Introduction

The average after-tax rate of return required by all providers of financial capital, adjusted for the perceived riskiness of the cash flows distributable to them ('Free Cash Flows to the Firm' / 'FCFF') and weighted by the market values of each source of financing, is called the 'Weighted Average Cost of Capital' ('WACC'). In Part 1, the discount rate 'r' is the WACC.

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

$$\text{Post-tax WACC} = \text{Required return for equity investors} \times \frac{E}{D+E} + \text{Required return for debt providers} \times \frac{D}{D+E}$$

where the required return (income and capital growth) comprises a risk free rate (R_f) plus a premium for equity or debt risk:

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

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). As debt interest is tax deductible, whereas equity dividends are not, the pre-tax cost of debt must be adjusted to the after-tax equivalent (K_d (1 – tax rate t)), assuming tax relief is available in the same period the interest is paid.

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 above 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, assuming recognised at amortised cost (to be discussed in Part 4), if the yield to maturity at the valuation date is the same as when issued.

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.

In theory, the capital structure should be adjusted towards some optimum level. 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, 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), so as not to alarm investors.

If leverage changes during the forecast period, the WACC will change. It is usually assumed that the business will adjust its capital structure to its target level before the end of the forecast period, and so a constant WACC assumption might be justifiable (the leverage set in the WACC equation would then be this target leverage, using market values). Adjusting the capital structure can be done by changing debt (borrowing or repaying debt) and/or changing equity (paying special dividends from debt funding or buying back shares). However, assuming a constant WACC 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).

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. Alternatively, we could assume a leverage figure in the WACC calculation and avoid the need to calculate debt each period (not required for a FCFF valuation, but required when valuing equity directly, as discussed in the next Part).

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') (amongst other 'bridge' items – discussed in Parts 4 and 5)
- Leverage in the WACC: L = net debt / (net debt + equity)
- Equity beta in CAPM Cost of Equity, when re-gearing using Net D / E
- Cost of debt in the WACC (see Damodaran (2025) ch.15):

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

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

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 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).

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 (discussed in more detail in Appendix 1). 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}). In the WACC formula, deductibility of interest is included by reducing the cost of debt by the marginal tax rate (t):

$$WACC_{post\text{-}tax} = K_g \left(\frac{E}{D+E}\right) + K_d\ (1-t) \left(\frac{D}{D+E}\right)$$

Cost of Equity

The total return achieved over a single period for an equity investor in a quoted company is the sum of the cash inflow assumed to arise during the period (dividend) plus the change in market value (ex-dividend) over the period (capital gain), as a percentage of the opening market value (ex-dividend), representing the dividend yield and capital growth. If this return was expected at the start of the period, it would represent the required return or 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).

Asset pricing models try to identify which risks are relevant to equity investors and how to capture such risk in the required return. The CAPM assumes only some of the total risk of any stock (uncertainty about the future amount and timing of any income or capital gains) 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).

