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WACC: DEFINITION, MISCONCEPTIONS AND ERRORS

Pablo Fernández[1]

Abstract

The WACC is just the rate at which the Free Cash Flows must be discounted to obtain the same result as in the valuation using Equity Cash Flows discounted at the required return to equity (Ke).

The WACC is neither a cost nor a required return: it is a weighted average of a cost and a required return. To refer to the WACC as the "cost of capital" can be misleading because it is not a cost.

The paper presents 7 errors caused by not remembering the definition of WACC and shows the relationship between the WACC and the value of the tax shields (VTS).

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WACC: DEFINITION, MISCONCEPTIONS AND ERRORS

1. Definition of WACC

There are two basic methods for valuing companies by discounted cash flows:

Method 1. Using the expected equity cash flow (ECF) and the required return to equity (Ke).

Equation [1] indicates that the value of the equity (E) is the present value of the expected equity cash flows (ECF) discounted at the required return to equity (Ke).

[1] $E_0 = PV_0 [Ke_t; ECF_t]$

Equation [2] indicates that the value of the debt (D) is the present value of the expected debt cash flows (CFd) discounted at the required return to debt (Kd).

[2] $D_0 = PV_0 [Kd_t; CFd_t]$

Method 2. Using the free cash flow and the WACC (weighted average cost of capital).

The **free cash flow (FCF)** is the hypothetical equity cash flow when the company has no debt. The expression that relates the FCF (Free Cash Flow) with the ECF is:

[3] $ECF_t = FCF_t + \Delta D_t - I_t (1 - T)$

ΔD_t is the increase in debt, and I_t is the interest paid by the company. $CFd_t = I_t - \Delta D_t$

Equation [4] indicates that the value of the debt (D) plus that of the shareholders' equity (E) is the present value of the expected free cash flows (FCF) that the company will generate, discounted at the weighted average cost of capital (WACC):

[4] $E_0 + D_0 = PV_0 [WACC_t ; FCF_t]$

The WACC is the rate at which the FCF must be discounted so that equation [4] gives the same result as that given by the sum of [1] and [2]. By doing so, the expression of the WACC (Weighted Average Cost of Capital) is given by [5] (see Exhibit 1):

[5] $WACC_t = [E_{t-1}\, Ke_t + D_{t-1}\, Kd_t\, (1-T)] / [E_{t-1} + D_{t-1}]$

T is the effective tax rate applied to interest in equation [3].

$E_{t-1} + D_{t-1}$ are **not** market values nor book values: in actual fact, E_{t-1} and D_{t-1} are the values obtained when the valuation is performed using formulae [1], [2] or [4].[1]

D = Value of debt E = Value of equity Ebv = Book value of equity ECF = Equity cash flow FCF = Free cash flow N = Book value of the debt	I = Interest paid PV = Present value r = Cost of debt R_F = Risk-free rate g = Growth rate	WACC = Weighted average cost of capital Ke = Required return to levered equity Kd = Required return to debt VTS = Value of the tax shield P_M = Required market risk premium Vu = Value of equity in the unlevered company Ku = required return to unlevered equity

The WACC is a weighted average of **two very different magnitudes**:

- a cost: the cost of debt, and
- a required return: the required return to equity (Ke). Although Ke is called many times cost of equity, there is a big difference between a cost and a required return.

Thus, the WACC is neither a cost nor a required return, but a weighted average of a cost and a required return. To refer to WACC as "cost of capital" can be misleading because it is not a cost.

2. Some Errors Due to not Remembering the Definition of WACC

2.1. Using a wrong tax rate T to calculate the WACC. The correct tax rate (T) that should be used every year is the T that relates the ECF and the FCF in equation [3], as shown in Exhibit 1.

2.2. Calculating the WACC using book values of debt and equity. The appropriate values of debt and equity are those resulting from the valuation (E and D).

2.3. Calculating the WACC assuming a capital structure that is neither the current one nor the forecast: the debt to equity ratio used to calculate the WACC is different from the debt to equity ratio resulting from the valuation. This error appears in a valuation by an investment bank. Current debt was 125, the enterprise value was 2180, and the debt to equity ratio used to calculate the WACC was 50%.

