Introduction

This is Part 2 of a three part series on Business Valuation. Part 1 discussed Discounted Cash Flows ('DCF') and Enterprise Value. In a DCF valuation, 'Free Cash Flows to the Firm' / 'FCFF' are discounted using risk adjusted discount rates that represent the return required by the providers of each type of capital ('Cost of Capital'). This part discusses how the Cost of Capital is calculated in a simplified capital structure (debt and equity) to give a blended rate ('Weighted Average Cost of Capital' or 'WACC'). Theory relating to the tax benefits of debt finance and impact on the cost of capital ('Tax Shield') is discussed in the Appendix.

Contents

Notes

1. This is a new version of a paper originally published in September 2025 (now part of a series of three papers). No A.I. was used.

Overview of WACC

Total and Required Return for each investor

The actual return from holding equity or debt instruments is the increase in wealth for the investor over some measurement period compared to opening wealth (market values). 'Total Return' measures the change in market value over the period plus any income (dividends, interest or coupons), as a percentage of the opening market value (capital gain plus income yield). The required return is the Total Return that an equity or debt investor would expect to receive before deciding to invest, referred to as the 'Cost of Equity' ('K_e') and 'Cost of Debt' ('K_d'), respectively.

Average Required Return for all investors

The average rate of return required by all providers of financial capital to the business, adjusted for the perceived riskiness of the cash flows distributable to them (FCFF) and weighted by the market values of each source of financing, is the 'Weighted Average Cost of Capital' ('WACC'). In Part 1, the discount rate 'r' is the WACC. The WACC should be calculated on an after-tax basis, since it is used to discount after-tax cash flows. As debt interest is tax deductible in most jurisdictions, whereas equity dividends are not (they are paid out of taxed profits), the pre-tax cost of debt must be adjusted to the after-tax equivalent, assuming tax relief is available in the same period the interest is paid (effectively giving a cash inflow)

Leverage

Leverage ('L') measures debt as a proportion of financial capital (in book value or market value terms): L = D / (D + E) (assuming equity is the only other source of finance – any other financial claims, such as preference shares, leases, or pension deficits would be added in). Gearing ('G') is the ratio D / E (so G = L / (1 – L)). Leverage (L = G / (1 + G)), measured at market value, features in the WACC calculation, and gearing in the Cost of Equity, if using the 'Capital Asset Pricing Model' ('CAPM'). The market value of a debt instrument should be the same as its book value if it is recognised at amortised cost and the yield to maturity at the valuation date has not changed since the issue date.

WACC definition

Taking the simple case of debt and equity as the only sources of financing, the WACC can be shown as:

Post-tax WACC = Cost of Equity (K_e) x (1 – L) + Cost of Debt (K_d) x (1 – t) x L

where L = Leverage or Debt / (Debt + Equity) using market values
t = marginal tax rate
K_d represents the expected yield from holding the debt to maturity (if issued at par or face value, the yield at issue would be the coupon or interest rate).

Risk Premium

If risk is defined as the uncertainty about the timing and amount of expected or promised cash flows, then the rate of return on a financial instrument would be considered risk free if the timing and amount were certain. The closest we can get to that would be some type of fixed interest debt instrument whose issuer would not fail to repay (zero default risk), such as a government bond.

Dividends to equity investors are not promised but at the company's discretion, and there is no obligation to return the amount invested. By contrast, interest payments and debt principal repayments are contractually promised. This makes equity riskier than debt, giving it a higher risk premium.

The cost of debt and equity can be written in terms of the risk free rate (R_f) and risk premium:

- Debt return (Cost of Debt K_d) = R_f + Debt Risk Premium ('DRP')
- Equity return (Cost of Equity K_e) = R_f + Equity Risk Premium ('ERP')

Cost of Debt

Pre-tax Cost of Debt

The pre-tax cost of debt represents the 'marginal return' expected at the valuation date on new borrowing with a maturity and currency matching the cash flow forecast. It should be based on the expected cash flows from a debt instrument, representing the contractual (promised) cash flows adjusted downwards for likelihood of non-payment (probability weighted cash flows) over the period to maturity, meaning the promised yield to maturity will be more than the expected yield (as for R_f in the CAPM, the time to maturity should be long term as well to match the forecast cash flows in the valuation).

A quoted debt instrument could be used, issued by the company being valued itself or issued by a 'proxy' company with a similar credit risk (for example, by estimating a likely 'synthetic' credit rating for the business using a credit rating model and determining what yield is available in the market for such a rating). Alternatively, an estimate could be made for the actual cost of debt the business would incur if it borrowed new long term funds (the marginal or incremental pre-tax cost of debt).

Post-tax Cost of Debt

Assuming debt interest obtains full tax relief in the year paid (the 'tax shield' being interest x tax rate – discussed in more detail in Appendix 1), the pre-tax cost of debt should be reduced to reflect the lower after tax cost (post-tax cost of debt = pre-tax cost of debt x (1 – tax rate)). The tax rate should be the actual rate that would apply to the interest paid, typically the 'marginal' rate, which may or may not be the same as the statutory rate.

The tax deductibility of debt interest effectively generates a tax cash inflow ('Tax Shield') which can be forecasted and discounted at an assumed risk-adjusted rate. The value of the geared company (V_g) should, in theory, equal the value of the ungeared company (V_u) plus the value of the Tax Shield (V_{TS}).

Optimal Leverage

The capital structure should be adjusted towards some optimum level that minimises WACC and maximises value, so the textbooks say. As the cost of debt is less than the cost of equity, due to lower risk and the tax deductibility of interest, increasing debt in the capital structure should reduce WACC (and hence increases value for equity investors), but at some level this benefit will reverse as the risk of financial distress and default increases both the cost of debt and equity. In practice, the capital structure may be adjusted so as to align with the sector peer group (the industry average for comparable companies with similar growth and business risk), to avoid spooking investors.

Leverage and DCF Valuations

Over the forecast period, the WACC is often assumed to be constant (assuming the business is relatively mature). This implicitly assumes that either all the inputs to the calculation change in a manner that leaves the total WACC unchanged or, more likely, that leverage (based on market values) is constant and maintained at its optimal level by adjusting the level of debt (borrowing/repaying) and/or equity (distributing income as dividends or capital as buybacks). Since DCF forecasts ignore financing, no further leverage analysis need be done when assuming a constant WACC.

