Valuation errors with inconsistent gearing assumptions

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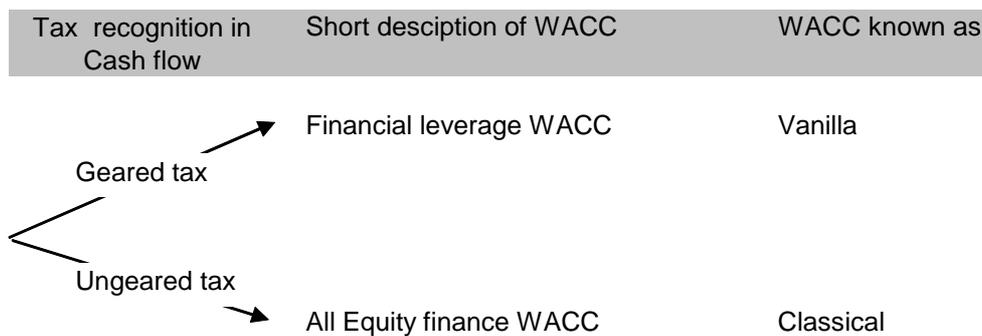Ph (613) 9654 6277
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BOOK versus MARKET GEARING ERRORS

LOGIC

We should always use the market gearing factor in our valuations. Book gearing is only correct for the one special case of an NPV = 0 project. For all other projects, we must use market gearing instead of book gearing. This is not usually a problem as many valuers use the "all equity" version for valuing an asset. It does, however, become a major source of error when the valuation model includes debt financing. In that case, we have to be very careful to not erroneously "create or destroy" value by having a different gearing in the WACC versus the amount of debt in the project.

The classical tax system only required we know two WACCs. These depended on whether the tax amount recognised in the cash flow was the actual tax after recognising the effect of tax shields ("geared tax") or whether the tax was based on no financing shields (an All Equity tax or an "ungeared tax"). The following diagram depicts this choice.

Figure 1: Classical WACCs

Tax recognition in Cash flow	Short desciption of WACC	WACC known as
	Financial leverage WACC	Vanilla
Geared tax		
Ungeared tax		
	All Equity finance WACC	Classical

The imputation tax system has complicated this process but fundamentally we still face the same decisions: do we recognise finance in the cash flow and/or credits or do we ignore the effect of finance? We will not pursue this issue here (we have done so elsewhere in our paper WACC_description.doc). The two valuation approaches are embodied in the following two formulae.

Valuation approaches using WACC

Geared cash flow		**Vanilla WACC**
Cash Flow	$X_O - T(X_O - X_D)$	Tax shield in the cash flow
WACC	$(1-g)R_E + gR_D$	

Un-geared cash flow		**Classical WACC**
Cash Flow	$X_O - TX_O$	All Equity (i.e. ungeared) cash flow
WACC	$(1-g)R_E + g(1-T)R_D$	

The imputation case can be included in this framework if we substitute the effective tax rate after imputation in place of the statutory tax rate.

As usual, the notation we use is

Notation	Item
Xo	EBIT(FCF version where capex for replenishment or the annualized equivalent thereof exactly offsets the depreciation deduction)
Xd	Interest payment on debt
Xo-Xd	Profit before tax
T	Statutory Company Tax Rate
Xo-Xg	Net operating profit after tax (nopat)
Capex	Capital expensed (and book value)
Allocation	
Xe	Cash flow to shareholders
Xd	Cash flow to debt holders
Xg	Cash flow to Tax Office as effective company tax
Xe+Xd	total excluding Tax (actual after tax cash flow to claimants)
Rates	
Re	Requited return on equity
Rd	Required return on debt
Ra	Required return on the asset (the WACC)
g	Gearing (D/V)
Valuation	
E	Market value of Equity
D	Market value of Debt
V	Total Enterprise value (at market)

The issue being addressed here is the gearing level, g. The all-equity version of the valuation formula is

$$NPV = -capex + \sum \frac{X_{O,t}(1-T)}{\left((1-g)R_e + g(1-T)R_d\right)^t}$$

which means that the only place financing occurs is in the WACC as the explicit gearing, g, and implicitly in the costs of capital R_e and R_d.

Once we have valued the asset, the allocation of debt (and implicitly equity) according to market values is

$$\$Debt = g \cdot (NPV + capex).$$

In contrast, the allocation of debt and equity capital according to book values is

$$\$Debt = g \cdot capex.$$

When we perform a valuation using the geared cash flow approach, the geared or vanilla WACC version of the formula is

$$NPV = -capex + \sum \frac{X_{O,t} - T(X_{o,t} - X_{d,t})}{\left((1-g)R_e + gR_d\right)^t}$$

$$where \quad X_d = R_d \times (NPV + capex)$$

It looks like we have to know the answer before we begin the valuation!

A common error is to use book gearing in the vanilla WACC formula. In the case of a positive NPV project (NPV > 0 hence capex < capex +NPV), this will *understate* the amount of debt capital on a market basis and so understate the amount of interest tax shield. The value obtained in this way will be wrong but conservative.