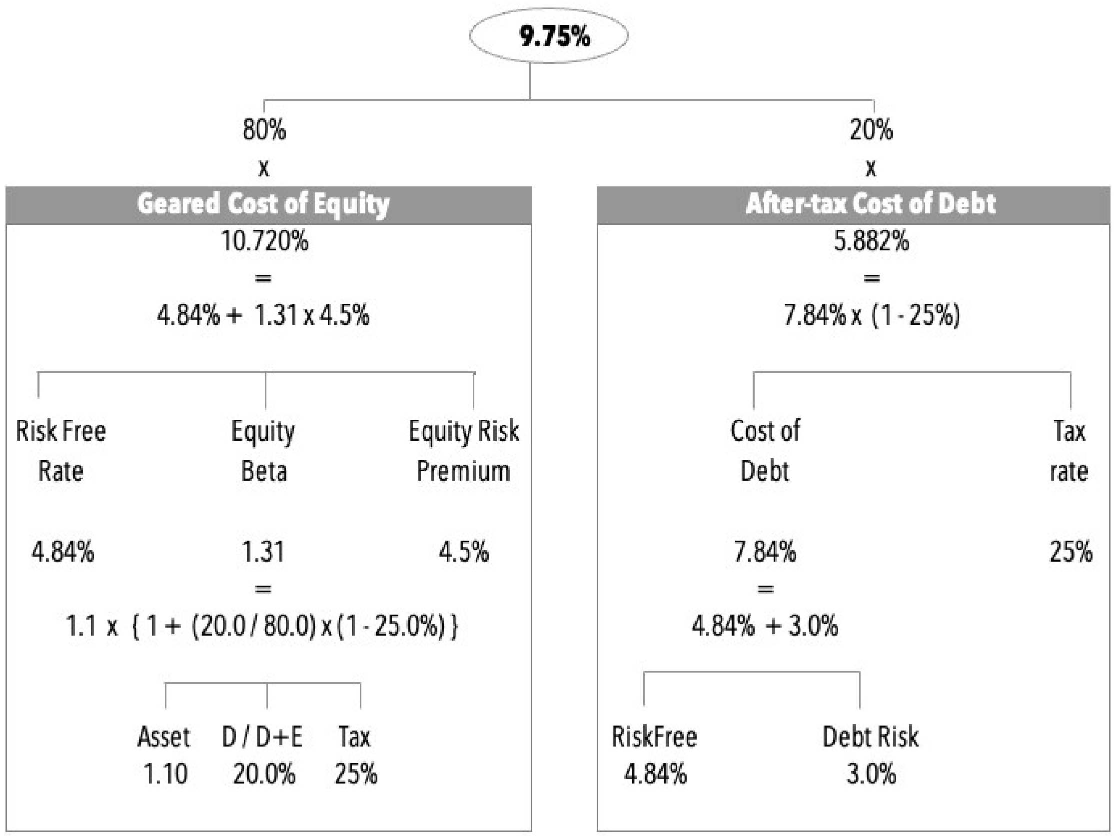
The volatility of the return on the stock may or may not exactly match volatility of the market index (as measured by the ratio of the standard deviation of their returns: $\sigma_{stock} / \sigma_{market}$). This relationship, when adjusted by how closely the returns match each other (correlation coefficient 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 $ß_a$ or 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: Cost of Equity (ungeared)(K_u) $= R_f + ß_a \times$ ERP. 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. This can be done using formulae discussed in Appendix 1: Cost of Equity (geared)(K_g) $= R_f + ß_g \times$ 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.

WACC

An example of how the WACC is built up is shown below. This version (9.75%) would be suitable when an amount of debt is assumed and the value of the tax shield does not depend on FCFF or the EntV (beta is re-geared adjusting D/E by (1 – t)). An alternative financing policy assumption is for the amount of debt to be based on an assumed leverage ratio applied to EntV, when the tax shield would depend on FCFF (beta is re-geared ignoring the tax adjustment, resulting in 10.0% in the example). Also, it is assumed here that the debt beta is ignored when re-levering the asset beta (see Appendix 1 for further discussion on tax shields and betas).



			Beta re-geared using	
			D(1-t)/E	D/E
Cost of debt				
Risk free rate		R_f	4.84%	"
Debt risk premium		DRP	3.00%	"
Pre-tax cost of debt	= 4.84% + 3.00%	K_d	7.84%	"
Tax rate		t	25.00%	"
Post-tax cost of debt	= 7.84% x (1 - 25.00%)	K_{dt}	5.88%	"
Debt ratio	D / E ratio = 25.00%	L	20.00%	"
Weighted rate			*1.176%*	*1.176%*
Cost of equity				
Risk free rate		R_f	4.84%	"
Equity risk premium		ERP	4.50%	"
Ungeared, assets beta		β_a	1.10	"
Ungeared cost equity	= 4.84% + 1.10 x 4.50%	K_u	9.79%	"
Geared equity beta	= 1.10 x (1+ [20% / 80%] x (1- 25.0%))	β_g	1.31	
Geared equity beta	= 1.10 x (1+ [20% / 80%])	β_g		1.38
Geared Cost of Equity	= 4.84% + 1.31 x 4.50%, 4.84% + 1.38 x 4.50%	K_g	10.72%	11.03%
Equity ratio		1 - L	80.00%	"
Weighted rate			*8.576%*	*8.824%*
WACC	= 1.176% + 8.576%, 1.176% + 8.824%		**9.75%**	**10.00%**

$$9.75\% = \left(R_f + \beta_a\left(1 + \frac{D}{E}(1-t)\right) ERP\right) \times \frac{E}{D+E} + \left(\left(R_f + \text{Debt Risk Premium}^4\right)(1-t)\right) \times \frac{D}{D+E}$$

$$10.0\% = \left(R_f + \beta_a\left(1 + \frac{D}{E}\right) ERP\right) \times \frac{E}{D+E} + \left(\left(R_f + \text{Debt Risk Premium}^4\right)(1-t)\right) \times \frac{D}{D+E}$$

Cross-border WACC

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. Cross border DCF approaches, including CAPM adjustments, are discussed briefly in Appendix 2.