This is wrong because the outstanding and forecast debt should be used to calculate the WACC. The equity value of a firm is given by the difference between the firm value and the outstanding debt, where the firm value is calculated using the WACC, and the WACC is

[1] Consequently, the valuation is an iterative process: the free cash flows are discounted at the WACC to calculate the company's value (D+E) but, in order to obtain the WACC, we need to know the company's value (D+E).

calculated using the outstanding (market value of) debt. Alternatively, if the firm starts with its current debt and moves towards another financial structure, then a variable WACC (different for each year) should be used, and the current debt should be deducted from the enterprise value.

2.4. The Enterprise Value (E + D) does not satisfy the time consistency formulae. Fernández (2002, page 401) shows that the relationship between the enterprise values of different years is:
$E_t+D_t = (E_{t-1}+D_{t-1})\ (1+WACC_t) - FCF_t$.
And the relationship between the equity values of different years is:
$E_t = E_{t-1}\ (1+Ke_t) - ECF_t$.

2.5. Considering that WACC / (1-T) is a reasonable return for the company's stakeholders. Some countries assume that a reasonable return on a telephone company's assets is WACC / (1-T). Obviously, this is not correct. And the error is even greater if the return is multiplied by book values.

2.6. Using the wrong formula for the WACC when the value of debt (D) is not equal to its book value (N). Fernández (2002, page 416) shows that the expression for the WACC when the value of debt (D) is not equal to its book value (N) is WACC = (E Ke + D Kd – N r T) / (E + D). Kd is the required return to debt and r is the cost of debt.

2.7. Another example is the valuation of a broadcasting company, performed by an investment bank (see Table 1), which discounted the expected FCFs at the WACC (10%) and assumed a constant growth of 2% after 2008. The valuation provided lines 1 to 7, and stated that the WACC was calculated assuming a constant Ke of 13.3% (line 5) and a constant Kd of 9% (line 6). The WACC was calculated using market values (the equity market value on the valuation date was 1,490 million and the debt value 1,184 million) and the statutory corporate tax rate of 35%.

The valuation also included the equity value at the end of 2002 (3,033; line 8) and the debt value at the end of 2002 (1,184; line 10). Table 2 provides the main results of the valuation according to the investment bank.

Table 1

Valuation of a broadcasting company performed by an investment bank

		2002	2003	2004	2005	2006	2007	2008
1	FCF		*-290*	*-102*	*250*	*354*	*459*	*496*
2	ECF		*0*	*0*	*0*	*0*	*34*	*35*
3	Interest expenses		*107*	*142*	*164*	*157*	*139*	*112*
4	Effective tax rate		*0.0%*	*0.0%*	*0.0%*	*0.0%*	*12.0%*	*35.0%*
5	Ke		*13.3%*	*13.3%*	*13.3%*	*13.3%*	*13.3%*	*13.3%*
6	Kd		*9.0%*	*9.0%*	*9.0%*	*9.0%*	*9.0%*	*9.0%*
7	WACC used in the valuation		*10.0%*	*10.0%*	*10.0%*	*10.0%*	*10.0%*	*10.0%*
8	Equity value (E)	*3,033*	3,436	3,893	4,410	4,997	5,627	6,341
9	ΔD = ECF - FCF + Int (1-T)		397	244	-86	-197	-303	-389
10	Debt value (D)	*1,184*	1,581	1,825	1,739	1,542	1,239	850
11	D/(D+E)	28.1%	31.5%	31.9%	28.3%	23.6%	18.0%	11.8%
12	WACC using lines 4,5,6,8,10		12.09%	11.95%	11.93%	12.08%	12.03%	11.96%

Table 2

Valuation using the wrong WACC of 10%

Present value in 2002 using a WACC of 10%	
Present value in 2002 of the free cash flows 2003-2008	647
Present value in 2002 of the residual value (g=2%)	3,570
Sum	4,217
Minus debt	-1,184
Equity value	3,033

The valuation has **two major errors**:

a. Wrong calculation of the WACC. To calculate the WACC, we need to know the evolution of the equity value and the debt value. We calculate the equity value based on the equity value provided for 2002. The formula that relates the equity value in one year to the equity value in the previous year is $E_t = E_{t-1} (1+Ke_t) - ECF_t$.

