WACC calculation

What is needed:

Cost of equity
Cost of debt
Weight (proportion) of equity
Weight (proportion) of debt
Tax rate

$$WACC = re\left(\frac{E}{D+E}\right) + rd^*\left(\frac{D}{D+E}\right)$$

Where:

re	is the cost of equity
rd*	is the after tax cost of debt (ie, rd * (1 – t))
E	is the weight (or value) of equity
D	is the weight (or value) of debt

Other terminology:

rd = debt required rate of return
rd* = cost of debt (rd x (1 – Tax rate))
βu = ungeared beta (or unleveraged beta or asset beta). This is the beta of the company as if it had no debt in the capital structure.
βe = equity beta
βd = debt beta. The equity beta will rise as more debt is introduced into the company. This indicates that equity is becoming riskier.

With APV (adjusted present value);
ru = the ungeared return on equity. This is the return on equity as if the company was 100% financed with equity (no debt).

COST OF EQUITY

Two main methods of calculating the cost of equity:

1. **Capital Asset Pricing Model (CAPM).**

CAPM: $re = rf + \beta e(rm - rf)$

Where:
- rf = risk free rate of interest
- βe = equity beta
- rm = return on the stockmarket
- (rm – rf) = equity risk premium (the extra return above the risk free rate gained from investing in the stockmarket

To calculate the cost of equity you need to use the equity beta.
The company has an asset (ungeared) beta. The asset beta is the weighted average of the equity and debt betas:

$$\beta_u = \beta_e \left(\frac{E}{D+E}\right) + \beta_d \left(\frac{D}{D+E}\right)$$

If the company is all equity (100% equity financed) $\beta_e = \beta_u$
If the company has debt in its capital structure, the β_e will be higher than the ungeared (asset) beta β_u this is because the equity is now more risky as the debt has a prior call on the company cash flows.

For example, the following could appear as part of a question:
The company is made up of 75% equity and 25% debt, the debt has a beta of 0.2 and the ungeared beta (β_u) is 1.1. (In a question to calculate the equity beta you will be given the debt beta and the ungeared beta and the relative weights of debt and equity.)

What is the equity beta?

The formula above is written out:

$$\beta_u = \beta_e \left(\frac{E}{D+E}\right) + \beta_d \left(\frac{D}{D+E}\right)$$

$$1.1 = \beta_e (0.75) + 0.2 (0.25)$$

$$0.75\beta_e = 1.1 - 0.05$$

$$\beta_e = \frac{1.05}{0.75}$$

$$\beta_e = 1.4$$

This 1.4 is the value for beta that you would use to put in the CAPM formula to work out the cost of equity for the company.

$$E(r) = rf + \beta_e(rm - rf)$$

$$E(r) = rf + 1.4(rm - rf)$$

Calculating WACC for a subsidiary's project. *(* this is a more difficult section)*

If this company had a subsidiary that was considering a project, and the project was of a different risk profile to that of the company. We would take the parent company ungeared beta and adjust it for any revenue volatility:

[1] Adjustment for rev. volatility: $\text{Company } B_u * \frac{\text{Rev. volatility of project}}{\text{Rev. volatility of company}}$

Then we need to adjust for any fixed cost differences between the project and the company:

[2] Adjustment for fixed costs: $\text{Rev. adjusted } B_u \text{ (from [1] above)} * \frac{1 + \text{project fixed cost}}{1 + \text{company fixed cost}}$

This will give you the ungeared beta of the project. This will allow you to work out the WACC of the project.

If the project is entirely equity financed you would just use the B_u that you have just calculated for the project in the CAPM formula [E(r) = $rf + \beta_e(rm - rf)$].

If the project is funded in part by debt you will have to use the original B_u formula to work out the individual debt and equity betas:

$$\beta_u = \beta_e \left(\frac{E}{D+E}\right) + \beta_d \left(\frac{D}{D+E}\right)$$

In any question when it comes to the project and you are faced with this calculation you will be given one out of the three betas (ie, given B_d, or B_e). The B_u you will have just calculated. So you have two out of the three betas. You will also have the weights for debt and equity, so you just readjust the formula to solve for the missing beta (as was show with the worked example at the top where we worked out the value for B_e given the other values).

To recap if you have a situation where there is a parent company and a subsidiary that is moving into a different area, we need to work out the company ungeared beta (we need to bring everthing back to 100% equity then make our adjustments). Adjust the company B_u for any revenue volatility or fixed cost differences. This gives us the project ungeared beta. If the project is not funded entirely by equity we have to work

out the individual debt and equity betas for the project – the project B_u is the weighted average of the debt and equity betas. From there you can work out the costs of debt and equity for the project and then put these into the WACC calculation.