This assumption may not be appropriate for some businesses or projects if leverage is required to change (in leveraged buyouts or project finance, for example, where debt repayments are scheduled and often not discretionary). Furthermore, as will be shown in Part 3 when alternative DCF methods are discussed, forecasting debt levels will be required if the tax benefits of debt financing need to be quantified and considered separately. Debt can be assumed (1) to remain at a fixed amount throughout the forecast and terminal period (unrealistic, but assumed by Modigliani & Miller in their groundbreaking work – see Appendix), (2) to change according to a cash flow requirements and mandatory repayment schedules or (3) to change in line with the value of the business. This third approach is used in this Series.

A DCF valuation for a private business poses a bit of a challenge if we need to verify that market value leverage reaches the target level, since no market price exists for the debt and equity. The Enterprise Value ('EntV') can be used as market value (i.e. fair value), so at any date we can set debt based on the required leverage using the EntV at that date. In practice, this means working backwards from the EntV at the end of the forecast period ('Terminal Value' / 'TV'), setting debt at this date and then calculating the EntV at the previous period (this will equal the TV plus final year FCFF, both discounted back one period) and setting debt at this date and so on. This process obviously causes circularity, as leverage depends on the EntV which depends on the WACC which depends on leverage.

Debt and Cash

Excess cash (and liquid investments) that could be used to repay some debt at any time (with no impact on operating cash flows), can be netted off 'gross debt' to 'net debt' (gross debt – cash). This means the following must be based on net debt:

- Debt deducted from EntV when calculating Equity Value ('EqV')
- Leverage in the WACC: L = Net Debt / (Net Debt + Equity)
- Equity beta in CAPM Cost of Equity, when re-gearing using Net Debt / Equity
- Cost of debt in the WACC (see Damodaran (2025) ch.15):

$$\text{Cost of net debt } K_{d_{net}} = \frac{(\text{Cost of gross debt } K_{d_{gross}} \times \text{Debt}) - (\text{Return on cash } R_{cash} \times \text{Cash})}{\text{Gross debt} - \text{Cash}}$$

The required return for cash would typically be the risk free rate (R_f), so that $K_{d_{gross}} = (R_f + DRP)$ and $K_{d_{net}} = R_f + (\text{Debt} / \text{Net Debt} \times DRP)$

Some argue that total cash on the balance sheet (and liquid investments), and not just a proportion deemed (arbitrarily) to be excess cash, should be deducted off gross debt (which would remove the issue of whether or not operating cash is treated on its own or part of working capital) or treated separately. Ignoring the net debt option and going for gross debt means cash is treated as a non-operating asset like other such items (e.g. investments in associates, equity investments, head office property etc.).

In the example in Part 1 of this Series (the WACC for that valuation is shown below), all excess cash is paid out and only operating cash is on the balance sheet (treated as part of working capital, so the WACC is calculated based on gross debt).

Cost of Equity

Risk and the Cost of Equity

As expectations change in the future (risk, operating returns, growth, dividends, etc), so the cost of equity changes. Expected return increases with risk, as indicated by the level of volatility or standard deviation of returns. Equity risk will depend on market risk (share price volatility due to market volatility, as measured by some market index), business risk (riskiness associated with FCFF) and financial risk (risk associated with leverage affecting 'Free Cash Flows to Equity' / 'FCFE', used to pay dividends, subject to sufficient legally distributable profits being available).

Effect of leverage

For equity investors, leverage adds financial risk (a greater chance the business defaults on its debt) to the business risk (the uncertainty as to the amount and timing of future operating cash flows). Equity investors will require a higher 'geared' (or 'levered') cost of equity (K_g) when facing both types of risk, whereas an ungeared (or unlevered) all-equity financed business will be expected to generate an ungeared cost of equity (K_u) that compensates them for business risk only.

Identifying relevant risks

Asset pricing models try to identify which risks are relevant to equity investors and how to capture such risk in the required return. The 'Capital Asset Pricing Model' ('CAPM') assumes only some of the total risk of any stock needs to be rewarded. Assuming an investor is sufficiently diversified and constructs a portfolio of investments with a total risk that is less than the risk of the individual portfolio stocks (selecting securities that are negatively correlated with each other, such that negative factors for one stock are positive for another), some of the risk of the stock (the specific, unique or unsystematic part) can be eliminated, leaving residual risk that relates to the market as a whole (systematic or market risk). This means that, ignoring leverage for now, the sensitivity of the stock to market risk is all that needs to be considered. Other models have expanded on CAPM to introduce additional risk factors (Fama & French 2015).

CAPM derived Cost of Equity

The volatility of the return on the stock may or may not exactly match volatility of the market index (as measured by the ratio of the standard deviation of their returns: $\sigma_{stock} / \sigma_{market}$). This relationship, when adjusted by how closely the returns match each other (correlation coefficient of stock vs. market returns), indicates the sensitivity of the stock to market risk, as measured by the equity 'beta' (= correlation coefficient $_{\text{stock vs market returns}}$ x $\sigma_{stock} / \sigma_{market}$).

If the stock risk matches market risk, beta = 1.0 and the required return would be the market return, comprising the Risk Free Rate (R_f)[1] and the 'Equity Risk Premium' ('ERP')[2]. The stock's sector is likely, however, to have different risk to the whole market, so the beta[3] reflecting business risk (asset beta $ß_a$, also known as the ungeared / unlevered beta $ß_u$) would not be 1.0, but lower or higher if the risk was lower or higher, respectively, than the market as a whole:

$$\text{Cost of Equity (ungeared)}(K_u) = R_f + ß_u \times ERP.$$

For a private business, the ungeared cost of equity can be estimated by taking the average or median of a sample of 'proxy' equity betas observed in the market (reflecting the same business risk characteristics as the private business), and adjusting for leverage to arrive at an average asset beta that can be used for the valuation and geared up to reflect leverage chosen for the valuation.

If financial risk is introduced via leverage, the asset beta needs to be increased to the equity beta (or geared / levered beta $ß_g$) to reflect the extra risk:

$$\text{Cost of Equity (geared)}(K_g) = R_f + ß_g \times ERP.$$

All components of the WACC will have a value weighted beta (geared equity beta $ß_g$ and debt beta $ß_d$ in this simple example) that measures the sensitivity of returns to market returns. If the debt beta is assumed to be zero, this assumes that debt holders do not bear any systematic risk and that equity investors are allocated all of the systematic risk.