To calculate the debt value, we can use the formula for the increase of debt, shown in line 9. The increase of debt can be calculated if we know the ECF, the FCF, the interest and the effective tax rate. Given line 9, it is easy to fill line 10.

Line 11 shows the debt ratio according to the valuation, which decreases with time.

If we calculate the WACC using lines 4, 5, 6, 8 and 10, we get line 12. The calculated WACC is higher than the WACC assumed and used by the investment bank.

b. The capital structure of 2008 is not valid for calculating the residual value because, to calculate the present value of the FCF growing at 2% using a single rate, a constant debt to equity ratio is needed.

To perform a correct valuation, assuming a constant WACC from 2009 on, we must recalculate Table 1. Tables 3 and 4 contain the valuation correcting the WACC. To assume a constant WACC from 2009 on, the debt must also increase by 2% per year (see line 9, 2009). This implies that the ECF (line 2) in 2009 is much higher than the ECF in 2008.

Simply by correcting the error in the WACC, the equity value is reduced from 3,033 to 2,014.

Table 3

Valuation calculating the WACC correctly

		2002	2003	2004	2005	2006	2007	2008	2009
1	FCF		-290	-102	250	354	459	496	505.9
2	ECF		0	0	0	0	34	35	473.2
3	Interest expenses		107	142	164	157	139	112	76.5
4	Effective tax rate		0.0%	0.0%	0.0%	0.0%	12.0%	35.0%	35.0%
5	Ke		13.3%	13.3%	13.3%	13.3%	13.3%	13.3%	13.3%
6	Kd		9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%
8	Equity value (E)	2,014	2,282	2,586	2,930	3,320	3,727	4,187	4,271
9	ΔD = ECF - FCF + Int (1-T)		397	244	-86	-197	-303	-389	17
10	Debt value (D)	1,184	1,581	1,825	1,739	1,542	1,239	850	867
11	D/(D+E)	37.0%	40.9%	41.4%	37.2%	31.7%	25.0%	16.9%	16.9%
12	WACC calculated with 4,5,6,8,10		11.71%	11.54%	11.52%	11.70%	11.59%	11.44%	12.04%

Table 4

Valuation using the corrected WACC from Table 3

Present value in 2002 using the WACC calculated in Table 3	
Present value in 2002 of the free cash flows 2003-2008	588
Present value in 2002 of the residual value (g=2%)	2,610
Sum	3,198
Minus debt	-1,184
Equity value	2,014

3. The WACC and the Value of Tax Shields (VTS)

The value of tax shields (VTS) defines the increase in the company's value as a result of the tax saving obtained by the payment of interest. However, there is no consensus in the existing literature regarding the correct way to compute the VTS. Modigliani and Miller (1963), Myers (1974), Luehrman (1997), Brealey and Myers (2000) and Damodaran (2006) propose discounting the tax savings due to interest payments on debt at the cost of debt (Kd), whereas Harris and Pringle (1985) and Ruback (1995, 2002) propose discounting these tax savings at the cost of capital for the unlevered firm (Ku). Miles and Ezzell (1985) propose discounting these tax savings the first year at the cost of debt (Kd) and the following years at Ku.

The value of the levered firm can be written as:

$$E + D = Vu + VTS \qquad (1)$$

where E is the value of the equity, D is the value of the debt, Vu is the value of the unlevered equity and VTS is the value of tax shields. From equation (1), we can derive equation (2):

$$E\,Ke + D\,Kd = Vu\,Ku + VTS\,KTS \qquad (2)$$

where Ke, Kd, Ku and K_{TS} are the required returns to the expected cash flows of equity, debt, assets (free cash flow) and tax shields. Modigliani and Miller consider that K_{TS} = Kd and Harris and Pringle consider that K_{TS} = Ku. These two scenarios correspond to two different financing

