Pre and Post Tax Discount Rates and Cash Flows – A Technical Note

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When discounting pre tax cash flows it is often assumed that discounting pre tax cash flows at pre tax discount rates will give the same answer as if after tax cash flows and after tax discount rates were used. However, this is not the case and material errors can arise, unless both the cash flows and the discount rate are after-tax. Drawing upon a series of analytical examples, common conceptual flaws in discount rate and cashflow stream selection are highlighted. In light of these, it is argued that discounted cashflow analysis should be configured on the basis of after tax cashflows discounted with after tax discount rates.

1. Introduction

This article examines the issues associated with the use of pre and post tax discount rates in the conduct of analytical procedures in which cashflow discounting is necessary. In particular, the paper addresses the matter of problems which arise when inappropriate assumptions are made in relation to the estimation and application of pre tax discount rates.

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For the reasons outlined below, the preferred (and technically correct) method to discount cash flows is to express cash flows forecasts on an after tax basis, and to discount those cash flows using an after tax discount rate.

The article is structured as follows. Section 2 discusses issues relating to the need for consistency in the selection of discount rates to be applied to streams of cashflows. Section 3 discusses problems associated with the calculation of pre tax cashflows, while Section 4 highlights the problems inherent with the estimation of pre tax discount rates. Section six includes a series of analytical examples which clearly demonstrate the errors which can arise in valuations where the conceptual errors outlined in sections 2, 3 and 4 are not avoided. Some brief conclusions are offered in Section 6.

2. Consistency between cash flows and discount rate

To ensure consistency between the cash flows and the discount rate used, the cash flows and the discount rate should be expressed on a consistent basis. That is, after tax cash flows must be discounted at after tax discount rates. There are a number of fundamental reasons why this is so:

a.   rates of return on equity investments are only observable on an after company tax basis

b.   the capital asset pricing model (CAPM), from which discount rates are derived, is based on stock market return of shares, which returns are calculated after company tax, and

c.   as a matter of logic, like should be compared with like.

3. Calculating pre-tax cash flows

Implicit in the approach based on discounting pre-tax cash flow at pre-tax discount rate is the proposition that pre-tax cash flow can be obtained by grossing up post-tax cash flow at a rate equal to one less the marginal corporate tax rate, or conversely, post-tax cash flow is simply pre-tax cash flow multiplied by a factor equal to one less the marginal corporate tax rate.

This proposition is not always correct because it ignores the divergence between pre-tax income, which is used for tax assessment, and pre-tax cash flow. This divergence arises:

a.   because cash flows may differ significantly from profits due, for example, to working capital movements and the timing of capital equipment purchases, etc

b.   due to the difference between the timing of revenue and expense recognition for accounting purposes and the time when cash receipts and cash outgoings actually occur.

The accrual accounting model, the basis of accounting adopted in most businesses (other than small, cash-based businesses), focuses on the acquisition and use of economic resources in operations, not on their associated cash flows. For example, although council rates may be paid once a year, under accrual accounting one twelfth of the amount is expensed each month.

The divergence between pre-tax income and cash flows and its consequence on the pre-tax approach is exacerbated by a number of issues, including that:

a.   depreciation and capital equipment purchases and disposals are not coterminous; and

b.   the existence of permanent tax differences (PMT) and temporary timing differences (TTD).

The flaw of the pre-tax approach is best understood if debt is assumed to be zero, and PMT and TTD are put aside, for the sake of simplicity and illustration. In which case, the difference between pre-tax income and pre-tax cash flow is mainly attributable to:

a.   movements in working capital

b.   tax depreciation

c.   tax losses (if any)

d.   capital expenditure (and capital receipts).

By definition, post-tax cash flow is equal to pre-tax cash flow less tax. Pre-tax income is not always equal to pre-tax cash flow due to the foregoing factors. Therefore, tax payable, which is determined by multiplying the marginal corporate tax rate (e.g. 36 percent) by pre-tax income, is generally different from pre-tax cash flow multiplied by the marginal corporate tax rate.

It mathematically follows that multiplying pre-tax cash flow by a factor equal to one less the marginal corporate tax rate is generally not equal to post-tax cash flow. This proposition can be further reinforced by deriving a mathematical relationship between pre-tax cash flow and post-tax cash flow. The derivation is presented below.