In the case of a negative NPV project, the error will *overstate* the amount of debt on a market basis and so overstate the interest tax shield. The correct NPV is even more negative than the NPV obtained using book gearing.

In one sense, book gearing gives the right signal about accepting or rejecting a project. We might be comfortable with using book gearing as a consequence. However, the situations where analysts use financial gearing are often ones where the financing structure is important and so financial measures such as debt interest cover ratios are important. These are precisely the ratios erroneously calculated using book gearing.

The understated debt capital understates the interest payment which in turn overstates the times interest cover: the ratio of the after-tax free cash flow to the interest payment.

If the financial structure is being juggled in order to meet debt covenants which include things like interest rate cover, then these will be wrong and the consequential financial penalty for any breach could be severe.

The apparent problem of seemingly needing to know the answer before starting, in the case of the vanilla WACC valuation, can be overcome by the simple device of numerically forcing the project to have either i) actual gearing matching assumed gearing keeping the amount of debt fixed, or ii) actual debt amount matching assumed debt amount keeping the gearing level fixed. These are *not* the same and they lead to different results. Of the two, the second is preferable from a valuation standpoint. It leads to defendable assumptions whereas the former can lead to inconsistency between the costs of capital and the gearing inputs.

Whilst all the calculations herein are for the classical tax system, everything carries over to the imputation tax system if we just change the statutory rate (currently 30%) for the effective rate after imputation (19.5% on average across Australia).

Numerical examples follow for both *All Equity* and *Vanilla* cases.

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Numerical Examples

a. Comparing All Equity with Vanilla WACC valuations.

Data item	Amount	Valuation item	Amount
WACC_allEquity	6.10%	"All Equity Financing" valuation	
Xo	$100	Pre-tax operating cash	$100.00
T	30%	Tax	$30.00
gamma	0	A-tax Operating Cash	$70.00
Re	10%	WACC	6.10%
Rd	5%	pv Operating Cash	$1,147.54
Capex	$1,000	Capex	-$1,000.00
Target Gearing	60%	*NPV*	**$147.54**

Market debt	$688.52
Market equity	$459.02
Total	$1,147.54

Data item	Amount	Valuation item	Amount	
WACC_vanilla	7.00%	Vanilla WACC valuation		
		Pre-tax operating cash	$100.00	
		Debt payment	$30.00	
Book gearing	60.00%	Taxable income	$70.00	
Actual gearing	53.16%	Tax	$21.00	
		After-tax operating cash	$79.00	
Book Debt	$600.00	WACC	7.00%	
Book equity	$400.00	pv Operating Cash	$1,128.57	
Total	$1,000.00	Capex	-$1,000.00	
		NPV	**$128.57**	Too low
		Interest Cover	**2.63**	

Data item	Amount	Valuation item	Amount	
WACC_vanilla	7.00%	Vanilla WACC valuation		
		Pre-tax operating cash	$100.00	
		Debt payment	$34.43	
		Taxable income	$65.57	
Book gearing	60.0%	Tax	$19.67	
Actual gearing	60.0%	After-tax operating cash	$80.33	
		WACC	7.00%	
Market debt	$688.52	pv Operating Cash	$1,147.54	
Market equity	$459.02	Capex	-$1,000.00	
Total	$1,147.54	*NPV*	**$147.54**	Correct
		Interest Cover	**2.33**	value

In this perpetuity example, we verify that the value of the asset, using either the All Equity valuation approach or the Financial Gearing approach via the vanilla WACC, both give identical valuations *provided* the amount of debt is based on the market value (ie the capex plus any value created via the NPV of the project). The book gearing approach is in error because the amount of debt used in that version of the project is actually less than the assumed amount via the WACC (53% actual against assumed 60%). This understates the amount of debt interest tax shield and so understates the after-tax cash flow. This leads to a lower value and a higher debt interest cover.

One way of overcoming this problem is to use a numerical goal seeking process to force consistency between actual values and assumed values. The first version of this approach forces a consistency between the actual gearing and assumed gearing, holding the debt amount as the given book amount –based on the asset book value (typically the capex) and the target gearing.

b. Forcing the gearing to be consistent within the Vanilla WACC valuation

Data item	Amount	Valuation item	Amount
Start			
WACC_vanilla	7.00%	Vanilla WACC valuation	
		Pre-tax operating cash	$100.00
Book gearing	60.00%	Debt payment	$30.00
Actual gearing	53.16%	Taxable income	$70.00
Book Debt	$600.00	Tax	$21.00
Book equity	$400.00	After-tax operating cash	$79.00
Total	$1,000.00	WACC	7.00%
		pv Operating Cash	$1,128.57
Goal Seek - %Gearing		Capex	-$1,000.00
Assumed gearing	60.00%	*NPV*	**$128.57**
Discrepancy	-6.84%	*Interest Cover*	**2.63**