strategies: the first is valid for a company that has a preset amount of debt and the second should be valid for a company that has a fixed leverage ratio in market value terms [D = L (D + E)]. However, as Miles and Ezzell (1985) and Arzac and Glosten (2005) prove, the required return for the tax shield (K_{TS}) of a company that has a fixed leverage ratio in market value terms is Kd for the tax shields of the first period and Ku thereafter. It is not possible to derive a debt policy such that the appropriate discount rate for the tax shields is Ku in all periods. $D_t = L (D_t + E_t)$ implies that D_t is also proportional to FCF_t. Miles and Ezzell's (1985) correct formula for the VTS of a perpetuity growing at a rate g is:

$$VTS^{ME} = \frac{D\ Kd\ T}{(Ku - g)} \frac{(1 + Ku)}{(1 + Kd)} \tag{3}$$

Formula (3) is identical to formulae (21) of Miles and Ezzell (1985), (13) of Arzac and Glosten (2005) and (7) of Lewellen and Emery (1986). However, Farber, Gillet and Szafarz (2006) and Harris and Pringle (1985) present a formula that does not correspond to ME assumption:

$$VTS^{HP} = \frac{DKd\ T}{(Ku - g)} \tag{4}$$

If debt is adjusted continuously, not only at the end of the period, then the ME formula (3) changes to

$$VTS = D\,\rho\,T/\,(\kappa - \gamma) \tag{5}$$

where $\rho = \ln(1+ Kd)$, $\gamma = \ln(1+g)$, and $\kappa = \ln(1+ Ku)$. Perhaps formula (5) induces Farber et al (2006) and Harris and Pringle (1985) to use (4) as the expression for the value of tax shields when the company maintains a constant market value leverage ratio (but then Kd, g and Ku should also be expressed in continuous time). (4) is incorrect for discrete time: (3) is the correct formula.

Fernández (2007) values a firm when its debt policy is determined by a book-value ratio. He argues that, when managers have a target capital structure, it is usually in book-value terms (as opposed to market-value terms), in large part because this is what credit rating agencies pay attention to. He gets the VTS of a company that maintains a fixed book-value leverage ratio:

$$VTS^{FER} = \frac{D\,Ku\,T}{Ku - g} \tag{6}$$

Fernández (2007), using data of United States companies, compares the correlation coefficients of the increases of debt with the increases of assets measured in book-value terms, and in market-value terms. He finds that the average and the median of the book-value correlation coefficients are higher (and the standard deviation smaller) in book-value terms than in market-value terms. According to ME, the correlation between ΔD and $\Delta(D+E)$ should be 1, but it is only 0.23 on average. The correlation between ΔD and $\Delta(D+Ebv)$ was 0.77 on average.

For perpetuities with a constant growth rate (g), the relationship between expected values in t=1 of the free cash flow (FCF) and the equity cash flow (ECF) is:

$$ECF0(1+g) = FCF0(1+g) - D0\ Kd\ (1-T) + g\ D0 \quad (7)$$

The value of the equity today (E) is equal to the present value of the expected equity cash flows. If Ke is the average appropriate discount rate for the expected equity cash flows, then $E = ECF_0(1+g) / (Ke - g)$, and equation (8) is equivalent to:

$$E\ Ke = Vu\ Ku - D\ Kd + VTS\ g + D\ Kd\ T \quad (8)$$

And the general equation for the Ke is:

$$Ke = Ku + \frac{D}{E}[Ku - Kd(1-T)] - \frac{VTS}{E}(Ku - g) \quad (9)$$

The WACC is the appropriate discount rate for the expected free cash flows, such that $D_0+E_0= FCF_0(1+g) / (WACC-g)$. The equation that relates the WACC and the VTS is (11):

$$WACC = Ku - \left(\frac{VTS}{D+E}\right)(Ku - g) \quad (10)$$

4. An Example

The following example is taken from Fernández (2009). The balance sheet and income statement forecasts for the next 5 years are shown in Table 5. After year 3, the balance sheet and the income statement are expected to grow at an annual rate of 2%. Using the balance sheet and income statement forecasts in Table 5, we can readily obtain the cash flows given in Table 6. Obviously, the cash flows grow at a rate of 2% after year 4.