The next paper will discuss how alternative DCF valuation methods can be used (Economic Profits, Adjusted Present Value, Capital Cash Flows, Residual Income), incorporating some of the information in Appendix 1.

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: $DRP = ß_d \times ERP$, where $ß_d$ is the 'Debt Beta' equal to DRP / ERP (see https://edbodmer.com/debt-beta-and-credit-spreads/).

Suggested reading

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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}'):

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

$$\text{and since} \quad V_g = \text{Equity Market Value (E)} + \text{Debt Market Value (D)}$$

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

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

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:

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

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 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 $\Psi = K_u$ 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):

			CFD		Tax Shield (TS)
CFE	=	FCFF	- debt decr. (+ debt incr.) - Interest	+	tax rate x interest
	=	FCFF	$- \; (D_{n-1} - D_n) \; - D_{n-1} K_d$	+	$t.\, D_{n-1}.\, K_d.$
∴ FCFF	=	CFE	+ 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 ($FCFF = V_g . WACC_g$, $CFE = E . K_g$, $CFD = D.\, K_d$), $TS = V_{TS}\ \Psi$):

$$V_{g\,n-1} . WACC_{gn} = E_{n-1} . K_{gn} + D_{n-1} . K_{dn} - D_{n-1} . K_{dn}\, t$$

$$WACC_{gn} = \frac{E_{n-1} . K_{gn}}{V_{g\,n-1}} + \frac{D_{n-1} . K_{dn}\ (1 - t)}{V_{g\,n-1}}$$

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

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

And $FCFF = V_u K_u = K_u . (V_g - V_{TS})$ (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):

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

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

Since $FCFF = CFE + CFD - TS$

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

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):

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

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

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

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

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

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

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

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

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:

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

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

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

$$ß_g = ß_u + (ß_u - ß_d)\left[\frac{D}{E}\right] - (ß_u - ß_{TS})\left[\frac{V_{TS}}{E}\right]$$ A1.5

- 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:

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

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

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

$$WACC = K_u\left(1 - t . L\right)$$

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

Beta Relevering

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 $ß_d = 0$ ('Practioners' formula')

$$ß_g = ß_u \left(1 + \frac{D}{E}\right) \qquad \text{A1.8}$$

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 $ß_{TS} = ß_D$. The equity beta formula (A1.5) becomes:

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

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

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

If it is assumed $ß_d = 0$, 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)):

$$ß_g = ß_u \left(1 + \frac{D}{E}(1-t)\right) \qquad \text{D is constant} \qquad \text{A1.13}$$

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).

Based on the WACC example in the main text, there are a six different results depending on whether (1) the beta re-levering includes or excludes the adjustment (1 – t) and (2) the beta re-levering includes or excludes the debt beta, and for both cases whether the WACC is on a post-tax or pre-tax basis (there are four different beta and cost of equity results):

Cost of debt				
Risk free rate			R_f	4.84%
Debt Risk Premium			DRP	3.00%
Pre-tax cost of debt		= 4.84% + 3.00%	K_d	7.84%
Tax rate			t	25.00%
Post-tax cost of debt		= 7.84% x (1 - 25.00%)	K_{dt}	5.88%
Debt ratio			L	20.00%
Cost of equity				
Risk free rate			Rf	4.84%
Equity risk premium			ERP	4.50%
Ungeared, assets beta			βa	1.1000
Implied debt beta	= ERP / ERP		βd	0.0000
Ungeared cost equity	$K_u = R_f + \beta_a$ ERP	= 4.84% + 1.10 x 4.50%	K_u	9.79%
Tax adjustment	1 - t		1 - t	0.00%
Geared equity beta	$\beta_e = \beta_a + (\beta_a - \beta_d)$ D / E (1-t)	= 1.10 + (1.10 - 0.00) x 20% / 80%)	βe	1.3750
Geared Cost of Equity	Kg= R_f + βe ERP	= 4.84% + 1.38 x 4.50%	K_g	11.03%
Equity ratio			1 - L	80.00%
Weighted rate				*8.824%*
Debt = Leverage % x Enteprise Value				
WACC (post-tax)				10.00%
WACC (pre-tax) (i.e. assume t = 0)				10.39%