The method chosen to calculate the geared equity beta makes implicit assumptions about debt financing policy (tax shield) and debt systematic risk (whether or not the debt beta is zero). This is discussed in more detail in the Appendix, but a brief technical discussion follows:

- *Ignoring tax*, the value of an ungeared company (V_u) should theoretically equal the value of an otherwise identical geared company ($V_g = D + E$) and the beta relationship would be:

$$ß_u = ß_g \left(\frac{E}{D+E}\right) + ß_d \left(\frac{D}{D+E}\right)$$

$$\therefore\ ß_g = ß_u + (ß_u - ß_d)\left(\frac{D}{E}\right)$$

If we assume $ß_d = 0$, then

$$ß_g = ß_u \left(1 + \frac{D}{E}\right)$$

- *Including tax*, the value of an ungeared company V_u plus the value of the tax shield V_{TS} (PV of tax recoverable on debt interest cash flows) should equal the value of the otherwise identical geared company ($V_g = D + E$). The general equation for beta calculated as follows:

$$V_u + V_{TS} = E + D$$

$$ß_u \left(\frac{V_U}{D+E}\right) + ß_{TS}\left(\frac{V_{TS}}{D+E}\right) = ß_g \left(\frac{E}{D+E}\right) + ßd \left(\frac{D}{D+E}\right)$$

$$\therefore\ ß_g = ß_u + (ß_u - ß_d)\left(\frac{D}{E}\right) - (ß_u - ß_{TS})\left(\frac{V_{TS}}{E}\right) \quad \textbf{General ß Equation}$$

If debt is assumed to vary as a constant proportion of enterprise value (debt amount = leverage % x Enterprise Value), the riskiness of the tax shield is the same as business risk and hence $ß_{TS} = ß_u$. This gives the same equation as if tax was ignored, and, as above, if we assume $ß_d = 0$, the re-gearing beta formula becomes what is called the 'Practioners' Formula':

$$ß_g = ß_u \left(1 + \frac{D}{E}\right)$$

If debt does not depend on the value of the business but is a known amount, the riskiness of the tax shield can be assumed to be the same as the riskiness of debt, so that $ß_{TS} = ß_d$. Assuming a perpetuity scenario, the PV of the tax shield would equal the tax on debt interest divided by the discount rate ψ:

$$V_{TS} = \frac{K_d \cdot t \cdot D}{\psi} \quad (K_d = \text{pre-tax cost of debt, } t = \text{tax rate, } D = \text{amount of debt})$$

If the tax shield risk equals the debt risk, $\psi = K_d$, so $V_{TS} = t.D$

Substituting $ß_{TS} = ß_d$ and $V_{TS} = t.D$ into the general beta equation and re-arranging, we have:

$$ß_g = ß_u + (ß_u - ß_d)\frac{D}{E}(1-t)$$

If we assume $ß_d = 0$, the re-gearing beta formula becomes what is called the 'Hamada Formula'.

$$ß_g = ß_u + (ß_u - ß_d)\frac{D}{E}(1-t)$$

$$ß_g = ß_u \left(1 + \frac{D}{E}\ 1-t)\right)$$

WACC Formula

In the WACC formula, deductibility of interest is incorporated by reducing the cost of debt by the marginal tax rate (t):

$$WACC_{post\text{-}tax} = \text{Cost of Equity} \times \text{Equity weighting} + \text{Post-tax Cost of Debt} \times \text{Debt weighting}$$

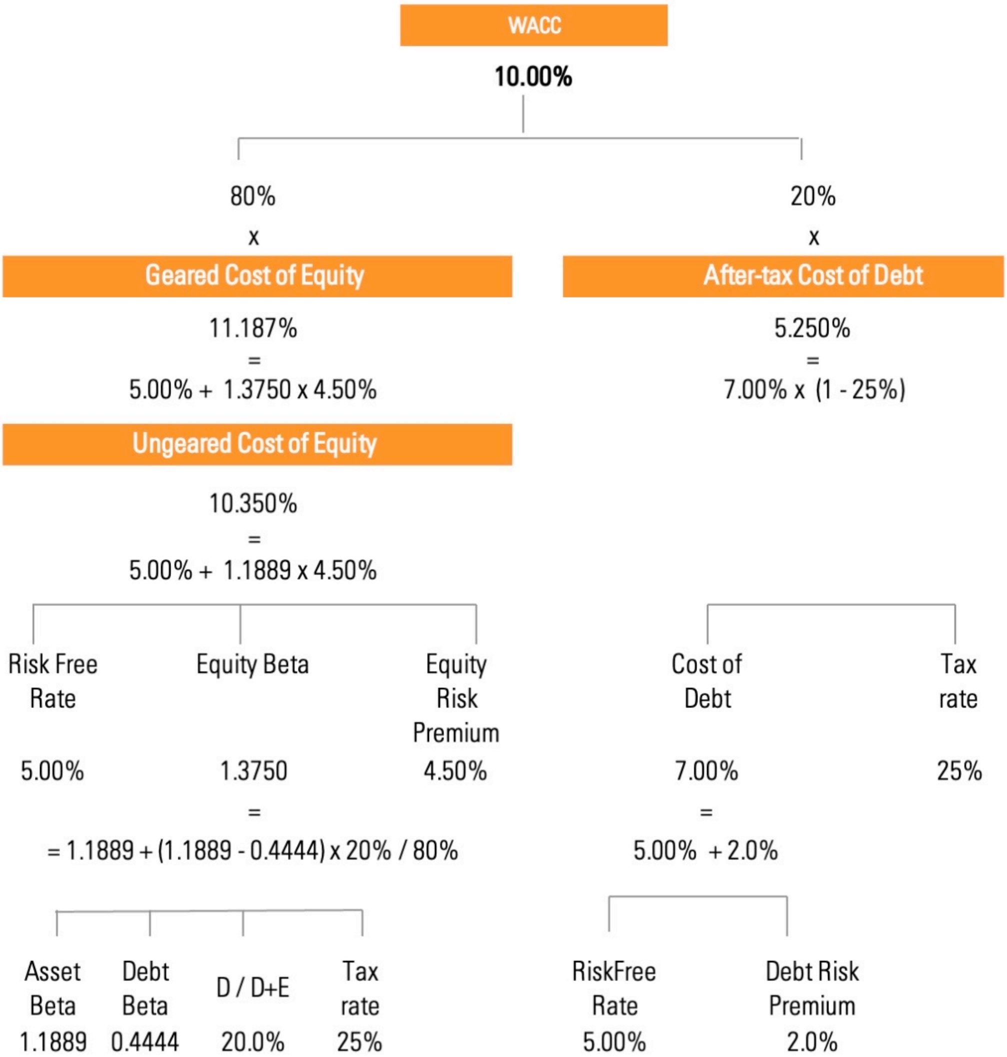
$$= K_g \times \left(\frac{E}{D+E}\right) + K_d\ (1-t) \times \left(\frac{D}{D+E}\right)$$

D and E represent the market values of Net Debt and Equity, so that D + E equals the Enterprise Value.