Table 5

Balance sheet and income statement forecasts

	0	1	2	3	4	5
WCR (working capital requirements)	400	430	515	550	561.00	572.22
Gross fixed assets	1,600	1,800	2,300	2,600	2,913.00	3,232.26
- accumulated depreciation		200	450	720	995.40	1,276.31
Net fixed assets	1,600	1,600	1,850	1,880	1,917.60	1,955.95
TOTAL ASSETS	2,000	2,030	2,365	2,430	2,478.60	2,528
Debt (N)	1,500	1,500	1,500	1,500	1,530.00	1,560.60
Equity (book value)	500	530	865	930	948.60	967.57
TOTAL LIABILITIES	2,000	2,030	2,365	2,430	2,478.60	2,528
Income statement						
Margin		420	680	740	765.00	780
Interest payments		120	120	120	120.00	122
PBT (profit before tax)		300	560	620	645.00	658
Taxes		105	196	217	225.75	230.27
PAT (profit after tax = net income)		195	364	403	419.25	427.64

Table 6

Cash flow forecasts

	1	2	3	4	5
PAT (profit after tax)	195	364	403	419.25	427.64
+ depreciation	200	250.00	270.00	275.40	280.91
+ increase of debt	0	0.00	0.00	30.00	30.60
- increase of working capital requirements	-30	-85	-35	-11	-11.22
- investment in fixed assets	-200	-500.00	-300.00	-313.00	-319.26
ECF	165.00	29.00	338.00	400.65	408.66
FCF [3]	243.00	107.00	416.00	448.65	457.62
CFd	120.00	120.00	120.00	90.00	91.80

The risk-free rate is 6%. The cost of debt is 8%. The corporate tax rate is 35%, and the required return to the unlevered equity (Ku) is 10%.

The valuation according to Fernández (2007) is given in Table 7. The value of the debt is equal to the nominal value (book value) given in Table 5 because we have considered that the required return to debt is equal to its cost (8%). The required return to equity (Ke) and the VTS have been calculated using (9) and (6).

The valuation according to Miles and Ezzell (1985) is given in Table 8. The required return to equity (Ke) and the VTS have been calculated using (9) and (3).

The valuation according to Myers (1974) is given in Table 9.

Table 7

Valuation according to Fernández (2007)

	0	1	2	3	4	5
Ke	10.49%	10.46%	10.42%	10.41%	10.41%	10.41%
E = PV(Ke;ECF)	**3,958.96**	**4,209.36**	**4,620.80**	**4,764.38**	**4,859.66**	**4,956.86**
D = PV(CFd;Kd)	1,500.00	1,500.00	1,500.00	1,500.00	1,530.00	1,560.60
E+D = PV(WACC;FCF)	5,458.96	5,709.36	6,120.80	6,264.38	6,389.66	6,517.46
WACC	9.04%	9.08%	9.14%	9.16%	9.16%	9.16%
[4] - D = E	**3,958.96**	**4,209.36**	**4,620.80**	**4,764.38**	**4,859.66**	**4,956.86**
VTS = PV(Ku;D T Ku)	623.61	633.47	644.32	656.25	669.38	682.76
Vu = PV(Ku;FCF)	4,835.35	5,075.89	5,476.48	5,608.12	5,720.29	5,834.69
VTS + Vu	5,458.96	5,709.36	6,120.80	6,264.37	6,389.66	6,517.46
[9] - D = E	**3,958.96**	**4,209.36**	**4,620.80**	**4,764.37**	**4,859.66**	**4,956.86**

Table 8

Valuation according to Miles and Ezzell

	0	1	2	3	4	5
VTS = PV[Ku; T D Kd] (1+Ku)/(1+Kd)	508.13	516.16	525.00	534.72	545.42	556.33
Ke	10.76%	10.71%	10.65%	10.63%	10.63%	10.63%
E	**3,843.5**	**4,092.1**	**4,501.5**	**4,642.8**	**4,735.7**	**4,830.4**
WACC	9.199%	9.235%	9.287%	9.304%	9.304%	9.304%

