate of return in the home currency; in practice, this is often not the case
- One way to allow for this, in the case of emerging markets, is the **country spread model**
- This states that the equity risk premium for an emerging market is equal to the equity risk premium for the developed market plus a country premium
- The country premium is frequently based on the **sovereign bond yield spread** – the difference between the yield on government securities in each market

3.31

Outcome 3.5

Weighted average cost of capital

- The required rate of return for suppliers of capital to a firm is usually calculated as a weighted average of the cost of each source of capital

$$WACC = \left(\frac{E}{E+D+HS}\right) r_e + \left(\frac{D}{E+D+HS}\right) r_d (1-Taxrate) + \left(\frac{HS}{E+D+HS}\right) r_{hs}$$

Market value of equity

Total market value of capital

Propotion of debt and hybrid securities in the capital structure

Cost of equity

Before tax cost of debt

After tax cost of debt

After tax cost of hybrid securities

Outcome 3.5

Cost of equity

- As we have discussed, the most common method of estimating the cost of equity is the CAPM

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

Mature equity market premium

Preferably bottom-up beta
Based on comparable firms
Using the firm's own financial leverage

Long term government bond rate
Defined in the same currency as the cash flows
Defined as real or nominal, consistent with cash flows

Outcome 3.5

Cost of equity

- Based on the previous example, you calculate Boeing's bottom-up beta to be 1.0022 and the historical risk premium of the U.S. market to be 5.51%
- Assume the U.S. Treasury bond rate is 5%
- **Calculate the cost of equity for Boeing**

Outcome 3.5

Cost of debt

- The cost of debt measures the current cost to the firm of borrowing funds to finance projects
  - The current yield on the firm's widely-traded long-term bonds
  - The cost of debt is taxed at the corporate tax rate

$$\text{After-tax cost of debt} = (r_f + \text{Company default spread})(1-t)$$

The average default spread for similarly rated firms
The average default spread on recent borrowings of the firm
The average default spread for stocks with a rating similar to a synthetic rating ascribed to the firm

Outcome 3.5

Cost of debt

- Boeing is rated AA by S&P
- The U.S. corporate tax rate is 35%, although Boeing's effective tax rate is 27%
- In the previous year Boeing had operating income of $1,720m and interest expenses of $453m
- Assume the U.S. Treasury bond rate is 5%
- Use the table overleaf as required
- **Calculate the cost of debt for Boeing using both the actual rating and the synthetic rating method**

Outcome 3.5

Cost of debt

Interest coverage ratio	Rating	Spread
> 8.5	AAA	0.75%
6.5 - 8.5	AA	1.00%
5.5 - 6.5	A+	1.50%
4.25 - 5.5	A	1.80%
3.0 - 4.25	A-	2.00%
2.5 - 3.0	BBB	2.25%
2.0 - 2.5	BB	3.50%
1.75 - 2.0	B+	4.75%
1.5 - 1.75	B	6.50%
1.25 - 1.5	B-	8.00%
0.8 - 1.25	CCC	10.00%
0.65 - 0.8	CC	11.50%
0.2 - 0.65	C	12.70%
< 0.2	D	14.00%

Outcome 3.5

Cost of debt

- The cost of debt may need to be adjusted for country risk in the case of an emerging market stock

$$\text{After-tax cost of debt in emerging market} = \left(r_f + \text{Company default spread}_{\text{synthetic rating}} + \text{Company default spread}_{\text{emerging market}}\right)(1-t)$$

Outcome 3.5

Cost of hybrid securities

- The firm may be funded by some form of **hybrid securities**
- This is a source of capital with characteristics similar to both debt and equity
- Preferred stock
  - Preferred shareholders have preference over common shareholders
  - Usually the dividend is a constant dollar amount
  - The stream of dividends represents a perpetuity, and the cost of preference shares can be found using the perpetuity formula

$$P_{ps} = \frac{D_{ps}}{r_{ps}} \therefore r_{ps} = \frac{D_{ps}}{P_{ps}}$$

Outcome 3.5

Cost of hybrid securities

- Convertible bonds
  - If the capital has option characteristics (such as a convertible bond) the value of the bond, as a non-convertible bond, is deducted from the total value of the bond to determine the value of the option
  - The non-convertible bond is costed at the cost of debt and the option is costed at the cost of equity
  - The cost of the convertible bond is a weighted average of these costs

$$r_{cb} = \left(\frac{V_{ncb}}{V_{cb}}\right) r_d + \left(1 - \frac{V_{ncb}}{V_{cb}}\right) r_e$$

Outcome 3.5

Cost of hybrid securities

- In 1999, Amazon.com Inc. issued $1.25bn of 10-year bonds with a coupon of 4.75%
- It was losing money and was rated CCC+, which meant that it would have paid 11% for straight (non-convertible) bonds at the time
- The bonds were issued at a 2% discount to par
- **Calculate the cost of capital for Amazon's convertible bond.**

Outcome 3.5

Weighting of capital

- Include in the weighting of debt
  - All interest-bearing debt, including both short and long-term debt
  - The present value of the firm's operating lease commitments, discounted at the firm's pre-tax cost of debt
- Use market values rather than book values
  - Market value of equity equals the number of shares outstanding multiplied by the current share price
  - Estimated market value of debt equals the value of a bond with:
    - A face value equal to the book value of debt
    - A coupon equal to the current interest expense
    - A maturity equal to the average maturity
    - A discount rate equal to the average cost of debt

Outcome 3.5

Weighted average cost of capital

- Assume the cost of equity for Boeing is 10.52%, the cost of debt is 3.9% and the ratio of the market value of debt to the market value of equity is 12.45%
- **Calculate the weighted average cost of capital for Boeing.**

Slides created by Rob Brooks, La Trobe School of Economics & Finance based on Pinto, et al (2010). 3.43

Outcome 3.6

Best practice

Firms using CAPM to estimate cost of equity	81%
Firms using 10-year Treasuries or longer r_f	70%
Firms using a published source for beta	52%
Firms using a marginal borrowing and tax rate	52%
Firms using market value weights for debt & equity	59%

Source: Bruner, et al (1998) 3.44