If you are not given the revenue volatilities and fixed cost differences you may be supplied with details of a proxy company. This would be a company that is operating in the same area as the subsidiary and has the same risk profile. You would use this company to work out the WACC because the WACC that you want has to reflect the risk of the cash flows (if the subsidiary is going into a new area then the parent company WACC will not reflect that risk). With the proxy company you will usually be given debt and equity betas and debt and equity weights. This allows you to calculate the ungeared beta (B_u) for the proxy company. This will be the ungeared beta for the subsidiary's project. This ungeared beta will then need to be adjusted if the subsidiary is not using 100% equity financing in the project, using the formula:

$$\beta_u = \beta_e \left(\frac{E}{D+E}\right) + \beta_d \left(\frac{D}{D+E}\right)$$

Then the costs of capital and then the WACC can be worked out.

2. **Dividend growth model (DGM)**

DGM: $$r = \frac{D1}{P0} + g$$

Where: D1 = dividend in next period
(ie. D0 is the dividend received today,
D1 = D0 * (1 + g))
g = growth rate in dividends
P0 = share price today

This comes from the share valuation model:

$$P0 = \frac{D1}{r - g}$$

g (the growth rate of dividends) can be worked out if you are given dividends for two different periods: eg, Dividend today (2012) is 10p, dividend in 2008 was 7.5p. What is the growth rate?

Take the end dividend (today) and divide by the start dividend, this will give you a growth factor over the number of years. Take the root of the number of periods (eg. in this example, four periods, take the fourth root), subtract 1 from your answer to give you your growth rate.

Eg. $(FV/PV)^{1/n} - 1$

FV = end dividend (10p)
PV = start dividend (7.5p)
n = number of periods

$= (10/ 7.5)^{1/4} - 1$

$= 1.3333^{0.25} - 1$

$= 0.07457$

Growth rate in dividends = 7.457%

So, using the figures above D1 = 10p * 1.07457

$= 10.7457$

If this was an exam type question, you would be given P0, and the dividend figures above, and would be asked to work out the cost of equity.

In this case assume P0 = 200p, what is the cost of equity ('r' in the formula)?

$$r = \frac{D1}{P0} + g$$

$$= \frac{10.7457}{200} + 0.07457$$

$= 0.05373 + 0.07457$

$= 0.1283$

Cost of equity = 12.83%

In any question like this, from the text in the question work out which of the elements of either the CAPM or the Dividend Growth Model you have. Write out your formula for the two methods, tick off the elements of each that are in the question and build up your cost of equity from there. (The usual mistake using the DGM is not adjusting the D0 figure to D1. In the question you would probably be given D0 and you then have to work out what D1 is.)

COST OF DEBT

There are three ways of calculating the cost of debt. The first two are the more likely to appear in an exam question.

1. **Using the CAPM**; $rd^* = [rf + \beta_d(rm - rf)] * (1 - t)$

need to be given:
- β_d = debt beta
- t = tax rate (assume 30% tax in all these calculations)
- rf = risk free rate of interest
- rm = return on the stockmarket (or be given the equity rsik premium, which is (rm – rf)).

Eg. A company has an equity beta of 1.4 and a debt beta of 0.2, the risk free rate of return is 4.5%, the stock market risk premium is 6.5%, and the tax rate is 30%. What is the cost of debt?

Using the above formula:

$rd^* = [rf + \beta_d(rm - rf)] * (1 - t)$

$rd^* = [0.045 + (0.2 * 0.065)] * (1 - 0.30)$

$rd^* = [0.045 + 0.013] * 0.7$

$rd^* = 0.058 * 0.7$

$rd^* = 0.0406$

$rd^* = 4.06\%$ This is the after tax cost of debt, and is what you would multiply by the weight of debt to get your WACC (plus the weighted cost of equity).

(The cost of equity is $re = [rf + \beta_e(rm - rf)]$, $= 0.045 + (1.4 * 0.065) = 0.136$, ie, 13.6%)

2. Cost of debt can be calculated using the **YIELD TO MATURITY** (this has been asked in the exams a number of times).

Take the current market price of the bond as a cash outflow and all the subsequent cash flows (coupon/ interest payments, and the redemption of the bond) as inflows. This method follows the procedure outlined in the FAQ 'Yield to Maturity – Help' on the Finance website and also in the file 'Bond pricing and yield to maturity' in the zip folder (there are worked examples in these locations).

For example, a company has a bond that has just made the coupon payment today (so that can be ignored) and has exactly three years to redemption. The coupon is 6%, and the current price of the bond in the market is £104.50.

What is the cost of debt?

You would solve the equation:

$$-£104.50 + \frac{6}{(1 + YTM)} + \frac{6}{(1 + YTM)^2} + \frac{6}{(1 + YTM)^3} + \frac{100}{(1 + YTM)^3} = 0$$

You would guess values for the yield to maturity (YTM) that would give you a positive value and a negative value, then interpolate to obtain the exact YTM.

Examples of these calculations are in exercise set 3 from the blue and white folder.