In Part 1 it was noted that the DCF Enterprise Value is reduced by the market value of debt and items treated as debt for the valuation (debt-equivalents, like pension deficits) as part of the calculation to reach the DCF Equity Value. All components of the Enterprise-Equity Value 'Bridge' must be included in the WACC calculation (the discussion above is limited to pure debt, to simplify matters).This requires extra terms in the above calculation for each component's post-tax financing costs and weighting.

WACC Example

The following example assumes that debt depends on the enteprise value and that the debt beta is not zero (this WACC is used in Part 3 and the method of calculation allows all 7 DCF methods to agree):



The debt beta is calculated as Debt Risk Premium (2.0%) / Equity Risk Premium (4.50%). The asset beta is assumed and would be based on a sample of 'proxy' quoted companies.

This example uses the Harris & Pringle (1985) approach (see Appendix), and allows the Cost of Equity and WACC to be calculated ignoring the beta entirely:

$$K_g = K_u + (K_u - K_d)\ \frac{D}{E}$$ see A1.6 in Appendix

$$11.187\% = 10.350\% + (10.350\% - 7.00\%) \times 20\% / 80\%$$

$$WACC = K_u - K_d.\ t.\ L$$ see A1.7 in Appendix

$$10.000\% = 10.350\% - 7.00\% \times 25\% \times 20\%$$

Foreign Risk

The return required by investors for investing in a business located outside their 'home' country will reflect the different risks compared to a business located in their jurisdiction. A number of variations to the general CAPM have been suggested to estimate the return required by equity investors ('home' investors) when they invest in entities located outside their jurisdiction ('foreign' entities), where the risks are likely to be different to an otherwise identical business based in their home country. Such risks include: political risk (e.g. default on government bonds making them risky and not risk free, or tax changes), currency risk (e.g. exchange rate fluctuations affecting conversion of foreign currency to home currency denominated cash flows), and inflation risk (affecting nominal cash flows and discount rates). How these incremental risks are quantified and incorporated into the discount rate has led to a variety of approaches.

As for the general CAPM, the risk reflected in the discount rate should, the theory says, be total risks that cannot be diversified away via portfolio allocation. The discount rate for an investor in a fully integrated market who holds a globally diversified portfolio that allows country risk to be diversified away is likely to be different to the rate for an investor in a segmented market who only holds investments in that market.

CAPM Models

If markets are fully integrated, so that the price of non-currency risk for a company based at home is the same as for an otherwise identical company based in another country, each market has the same risk (markets are perfectly correlated with each other) and so the beta of any company can be measured against the world equity risk premium (ERP). The same real WACC (same real risk free rate and risk premium) can be used for valuation purposes. In such a market, it is assumed investors hold diversified global portfolios, so that the return required for home based investors from investing in the foreign entity is:

$$\text{World CAPM } K_{eH} = R_{F\,World} + \beta_{World} \times ERP_{World}$$

where:

$R_{F\,World}$ typically the US risk-free rate

ERP measured in the same currency as $R_{F\,World}$

β_{World} represents the foreign company beta as measured against the world market index.

If markets are not integrated but fully segmented, then investors based in the same jurisdiction as the foreign entity will only invest in the local market. The inputs for this 'Local CAPM' would be those for the country and expressed in that country's currency:

$$\text{Local CAPM } K_{eL} = R_{F\,Local} + \beta_{Local} \times ERP_{Local}$$

Between these two extremes there are a number of variations that incorporate country risk (see Harrington, Nunes & Aboulamer- Kroll (2023)). These include the following:

- Country Risk Premium (CRP): adding a CRP to a CAPM that has world inputs (World CAPM above), mature market inputs (such as the US) or inputs for the market where the investor are based (home investors). The Country Yield Spread model (CYSM) (Mariscal & Lee, Goldman Sachs (1993)) measures the CRP as the yield on a government bond issued in the foreign country (in local currency) less the yield on a government bond issued in the home country (in home currency, taken as US$ R_f). Ideally the foreign country bond would be issued in the same currency as the home government bond.

$$\text{Home (CYSM) CAPM } K_{eH} = R_{F\ Homel} + \beta_{Home} \times ERP_{Home} + CRP_{Foreign}$$

- Relative Volatility Models:

    - Adjusting the ERP by the relative volatility of the foreign market versus the home market:

$$\text{Home (RV) CAPM } K_{eH} = R_{F\ Homel} + \beta_{Home} \times ERP_{Home} \left(\frac{\sigma_{\text{Foreign stock market}}}{\sigma_{\text{Home stock market}}} \right)$$

    - Adjust the CRP by the relative volatility (from the point of view of U.S. investors, so 'Home' is the U.S.)(Damodaran (2025)):

$$\text{Home } (RV_{Damodaran})\ K_{eH} = R_{F\ Homel} + \beta_{Home} \,.\, ERP_{Home} + \lambda \,.\, CRP_{Foreign} \left(\frac{\sigma_{\text{Foreign stock market}}}{\sigma_{\text{Foreign bond market}}} \right)$$

    Where λ is a measure of exposure to local risk and the CRP (as measured by the yield differential on local versus home government bonds), adjusted by the relative volatility of the local stock market returns to local bond market market returns

Basic International DCF Principles

Diversifiable foreign risks that can be quantified should be incorporated in the cash flows by adjusting for the probability weighted expectations (and not included in the WACC, to avoid double counting – WACC risks will be non-diversifiable risks such as country and sector risk).