Data item	Amount	Valuation item	Amount
End			
WACC_vanilla	7.25%	Vanilla WACC valuation	
		Pre-tax operating cash	$100.00
Book gearing	60.00%	Debt payment	$30.00
Actual gearing	55.05%	Taxable income	$70.00
Book Debt	$600.00	Tax	$21.00
Book equity	$400.00	After-tax operating cash	$79.00
Total	$1,000.00	WACC	7.25%
		pv Operating Cash	$1,090.00
Goal Seek - %Gearing		Capex	-$1,000.00
Assumed gearing	55.05%	*NPV*	**$90.00**
Discrepancy	0.00%	*Interest Cover*	**2.63**

We start (top panel) with an assumed gearing (book gearing is a good start) in the valuation model and calculate the actual gearing resulting from that model. In this case the book gearing of 60% leads to an actual gearing of 53.16% (calculated as $600/$1,128.57). This is a discrepancy of 6.84%. We use Goal Seek to force the discrepancy to zero by changing the assumed gearing. The result (bottom panel) finds that a gearing of 55.05% is consistent with the actual gearing resulting from the model.

Whilst this is easy to do numerically, it is not the wise way to approach the problem. The costs of capital would have been measured in the market with a certain gearing. In addition, the gearing is often a target gearing which is applicable to the asset and should be a given, not a variable. Note also the valuation is **wrong** both in the before and after Goal Seek operations. The model value has moved in the wrong direction – it has decreased.

The second and preferable approach to the problem forces a consistency between the actual amount of debt and the assumed amount of debt, holding the gearing constant as the target gearing. This is consistent with the All Equity version of the valuation in which we do not have to nominate a debt

amount before calculating the values but just need to multiply the asset value by the target gearing ex-post the valuation calculation. The nominated approach forces the ex-ante and ex-post debt amounts to be equal while holding the gearing at the assumed target gearing level so this approach will be consistent with the All Equity valuation approach.

c. Forcing the debt amount to be consistent within the Vanilla WACC valuation

Data item	Amount		Valuation item	Amount

Start	
WACC_vanilla	7.00%
Book gearing	60.00%
Actual gearing	53.16%
Book Debt	$600.00
Market Equity	$528.57
Total	$1,128.57

Vanilla WACC valuation	
Pre-tax operating cash	$100.00
Debt payment	$30.00
Taxable income	$70.00
Tax	$21.00
After-tax operating cash	$79.00
WACC	7.00%
pv Operating Cash	$1,128.57
Capex	-$1,000.00
NPV	**$128.57**
Interest Cover	**2.63**

Goal Seek - $Debt	
Assumed $Debt	$600.00
Discrepancy	$77.14

End	
WACC_vanilla	7.00%
Book gearing	60.00%
Actual gearing	60.00%
Book Debt	$688.52
Market Equity	$459.02
Total	$1,147.54

Vanilla WACC valuation	
Pre-tax operating cash	$100.00
Debt payment	$34.43
Taxable income	$65.57
Tax	$19.67
After-tax operating cash	$80.33
WACC	7.00%
pv Operating Cash	$1,147.54
Capex	-$1,000.00
NPV	**$147.54**
Interest Cover	**2.33**

Goal Seek - $Debt	
Assumed $Debt	$688.52
Discrepancy	$0.00

We start (top panel) with an assumed amount of debt (book debt is a good first guess) and then value the asset using the vanilla WACC approach with a given target gearing. Upon calculating the asset value, we then calculate the resulting debt amount as the asset value multiplied by the target gearing (60% of $1,128.57 in the above example). We compare this resulting debt amount to the assumed debt amount and call the difference a discrepancy ($77.14 above). We use Goal Seek to set the discrepancy to zero by changing the assumed debt amount. The result is seen in the bottom panel.

This approach keeps the cost of capital as a given which is desirable in that the cost of debt and cost of equity will only be applicable for the gearing levels in which they are observed or calculated. We are avoiding any implicit problems such as "creating or destroying" value by changing the gearing with fixed costs of capital (hence altering the WACC) and pretending that this re-gearing alters asset values.

Summary

Gearing levels are always taken as market gearing inside WACC valuations. This is easily done with an all-equity valuation but more difficult with a vanilla WACC valuation. The way around this problem is to force the debt level and associated interest payments and tax shields to be consistent before and after the valuation calculation. This is trivially done via a spreadsheet using a built-in goal seeking utility.

It should be noted that there are other problems with gearing not addressed in this Note. Not the least is the case of projects valued with project finance. In these cases, the debt repayments are typically concentrated in the early stages of the project and the equity extraction is allocated to the back or later stages of the project. The gearing of such a project undergoes large swings through time. Such projects are best valued using the sum of the value of the debt and the value of the equity. This will allow for the timing variations alluded to above. A WACC valuation is a combined debt and equity valuation done in one hit along with a raft of assumptions such as a given gearing. If these assumptions are substantially violated then we could not expect the WACC valuation model to deliver reasonable results.

Some academics have proposed valuation models that allow for changing gearing levels but we rarely see practitioners using them so a modified approach of commonly used methods is our preference.

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