In this derivation, the following notations are used:

CFAT	Post-tax cash flow
CFBT	Pre-tax cash flow
OC	Operating cost (excluding depreciation / amortisation)
OR	Operating revenue
T	Corporate tax rate
TD	Tax depreciation
TL	Tax losses
TP	Tax paid
ΔWC	Changes in working capital
Capex	Capital expenditure

CFBT	=	OR – OC + ΔWC – Capex	(1)
CFAT	=	CFBT – TP	(2)
TP	=	(OR – OC – TD – TL) x T	(3)

Substituting (3) into (2) yields

CFAT	=	CFBT – (OR – OC – TD – TL) x T	(4)

Rearranging (1) gives

(OR – OC)	=	CFBT – ΔWC + capex	(5)

Substituting (5) into (4) yields

CFAT	=	CFBT – (CFBT – ΔWC +Capex – TD – TL) x T	(6)
CFAT	=	CFBT – CFBT x T + (ΔWC –Capex + TD + TL) x T	

Collecting terms and rearranging gives

CFAT	=	CFBT (1 – T) + (ΔWC –Capex + TD + TL) x T	(7)

Equation (7) sets out a theoretical relationship between pre-tax cash flows (CFBT) and post- tax cash flows (CFAT). It is clear that CFAT is equal to CFBT (1-T) only if the second term of Equation (7), i.e. (ΔWC – Capex + TD + TL) x T, is zero. This is generally not the case because there is no reliable relationship between working capital, capital expenditure, tax depreciation and tax losses.

A limited circumstance under which the second term of Equation (7) might be zero is mature profitable businesses where there is likely to be no change in working capital requirement and depreciation is likely to be equal to capital expenditure. This is consistent with the examples of no growth perpetual cash flow scenarios discussed below.

The following numerical example shows that post-tax cash flow is not equal to pre-tax cash flow multiplied by a factor equal to one less the marginal corporate tax rate:

Pre-tax calculation		Tax		Post-tax calculation	
Revenue	100,000	Revenue	100,000	Pre-tax cash flow	20,000
Less cost	50,000	Less cost	50,000	Less tax paid	10,500
Less change in WC	10,000	Less tax depreciation	15,000	Post-tax cash flow	9,500
Less Capex	20,000	Less tax losses	Nil		
Pre-tax cash flow	20,000	Pre-tax income	35,000		
		Tax rate	30%		
		Tax paid	10,500		

Pre-tax cash flow x (1 – 0.30) = $14,000* ≠ $9,500 = post-tax cash flow

* Being $20,000 x 0.7

4. Calculating pre tax discount rates

Pre tax discount rates are often (but incorrectly) calculated by grossing up the after tax discount rate by one less the marginal corporate tax rate. On this basis, an after tax discount rate of 14% per annum, assuming a tax rate of 30%, equals a pre tax discount rate of 20% per annum.

However, there are various difficulties in undertaking a pre tax discounted cash flow (DCF) analysis. In summary, the grossing up formula used to derive pre tax discount rates is an over-simplification and only holds under limited circumstances.

Firstly, there is no practical reliable method to calculate a pre tax discount rate, and they can not simply be calculated by grossing up the after tax discount rate. Secondly, investors are interested in after tax rather than pre tax returns. Furthermore, the variables used to calculate the cost of equity (including beta and the market risk premium) are based on movements in company stock prices which are based on companies after tax (not pre tax) results.

The CAPM variables of the cost of equity and the pricing of company shares are therefore measured on an after tax basis. Thus it is simply not possible to empirically verify pre tax rates of return for equities and similar assets.

5. Analytical Examples

The following examples show that there are fundamental errors when calculating the present value of cash flows using pre-tax discount rates

In particular, the examples show that adjusting an after tax discount rate to calculate a pre-tax discount rate using the above gross up formula will only lead to the same values being determined on a before and after tax basis when the cash flows are in perpetuity with no growth.

While grossing up pre-tax cash flow to obtain post-tax cash flow may, as shown above, be appropriate only in the case of cash flow perpetuities with no or constant growth, in order to ease the exposition of the inappropriateness of using grossed-up pre-tax discount rate alone, in all the examples it is assumed, for the purpose of illustration that post-tax cash flow is equal to pre-tax cash flow multiplied by a factor equal to one less the marginal corporate tax rate.