Cash flows of the foreign operation can be forecasted in the foreign currency and:
- discounted at a rate that reflects that currency, in either real or nominal terms, and the present value translated into the home currency at the valuation date spot rate, or
- translated into home currency at expected future exchange rates and discounted at a rate based on the home currency.

The discount rate must be consistent with how the cash flows are measured, so a nominal or real foreign ($WACC_{Fn}$, $WACC_{Fr}$) or home ($WACC_{Hn}$, $WACC_{Hr}$) rate must match with nominal or real foreign or home currency cash flows. If only inflation and exchange rates are determining factors, real home and real foreign discount rates should in theory be the same according to the International Fisher Effect, where $(1 + WACC_{Hn}) / (1 + \text{home inflation rate}) = (1 + WACC_{Fn}) / (1 + \text{foreign inflation rate})$. This assumes all cash flow components are affected equally by inflation, which might not arise in practice.

A simplified example show how the two approaches would equal each other is given below:

		Period 2 workings	Forecast Year 0	1	2	3	4	5
Foreign currency cash flows (Nominal)				500.0	800.0	1,245.0	1,710.0	2,120.0
Home WACC								
Inflation rate				2.00%	2.00%	2.00%	2.00%	2.00%
Risk free rate	Nominal			5.06%	5.06%	5.06%	5.06%	5.06%
Risk free rate	Real	= (1 + 5.06%) / (1 + 2.00%) - 1		3.00%	3.00%	3.00%	3.00%	3.00%
Foreign risk premium				4.93%	4.93%	4.93%	4.93%	4.93%
Parity exchang rate		see below	125.00	131.74	139.49	148.38	157.83	167.89
Risk premium adjusted		= 4.93% x 131.74 / 139.49		4.68%	4.65%	4.63%	4.63%	4.63%
$WACC_{Hn}$	Nominal	= 5.06% + 4.65%		9.74%	9.71%	9.69%	9.69%	9.69%
$WACC_{Hr}$	Real	= (1 + 9.71%) / (1 + 2.00%) - 1		7.58%	7.56%	7.54%	7.54%	7.54%
DCF using home WACC								
Foreign currency cash flows (nomi		see above		500.0	800.0	1,245.0	1,710.0	2,120.0
Parity exchange rate		see below	125.00	131.74	139.49	148.38	157.83	167.89
Home currency cash flows (nominal)				3.8	5.7	8.4	10.8	12.6
Discount factor	$WACC_{Hn}$			0.9113	0.8306	0.7572	0.6903	0.6293
PV (using nominal)		PV =	**30.0**	3.5	4.8	6.4	7.5	7.9
Foreign currency cash flows (real)		see below		465.12	689.06	988.34	1251.14	1429.60
Spot exchange rate at time 0				125.00	125.00	125.00	125.00	125.00
Home currency cash flows (real)				3.7	5.5	7.9	10.0	11.4
Discount factor	$WACC_{Hr}$			0.9295	0.8641	0.8035	0.7472	0.6948
PV (using real)		PV =	**30.0**	3.5	4.8	6.4	7.5	7.9
Foreign WACC								
Inflation rate				7.50%	8.00%	8.50%	8.50%	8.50%
Inflation index (compounded)		= 1.075 x (1 + 8.00%) = 1.161	1.000	1.075	1.161	1.260	1.367	1.483
Risk free rate	Nominal	= (1 + 5.06%) x (1 + 8.00%) / (1 + 2.00%) - 1		10.73%	11.24%	11.76%	11.76%	11.76%
Risk free rate	Real	= (1 + 11.24%) / (1 + 8.00%) - 1		3.00%	3.00%	3.00%	3.00%	3.00%
Risk premium				4.93%	4.93%	4.93%	4.93%	4.93%
$WACC_{Fn}$	Nominal	= 11.24% + 4.93%		15.65%	16.17%	16.68%	16.68%	16.68%
$WACC_{Fr}$	Real	= (1 + 16.17%) / (1 + 8.00%) - 1		7.58%	7.56%	7.54%	7.54%	7.54%
DCF using foreign WACC								
Foreign currency cash flows (nominal)				500.0	800.0	1,245.0	1,710.0	2,120.0
Discount factor	$WACC_{Fn}$	= 1/{ (1 / 0.8647) x (1 + 16.17%) } = 0.7443		0.8647	0.7443	0.6379	0.5467	0.4685
PV (using nominal)			3,750.0	432.3	595.4	794.2	934.8	993.2
Translated at spot rate		PV =	**30.0**					
Foreign currency cash flows (nominal)				500.0	800.0	1,245.0	1,710.0	2,120.0
Inflation index				1.075	1.161	1.260	1.367	1.483
Foreign currency cash flows (real)				465.1	689.1	988.3	1,251.1	1,429.6
Discount factor	$WACC_{Fr}$			0.9295	0.8641	0.8035	0.7472	0.6948
PV (using real)			3,750.0	432.3	595.4	794.2	934.8	993.2
Translated at spot rate		PV =	**30.0**					
Parity exchange rate		= 131.74 x (1 + 11.24%) / (1 + 4.93%)	125.00	131.74	139.49	148.38	157.83	167.89

Notes

1 R_f is typically measured using the yield to maturity, at the valuation date, for a government bond maturing in 10 years, in the same currency as the stock currency / cash flows. This yield is meant to estimate the risk free return over the period for which the cost of equity is being calculated, which for a constant cost of equity (or WACC) would be the life of the business or project. As risk free yields comprise a real risk free rate, a premium for expected inflation and a premium for market risk (the general level of interest rates affecting bond prices), a longer term bond might be more sensitive to unexpected changes in inflation and not risk free.

2 ERP should be a forward looking estimate, but may, in practice, be based on observed historic returns over a long term period, on the assumption that the ERP will revert to the long term average. An ERP, however, can be implied from current market prices using stock valuation tools. The ERP should be the market required return in excess of whatever risk free rate is used in the WACC

3 Asset betas can be estimated by de-levering observed quoted company equity betas, and are available from beta consultancy firms or other providers (e.g. Bloomberg).

4 The 'Debt Risk Premium' ('DRP') or 'Credit Spread' is the required return for debt holders (pre-tax cost of debt) in excess of the risk free rate: $K_d = R_f + DRP$. As for the cost of equity, DRP can be expressed in terms of ERP: DRP = $ß_d$ x ERP, where $ß_d$ is the 'Debt Beta' equal to DRP / ERP (see https://edbodmer.com/debt-beta-and-credit-spreads/).