Other possibilities include (equation references shown):

Beta Estimates			Note	
With tax:				
Debt = Leverage % x Enteprise Value	ßd = 0	Ignore (1 - t)	1	1.375
Debt = Leverage % x Enteprise Value	ßd > 0	Ignore (1 - t)	2	1.208
Debt = assumed amount	ßd = 0	Include (1 - t)	3	1.306
Debt = assumed amount	ßd > 0	Include(1 - t)	4	1.181
Without tax:				
Debt = Leverage % x Enteprise Value	ßd = 0	Ignore (1 - t)		1.375
Debt = Leverage % x Enteprise Value	ßd > 0	Ignore (1 - t)		1.208
Debt = assumed amount	ßd = 0	Ignore (1 - t)		1.375
Debt = assumed amount	ßd > 0	Ignore (1 - t)		1.208
Debt beta (= debt risk premium / equity risk premium)				0.67

1	ße = ßu + ßu (D/E)	A1.8	= 1.10 + 1.10 x (20% / 80%)
2	ße = ßu + (ßu - ßd) (D/E)		= 1.10 + (1.10 - 0.67) (20% / 80%)
3	ße = ßu + ßu (D/E) (1 - t)	A1.13	= 1.10 + 1.10 x (20% / 80%)(1 - 25%)
4	ße = ßu + (ßu - ßd) (D/E)(1 - t)		= 1.10 + (1.10 - 0.67) (20% / 80%)(1 - 25%)

Geared Cost of Equity

With tax:

Debt = Leverage % x Enteprise Value	ßd = 0	Ignore (1 - t)		11.03 %
Debt = Leverage % x Enteprise Value	ßd > 0	Ignore (1 - t)	5	10.28 %
Debt = assumed amount	ßd = 0	Include (1 - t)		10.72 %
Debt = assumed amount	ßd > 0	Include(1 - t)		10.16 %
Without tax:				
Debt = Leverage % x Enteprise Value	ßd = 0	Ignore (1 - t)		11.03 %
Debt = Leverage % x Enteprise Value	ßd > 0	Ignore (1 - t)		10.28 %
Debt = assumed amount	ßd = 0	Ignore (1 - t)		11.03 %
Debt = assumed amount	ßd > 0	Ignore (1 - t)		10.28 %

5 Kg A1.6 $= K_u - (K_u - K_d)\ D/E$ 10.28%

WACC

			Note	
With tax:				
Debt = Leverage % x Enteprise Value	ßd = 0	Ignore (1 - t) in β	6	10.00 %
Debt = Leverage % x Enteprise Value	ßd > 0	Ignore (1 - t) in β	7	9.40 %
Debt = assumed amount	ßd = 0	Include (1 - t) in β	8	9.75 %
Debt = assumed amount	ßd > 0	Include (1 - t) in β		9.30 %
Without tax:				
Debt = Leverage % x Enteprise Value	ßd = 0	Ignore (1 - t) in β and Kd	9	10.39 %
Debt = Leverage % x Enteprise Value	ßd > 0	Ignore (1 - t) in β and Kd	$= K_u$	9.79 %
Debt = assumed amount	ßd = 0	Ignore (1 - t) in β and Kd		10.39 %
Debt = assumed amount	ßd > 0	Ignore (1 - t) in β and Kd	$= K_u$	9.79 %

6 Post tax WACC $= K_u - R_f\, t.L + DRP\,(1 - t)\,L$ 10.00%

= 9.79% - 4.84% x 25% x 20% + 3.00% (1 - 25%) x 20.00% =

7 Post tax $WACC_{HP}$ A1.7 $= K_u - K_d.t.L$ 9.40%

= 9.79% - 7.84% x 25% x 20%

8 Post tax WACC $= K_u - K_u\, t.L + DRP\,(1 - t)\,L$ 9.75%

= 9.79% - 9.79% x 25% x 20% + 3.00% (1 - 25%) x 20.00% =

\+

$= \beta a\ ERP \times\ t.L$ 0.25%

= (1.1000 x 4.50%) x (1 - 25.0% x 20.0%) = =

WACC note 5 10.00%

9 Pre-tax WACC $= K_u + DRP\ L$ Used in Capital Cash Flows 10.39%

$= K_g.\,(1 - L) + K_d\, L$ 10.39%

Foreign Risk

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 DCF Principles

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