Table 9

Valuation according to Myers

	0	1	2	3	4	5
VTS = PV(Kd;D Kd T)	663.92	675.03	687.04	700.00	714.00	728.28
Ke	10.42%	10.39%	10.35%	10.33%	10.33%	10.33%
E	**3,999.27**	**4,250.92**	**4,663.51**	**4,808.13**	**4,904.29**	**5,002.37**
WACC	8.995%	9.035%	9.096%	9.112%	9.112%	9.112%

5. Conclusions

The WACC is just the rate at which the Free Cash Flows (FCF) must be discounted to obtain the same result as the valuation using Equity Cash Flows.

The WACC is neither a cost nor a required return: it is a weighted average of a cost and a required return. To refer to the WACC as the "cost of capital" can be misleading because it is not a cost.

The paper includes 7 errors caused by not remembering the definition of WACC.

The paper also shows that the relationship between the WACC and the value of the tax shields (VTS).

The WACC is a discount rate widely used in corporate finance. However, the correct calculation of the WACC rests on a correct valuation of the tax shields. The value of tax shields depends on the debt policy of the company. When the debt level is fixed, the tax shields should be discounted at the required return to debt. If the leverage ratio is fixed at market value, then Miles-Ezzell applies. Other debt policies should be explored. For example, Fernández (2007) develops valuation formulae for the situation in which the leverage ratio is fixed at book values and argues that it is more realistic to assume that a company maintains a fixed book value leverage ratio than to assume, as Miles-Ezzell do, that companies maintain a fixed market value leverage ratio.

Exhibit 1

Calculating the WACC

The inter-temporal form of equations [1], [2] and [4] is:

[1i] $E_{t+1} = E_t (1+Ke_{t+1}) - ECF_{t+1}$
[2i] $D_{t+1} = D_t (1+Kd_{t+1}) - CFd_{t+1}$
[4i] $[E_{t+1} + D_{t+1}] = [E_t + D_t] (1+WACC_{t+1}) - FCF_{t+1}$

The sum of [1i] and [2i] must be equal to [4i]:

$[E_t + D_t] + E_t Ke_{t+1} + D_t Kd_{t+1} - [ECF_{t+1} + CFd_{t+1}] = [E_t + D_t] (1+WACC_{t+1}) - FCF_{t+1}$
As $CFd_{t+1} = D_t Kd_{t+1} - [D_{t+1} - D_t]$ and $ECF_{t+1} = FCF_{t+1} + [D_{t+1} - D_t] - D_t Kd_{t+1} (1-T)$
$[ECF_{t+1} + CFd_{t+1}] = FCF_{t+1} + D_t Kd_{t+1} -- D_t Kd_{t+1} (1-T)$
and

$[E_t + D_t] + E_t Ke_{t+1} + D_t Kd_{t+1} (1-T)] - FCF_{t+1} = [E_t + D_t] (1+WACC_{t+1}) - FCF_{t+1}$
$[E_t + D_t] WACC_{t+1} = E_t Ke_{t+1} + D_t Kd_{t+1} (1-T)$

The WACC is: $$\boxed{WACC_{t+1} = \frac{E_t Ke_{t+1} + D_t Kd_{t+1}(1-T)}{E_t + D_t}}$$

T is the effective tax rate applied to interest in equation [3].

$E_t + D_t$ are **not** market values nor book values: in actual fact, E_t and D_t are the values obtained when the valuation is performed using formulae [1], [2] or [4].

WACC is a rate that can be multiplied by market values [E + D], but it is not appropriate to multiply the WACC by book values.

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Comments

I wish that the concept of WACC was conveyed to me in the manner that you espouse it when I took my corp. finance classes.