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MM Theory

Ignoring the tax benefits of debt, Modigliani & Miller (MM 1958) stated that the value of a business should not be affected by how it is financed, as FCFF will be the same ($FCFF_{ungeared} = FCFF_{geared}$), implying the WACC will be the same with or without any leverage. If the tax deductibility of interest is considered (MM 1961), the value of the geared business will be greater than the value of the ungeared business due to the present value of the tax inflows ('Tax Shield' / 'TS') from interest deductibility (Value of the 'Tax Shield' / 'V_{TS}'):

Value of geared firm (V_g) = Value of ungeared (V_u) + V_{TS}

and since V_g = Equity Market Value (E) + Debt Market Value (D)

$$V_u + V_{TS} = E + D$$

so $$V_u = E + D - V_{TS}$$

Assuming perpetual debt of D (a constant amount each year), with interest at the cost of debt K_d paid annually in perpetuity, V_{TS} can be calculated using the no-growth perpetuity formula (see Part 1), discounted at a rate Ψ that reflects the riskiness of the tax shield, so that:

$$V_g = V_u + \frac{K_d.t.D}{\Psi} \quad \Leftarrow \quad V_{TS}$$

Assuming $\Psi = K_d$ (MM also assumed $K_d = R_f$), this expression simplifies to:

$$V_g = V_u + t.D$$

Myers (1974) assumed $\Psi = K_d$ (but not $K_d = R_f$) on the basis that debt levels do not depend on FCFF or the EntV and the risk of tax shields relates to the ability of the business to generate sufficient income to offset the tax deductions. Miles and Ezzell (1980) assumed debt was continuously adjusted based on the assumed leverage as from the end of the first year rather than the valuation date. As the interest in the first year would be known, based on an assumed amount of debt at the valuation date (not dependent on the value of the business), the tax shield in the first year would be discounted at the risk free rate and thereafter at the ungeared cost of equity. The valuation at any future date would follow the same principle in respect of new debt issues in the first year after the valuation date. Harris and Pringle ('HP') (1985) assumed $\mathbf{\Psi = K_u}$ on the basis that debt levels (leverage) depend on the EntV and hence FCFF and business risk. As the tax shield cash flows depend on the value of the business, they should be discounted at the ungeared cost of equity (it is assumed that debt is continually adjusted to ensure leverage is constant with effect from the valuation date)

Finite period (general equation)

Cash flows distributable to equity investors ('Cash Flows to Equity' / 'CFE' = dividends + stock repurchases) are what remain of FCFF after payments to debt providers ('Cash Flows to Debt' / 'CFD' = pre-tax interest + debt principal net payments (- net new borrowings) less of tax relief on interest (Tax Shield cash flows = pre-tax interest x tax rate):

$$\text{CFE} = \text{FCFF} \overbrace{- \text{ debt decr. (+ debt incr.)} - \text{Interest}}^{\text{CFD}} + \overbrace{\text{tax rate x interest}}^{\text{Tax Shield (TS)}}$$

$$= \text{FCFF} - (D_{n-1} - D_n) - D_{n-1} K_d + t.\, D_{n-1}.\, K_d.$$

$$\therefore \text{FCFF} = \text{CFE} + \text{CFD} - t.\, D_{n-1}.\, K_d.$$

Cash flows can be expressed in terms of the opening value to which they related times the required return ($FCFF = V_g.WACC_g$, $CFE = E.K_g$, $CFD = D.\,K_d$), $TS = V_{TS}\ \Psi$):

$$V_{g_{n-1}} .\, WACC_{g_n} = E_{n-1}.\, K_{g_n} + D_{n-1}.\, K_{d_n} - D_{n-1}.\, K_{d_n}\, t$$

$$WACC_{g_n} = \frac{E_{n-1}.\, K_{g_n}}{V_{g_{n-1}}} + \frac{D_{n-1}.\, K_{d_n}\ (1 - t)}{V_{g_{n-1}}}$$

$$= \frac{E_{n-1}}{(D+E)_{n-1}} K_{g_n} + \frac{D_{n-1}}{(D+E)_{n-1}} K_{d_n}\ (1 - t)$$

The traditional WACC formula (see: Fernandez (2011) Exhibit 1; Mejia-Pelaez & Vélez–Pareja (2011) App.C)

where:

V_{TS}, D, E - market values of tax shields, debt and equity, respectively

K_g, K_d, Ψ - required return on equity and debt and the discount rate for tax shields

As $\quad FCFF = E.\,K_g + D.\,K_d - V_{TS}\ \Psi$

And $\quad FCFF = V_u\, K_u = K_u .\, (V_g - V_{TS})$ (from $V_g = V_u + V_{TS}$)

$$\therefore K_u .\, (V_g - V_{TS}) = E.\,K_g + D.\,K_d - V_{TS} .\, \Psi$$

The value of the tax shield can now be incorporated in the cost of equity formula by substituting D + E for V_g and re-arranging, to give a general equation for K_g (see: Koller et al. (McKinsey)(2025) Eq.C.6 p.878); Tham & Vélez–Pareja (2019) Eq.14; Mejia-Pelaez & Vélez–Pareja (2011) Eq.2; Vélez–Pareja, Ibragimov & Tham (2008) p.17):

$$K_g = K_u + (K_u - K_d)\frac{D}{E} - (K_U - \psi)\frac{V_{TS}}{E} \qquad \text{A1.1}$$

Note: D / E = L / (1 – L), where L is the leverage % D / D + E (or D / V_g)

$$\text{Since} \quad FCFF = CFE + CFD - TS$$

$$WACC_g . V_g + TS = K_g . E + K_d . D$$

Substituting K_g in the general equation (A1.1) into the above:

$$WACC_g . V_g + TS = \left(K_u + (K_u - K_d)\frac{D}{E} - (K_U - \psi)\frac{V_{TS}}{E} \right) E + K_d . D$$

After re-arranging, this becomes the general WACC formula (see: Tham & Vélez–Pareja,I (2019) Eq. 28; Mejia-Pelaez & Vélez–Pareja (2011) Eq.3):

$$WACC = K_u - (K_u - \psi)\frac{V_{TS}}{D+E} - \frac{TS}{D+E} \qquad \text{A1.2}$$