All examples also assume an after tax discount rate of 14% per annum, a tax rate of 30% and a pre tax discount rate of 20.0% per annum (being 14% divided by 1 less 0.30).

Where a perpetuity calculation is performed for a mature series of cash flows, i.e. no growth, the present value under pre and after-tax calculations is equivalent, as demonstrated below:

Example 1 - Cash flows in Perpetuity – No Growth

Pre tax calculations		After tax calculations	
Pre tax cash flow	$20,000	After tax cash flow	$14,000
Pre tax discount rate	20.0%	After tax discount rate	14%
Present value	$100,000[1]	Present value	$100,000[2]

Note:
1 $20,000/20% = $100,000
2 $14,000/14% = $100,000

The next calculation assumes cash flows grow in perpetuity at 5% per annum:

Example 2 - Cash flows in perpetuity – 5% Growth

Pre tax calculations		After tax calculations	
Pre tax cash flow	$20,000	After tax cash flow	$14,800
Growth rate (pa)	5%[1]	Growth rate (pa)	5%[1]
Pre tax discount rate	20%	After tax discount rate	14%
Present value	$140,000[2]	Present value	$163,333[3]

Note:
1 Strictly speaking, the same growth rate can be applied to pre-tax and post-tax cash flows only if (i) post-tax cash flow is equal to pre-tax cash flow multiplied by one less the marginal corporate tax rate; and (ii) the marginal corporate tax rate is constant.
2 $20,000 x 1.05/(20% - 5%) = $140,000.
3 $14,000 x 1.05/(14% - 5%) = $163,333.

As shown above the present values differ by a material margin depending on whether the calculation is undertaken on a pre or post tax basis. It is also possible to demonstrate similar phenomena focusing only on single period cashflows. The following table calculates the present value of a cash flow in one year's time, calculated on both a pre and post tax basis:

Example 3 – Single Period Cashflows

Pre tax calculations		After tax calculations	
Pre tax cash flow	$20,000	After tax cash flow	$14,000
Pre tax discount rate	20%	After tax discount rate	14%
Present value	$16,667[1]	Present value	$12,281[2]

Note:
1 $20,000/1.2 = $16,667.
2 $14,000/1.14=$12,281.

Again, it is clear from this example that grossing up the discount rate by 1 less the tax rate to discount pre tax cash flows does not result in a similar present value calculated using after tax cash flows and discount rates.

Furthermore, it is illogical that an investor would pay more than the after tax cash flow return. Consequently, the pre tax calculation must be fundamentally flawed given that the present value of the pre tax cash flow (i.e. $16,667) exceeds the after tax value of the cash flow even if it was received immediately (i.e. $14,000).

A similar pattern may be observed when contemplating multi period cashflows. The following example shows a five year cash flow, discounted using pre tax cash flows and discounts rates, and after tax cash flows and discount rates.

Example 4 – Multi Period Cashflows

Pre tax calculations:

Year	Pre tax Cash flow $	PV factor at 20% pa	Present value $
1	20,000	1.20	16,667
2	25,000	1.44	17,361
3	30,000	1.728	17,361
4	35,000	2.0736	16,879
5	40,000	2.4883	16,075
Total value			84,343

Post tax calculations:

Year	Post tax Cash flow $	PV factor at 12.8% pa	Present value $
1	14,000	1.114	12,281
2	17,500	1.2996	13,466
3	21,500	1.4815	14,174
4	24,500	1.6890	14,506
5	28,000	1.9254	14,542
Total value			68,969

Again, the pre and post tax present values are materially different, if the naïve grossed up pre-tax discount rate is applied.

6. Conclusion

This article has argued that there are fundamental errors in calculating the present value of cash flows using pre-tax cash flows and discount rates. There are only a few special cases where this approach may give the same answer as discounting after tax cash flows at after tax discount rate, for instance the case of cash flows in perpetuity with no growth. A series of analytical examples set out in section 5 clearly demonstrate this. Consequently, it is important that after tax cash flows and after tax discount rates are applied in DCF valuations. JARAF

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