As mentioned earlier if the cost of debt is asked for in the exam it will usually involve method 1. or 2. above. (There is always the possibility of a separate YTM calculation elsewhere in the exam, as a mcq, or as part of a smaller Case Study 2 question on bonds).

3. Cost of debt can be worked out using PERPETUITY formula. If the question says debt is irredeemable or perpetual (very rare in exams now), take the coupon (the original return on the bond when issued – this cash flow stays fixed through the life of the bond), and divide it by the current market price of the bond.

Eg., a company has an irredeemable bond, coupon of 7% and it has a market price today of £95 (The original issue price for the bond is £100). What is the cost of debt?

Perpetuity formula: $P0 = \frac{\text{Cash flow}}{\text{Interest rate}}$

$\text{Interest rate} = \frac{\text{Cash flow}}{P0}$

$\text{Cost of debt} = \frac{\text{Coupon cash flow}}{\text{Current price of bond}} * (1 - t)$

$rd^* = \frac{7}{95} * (1 - t)$

$rd^* = 0.07368 * (1 - 0.30)$

$rd^* = 0.05158 \ (5.158\%)$

Weights of debt and equity.

Sometimes the question will give the weights, eg., 75% equity and 25% debt, or one part debt to three parts equity.
If the weights have to be worked out, this will be from market values eg., a company has 200 million shares in issue with a market price of 450p each, it also has a £400 million, 7% bond outstanding, which is currently trading at £95 in the market.

Weights:	equity: 200 * 450p	=	£900 million		
	debt: 400 * 0.95	=	£380 million		
	Total market value	=	£1280 million		
	Equity weight	=	900 / 1280	=	0.7031
	Debt weight	=	380 / 1280	=	0.2969

(The debt when originally issued is priced at £100, this bond is trading at £95, so the market value of the debt is 400 * 0.95 = £380).

To calculate a WACC from here it is a case of plugging in the numbers you have worked out using the above methods into the equation:

$$WACC = re\left(\frac{E}{D+E}\right) + rd^*\left(\frac{D}{D+E}\right)$$

Where:	re	is the cost of equity
	rd*	is the after tax cost of debt (ie, rd * (1 – t))
	E	is the weight (or value) of equity
	D	is the weight (or value) of debt

Discount rate in other Capital Budgeting problems

The WACC **will not** be used in all situations – for evaluation of **leases** the cost of capital that is used is the after tax cost of debt (rd * (1 – t)), not the WACC.

But if there is any residual or salvage value in the lease evaluation that item would be discounted at the company's WACC as it is a risky cash flow unlike the lease cash flows.

In **APV (adjusted present value)** calculations, the rates that are used are the unleveraged cost of equity (ru), which is applied to the all equity cash flows (the same cash flows you would use in a WACC calculation), and the debt required rate of return (rd – not the after tax cost of debt rd*). rd is applied to the interest tax shield, which is the interest payment times the tax rate.

The APV is made up of NPVu + NPVf. NPVu is the base case NPV, the all equity cash flows discounted by ru, and NPVf is the present value of the tax shield, the tax shield cash flows discounted by rd.

The cost of capital will reflect the riskiness of the cash flows being evaluated.

For International Projects

If you have a domestic company undertaking a foreign project, the best way to evaluate it is to take the foreign cash flows of the project and discount them with a foreign WACC and then convert the NPV at the spot exchange rate into the domestic currency. Eg, if you have a UK company wanting to undertake a project in US. Calculate the UK WACC as normal. To adjust for the foreign (US) market, take (1 + UK WACC) and multiple by the interest rate differential between the two countries, ((1+forn interest rate)/(1+Domestic interest rate)). So we have;

US WACC = (1+UK WACC) * ((1+US i/r)/(1+UK i/r)) - 1

The most common error here is to take the UK WACC and multiply it by the interest rate differential. If you do that you will end up with a rate very close to the UK rate. The correct way is to multiply 1+UK WACC by interest rate differential. A quick check to carry out is to look at your answer and check that it is roughly the difference between the two interest rates (it won't be exactly the same).

To Summarise:

- For normal capital budgeting problems – use WACC on the FCF*.
- For Lease problems use rd to discount lease cash flows, use WACC to discount any salvage value at the end of the lease.
- For Equivalent Annual Cost problems – use WACC.
- For international projects – use WACC adjusted for the foreign market (1+DOM WACC) * ((1+Forn i/r)/(1+Dom i/r))
- For APV – use ru on the FCF* and use rd on tax shield cash flows.

Preparation for the Exam

If you are given a capital budgeting problem in the exam, you will have to provide a cost of capital to discount the cash flows.

A good way to prepare for this is to take the Past Papers where there are cost of capital questions and just do these cost of capital questions only, one after the other. Doing it this way lets you see the different ways the question is asked and how to deal with these. This should help you understand the process more clearly.