Note: TS = K_d. t. D where D = D / D + E and D + E = V_g

Perpetuity (general equation)

With constant growth, the value of the tax shield is (see: Mejia-Pelaez & Vélez–Pareja (2011) Eq.6):

$$V_{TS} = \frac{TS}{\Psi - g} = \frac{K_d.t.D}{\Psi - g}$$

The general equation K_g for a constant growth perpetuity is the finite equation (A1.1) with V_{TS} adjusted for growth:

$$K_g = K + (K_u - K_d)\frac{D}{E} - (K_u - \psi)\frac{\frac{TS}{\Psi - g}}{E}$$

$$K_g = K + (K_u - K_d)\frac{D}{E} - (K_u - \psi)\left(\frac{K_d.t}{\psi - g}\right)\frac{D}{E} \qquad \text{A1.3}$$

The general equation $WACC_g$ for a constant growth perpetuity is:

$$WACC = K_u - (K_u - g)\frac{V_{TS}}{D+E}$$ (see Fernandez (2011) Eq.10):

$$= K_u - (K_u - g)\frac{\frac{TS}{\psi - g}}{D+E}$$ (see Vélez–Pareja (2005) Eq. B7d)

$$WACC = K_u - (K_u - g)\left(\frac{K_d \cdot t \cdot L}{\psi - g}\right)$$ A1.4

The general equations K_g and WACC for a zero growth perpetuity is (setting g = 0 in A1.3 and A1.4):

$$K_g = K_u + (K_u - K_d)\frac{D}{E} - (K_U - \psi)\frac{K_d.t.D}{\psi}\frac{1}{E}$$

$$WACC = K_u\left(1 - \frac{K_d \cdot t \cdot L}{\psi}\right)$$

$$= K_u\left(1 - \frac{V_{TS}}{V_g}\right)$$

Since $\frac{K_d.t.L}{\psi} = \frac{K_d.\ t.\ (D / V_g)}{\psi}$ and $V_{TS} = \frac{t.D}{\psi}$ when g = 0

Beta

Weighted average betas can be applied to each component of the equation above:

$$V_u + V_{TS} = E + D$$

$$\beta_u\left(\frac{V_U}{D+E}\right) + \beta_{TS}\left(\frac{V_{TS}}{D+E}\right) = \beta_g\left(\frac{E}{D+E}\right) + \beta d\left(\frac{D}{D+E}\right)$$

In terms of the equity or geared beta, this can be re-arranged into a general equation:

$$\beta_g = \beta_u + (\beta_u - \beta_d)\left(\frac{D}{E}\right) - (\beta_u - \beta_{TS})\left(\frac{V_{TS}}{E}\right)$$ A1.5

Assuming $\Psi = K_u$ (Harris & Pringle)

Finite Period ($\Psi = K_u$)

If $\Psi = K_u$, it is assumed tax shield cash flows vary with FCFF and depend on the business risk.

The general equation for K_g over a finite period (eq. A1.1) with $\Psi = K_u$ is adjusted to (see: Vélez–Pareja, Ibragimov & Tham (2008) p.17):

$$K_g = K_u + (K_u - K_d)\frac{D}{E} - (K_U - \boxed{K_U})\frac{V_{TS}}{E}$$

$$\therefore \quad \boxed{K_g = K_u + (K_u - K_d)\frac{D}{E}} \qquad \text{A1.6}$$

The general equation for $WACC_g$ over a finite period (eq.A1.2) with $\Psi = K_u$ is adjusted to (see: Vélez–Pareja, Ibragimov & Tham (2008) p.17):

$$WACC = K_u - (K_u - \boxed{K_U})\frac{V_{TS}}{D+E} - \frac{TS}{D+E}$$

$$\therefore \quad WACC = K_u - \frac{TS}{D+E}$$

$$\therefore \quad WACC = K_u - K_d.t.\frac{D}{D+E}$$

$$\therefore \quad \boxed{WACC = K_u - K_d.t.\ L} \qquad \text{A1.7}$$

This is the general equation for finite WACC with K_u replacing Ψ

$$WACC = K_u\left(1 - \frac{K_d . t. L}{\Psi}\right) \rightarrow K_u\left(1 - \frac{K_d . t. L}{K_u}\right) \rightarrow K_u - K_d.t.L$$

Perpetuity ($\Psi = K_u$)

With constant growth and $\Psi = K_u$, the value of the tax shield is (see: Fernandez (2011) Eq.4):

$$V_{TS} = \frac{TS}{K_u - g} = \frac{K_d.t.D}{K_u - g}$$

The general equation K_g for a constant growth perpetuity (eq.A1.3) with $\Psi = K_u$ is adjused to:

$$K_g = K_u + (K_u - K_d)\frac{D}{E} - (K_u - \boxed{K_u})\frac{K_d . t}{\boxed{K_u} - g}\frac{D}{E}$$

$$\boxed{K_g = K_u + (K_u - K_d)\frac{D}{E}}$$ same as finite

The general equation $WACC_g$ for a constant growth perpetuity (eq.A1.4) with $\Psi = K_u$ is adjusted to

$$WACC = K_u - (K_u - g)\left(\frac{K_d . t. L}{\boxed{K_u} - g}\right)$$

$$\boxed{WACC = K_u - K_d .t. L}$$ same as finite

Note: The equations for perpetuities are the same whether or not g = 0

Assuming $\Psi = K_d$ (Myers)

Finite Period ($\Psi = K_d$)

If $\Psi = K_d$, it is assumed tax shield cash flows do not depend on FCFF and business risk.

The general equation for K_g over a finite period with $\Psi = K_d$ is adjusted to (see: Vélez–Pareja, Ibragimov & Tham (2008) p.18):

$$K_g = K_u + (K_u - K_d)\frac{D}{E} - (K_U - \boxed{K_d})\frac{V_{TS}}{E}$$

$$\therefore \quad \boxed{K_g = K_u + (K_u - K_d)\left(\frac{D}{E} - \frac{V_{TS}}{E}\right)} \quad \text{A1.9}$$

The general equation for $WACC_g$ over a finite period with $\Psi = K_d$ is adjusted to (see: Vélez–Pareja, Ibragimov & Tham (2008) p.18):

$$\boxed{WACC = K_u - (K_u - \boxed{K_d})\frac{V_{TS}}{D + E} - \frac{TS}{D + E}} \quad \text{A1.10}$$

Perpetuity ($\Psi = K_d$)

With positive growth and $\Psi = K_d$, the value of the tax shield is:

$$V_{TS} = \frac{K_d.t.D}{K_d - g}$$

The general equation K_g for a growing perpetuity with $\Psi = K_d$ is adjusted to:

$$K_g = \underbrace{K_u + (K_u - K_d)\frac{D}{E}}_{K_g \text{ if } \Psi = K_u} - (K_u - \boxed{K_d}).\left(\frac{K_d.t}{K_d - g}\right)\frac{D}{E}$$

$$K_g = K + (K_u - K_d)\frac{D}{E}\left(1 - \frac{K_d.t}{K_d - g}\right)$$ A1.11

The general equation $WACC_g$ for a growing perpetuity with $\Psi = K_d$ is adjusted to:

$$WACC = K_u - (K_u - g)\left(\frac{K_d.t.L}{\boxed{K_d} - g}\right)$$ A1.12

This assumes D grows at g

The general equations for K_g and WACC for a zero growth perpetuity with $\Psi = K_d$ are adjusted to (setting g = 0 in A1.11 and A1.12)(see Holthausen & Zmijewski (2012) p.63):

$$K_g = K_u + (K_u - K_d)\frac{D}{E}(1 - t)$$

$$WACC = K_u(1 - t.L)$$

Note: $V_{TS} = t.D$ (with zero growth and $\Psi = K_d$)

Beta Re-levering

If debt is set as a proportion of the EntV (D = leverage x EntV), the amount of debt will depend on business risk, so $\beta_u = \beta_{TS}$. The general beta equation (eq. A1.5) can be adjusted (see: Koller et al. (McKinsey)(2025) Exhibit C.3 p.880): Oded, Michel & Feinstein (2011) p.687):

$$\beta_g = \beta_u + (\beta_u - \beta_d)\left(\frac{D}{E}\right) - (\beta_u - \boxed{\beta_u})\left(\frac{V_{TS}}{E}\right)$$

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

If we assume $\beta_d = 0$ ('Practioners' formula')

$$\beta_g = \beta_u \left(1 + \frac{D}{E}\right)$$ A1.8

If the amount of D is known and does not depend on the value of the business, the riskiness of the tax shield can be assumed the same as the riskiness of debt, so that $\psi = K_d$ and $\beta_{TS} = \beta_D$. The equity beta formula (A1.5) becomes:

$$\beta_g = \beta_u + (\beta_u - \beta_d)\left(\frac{D}{E}\right) - (\beta_u - \beta_d)\left(\frac{V_{TS}}{E}\right)$$

$$\beta_g = \beta_u + (\beta_u - \beta_d)\left(\frac{D(1-t)}{E}\right)$$

Where $V_{TS} = \frac{K_d.t.D}{K_d}$

If it is assumed $\beta_d = 0$, the general beta equation is the 'Hamada' equation (see: Koller et al. (McKinsey)(2025) Exhibit C.3 p.880): Oded, Michel & Feinstein (2011) p.684; Hamada (1972)):

$$\beta_g = \beta_u \left(1 + \frac{D}{E}(1-t)\right)$$ D is constant A1.13

As Arzac (2005) states: [The Hamada] "equation … is a special result that applies only when the level of net debt is constant and the tax shield is riskless…… [and] does not apply in the important case in which the firm maintains a constant net debt ratio and cash flows are discounted at the weighted average cost of capital (WACC)" (see also Koller et al. (McKinsey) (2025) p.318). Therefore, the Practioners formula (eq. A1.8) should be used when adjusting the asset beta for financial risk in a DCF valuation where WACC uses leverage based on market values (forecast debt theoretically should be be based on this leverage as applied to period end EntVs).

Tax Deduction Restrictions in the UK

In the UK, taxation of debt instruments for companies falls under the Loan Relationship Rules (LRR) contained in Corporation Tax Act 2009 (CTA 2009), which includes 'money debts' arising from the actual lending of money (settled in cash, in another money debt or shares in any company). All profits and losses in the form of credits and debits (including interest) under the LRR are taxed as trading or non-trading income even if they are of a capital nature (i.e. capital gains and losses). Amounts recognised are those recognised in the profit and loss account under GAAP, unless the tax rules override the accounting rules (lending between connected companies, for example, has to be recognised using the amortised cost method and not fair value accounting, which the lender can use depending on its business model and other factors). Losses (excess debits over credits, or 'deficits') are relieved differently for trading and non-trading items.

Subject to avoidance arrangements, interest (not defined) is deductible for tax purposes, but may be restricted under the Corporate Interest Restriction ('CIR') provisions underTaxation (International and Other Provisions) Act 2010.These aim to restrict tax deduction for UK tax resident companies in a worldwide group (or single companies) in respect of net interest payable in excess of £2 million, so as to ensure deductions are commensurate with business activity subject to UK tax (OECD based rules designed to remove the advantage of shifting group debt to higher tax rate jurisdictions to maximise dedutions).The amount restricted ('Interest Capacity') is based on a percentage ('fixed ratio' 30%) of tax adjusted Earnings Before InterestTax Depreciation & Amortisation ('tax-EBITDA) for the UK companies, subject to a cap. If the worldwide group's net finance cost (making adjustments to align with UK tax rules and other adjustments) as a percentage of its EBITDA is higher than 30%, the UK companies in the group may elect to use this higher 'group ratio' in instead of the 30% fixed ratio (again subject to a cap). The group decides how to allocated the Interest Allowance to its UK group companies. The disallowed amount may be carried forward for deduction in future years ('reactivation'), subject to rules.

Interest deductions on a corporation tax return will be challenged if it is suspected one of the main purposes of the loan relationship is the avoidance of tax. These would include loans for an 'unallowable purpose' (not amongst the purposes of the company)[s441 CTA 2009], loan transactions not at arm's length [s444 CTA 2009] and interest which treated as a non-tax deductible distribution [s1000 CTA 2010].

As for a loss making company (where LRR deficits, including interest expense, would be carried forward for relief), restricting interest deductions under the CIR reduces the value of the tax shield (see Part 2) by delaying the tax benefits (until used in a future period), and hence increases the after-tax cost of debt in the affected years.