I really enjoyed your article on WACC: definitions, misconceptions, and errors. The main thing though is you have to look at certain industries when addressing these concerns. The banks are a prime example of this they did not take into account the vast amounts of off balance sheet SIV's that were highly leveraged. Which I am pretty sure were never used in WACC calculations by these firms. Also, there is a lot of different errors that are also in WACC that I have noticed over the years. The main one being is that the WACC is derived from assumptions made by individuals. One person can state that Ke should be 15% and another could say it should be at 10% depending on the sector that a firm is involved in. I was also a little bit confused on your version of the WACC model, such that you had (E*Ke+D*Kd(1-t))/(E+D) this is not showing the weights distributed evenly for the capital structure since you are dividing the whole equation by (E+D). In my view I believe a better form which is why WACC is called weighted average cost of capital is (E/(E+D))Ke+(D/(E+D)*Kd(1-t) this shows that each weight is distributed properly for each K value. One last thing is the fact that I would also talk about the effects of preferred stock on the WACC. This should be represented in the model as well because a majority of the bigger firms do take preferred stock as part of their capital structure. Overall, I thought it was very well written. Especially your points about the benefits of the tax savings on debt and how it is misused in the model in most cases. If you have any more questions feel free to let me know.

I find that your arguments cannot be supported in many reasons. I strongly recommend that you should pick up a different topic. When you pick up a topic please do not start your project right away. Please show me one page proposal so I can decide whether the topic works for you.

I would add that the reason the WACC is called the cost of capital is because it refers to the opportunity costs the firm incurs. In order to keep the investors invested in our firm we must meet their required rate of return. Looking at the balance sheet (D + E = Assets) all of the investors in our firm (bond holders and shareholders), expect to get a return on the funds that they have invested with us. The firm must meet these expected rates of returns for the investors or the investors will sell their bonds/shares and reinvest elsewhere – we consider this an opportunity cost because the company now needs to generate a higher rate of return on their own investments (assets) so that they can give the investors what they want and still have some left over to use for day-to-day operations and some additional profits.

Very thorough analysis of many important discount issues. Good job!

I must disagree that WACC does not represent a [future] cost to the firm, as a proposed project may not be undertaken. I do agree that it is an expected cost because the capital will be used in the future, so the firm is not absolutely certain of the future cost [probably, and certain "fudge" factors may be added to the WACC to compensate for an unknown future] unless it has cash on hand to use for a proposed project. The main reason I disagree with the premise that WACC does not represent a cost lies with the providers of the capital. Each provider of capital expects a return on capital, thus to provide this return [interest and, perhaps, dividends but certainly growth in stock value] the firm has to earn enough to repay the capital. If I borrow money to make money I expect to repay that money with interest; to me, this is a cost to my operation in the same manner that inventory and overhead are costs. To have a positive return to me, I must

cover all of my costs: pay for fixed and variable costs as well as pay the money with interest I obtained from others [OPM – Other Peoples' Money]. The question may be which cash flows [estimated FCF, proposed project estimated cash flows, etc.] should be used with WACC rather than is WACC a cost to the firm.

This paper has issues with word usage. For example, the phrase "this paper includes seven errors" leads the reader to think that the paper itself contains errors -- instead of the intended meaning that the paper identifies or discusses seven common errors.

I've really appreciated your paper that is trying to put some order on the too often misused WACC concept. I really enjoy when you go through the assessment of the market value of both equity and debt since there is simply a dichotomy when you use a book value in the event of making a valuation.

I am not an academic person but just a mere equity sell-side analyst, so my considerations do not look as rigorous as yours. Anyway I would be glad to share some points with you (my apologies in advance if you already have gone through these matters and already dismissed them).

1. The calculation of the capital structure should not just be a D/(D+E) ratio but should be a broader D/EV as in the EV there is also the minorities' contribution and generally the FCF to be discounted take into account also the minorities.

2. The least flawed D/EV calculation should start from the EV from your DCF model and the debt's market value year by year; I know for sure that this procedure drives to an iteration problem in my spreadsheet but after some 5-year experience I consider it an affordable compromise;

3. The pick of the Kd: recently I've come to the point that I should consider the marginal cost of debt of the company (which rate should the company pay if it would ask for €1 additional debt tomorrow) but I've got some problems if we consider a company with a financial indebtedness spread between fixed and variable (which is the base for the marginal cost of debt? The IRS plus the spread of the Euribor plus the spread?). Again the tax rate to be picked should not be the Group's tax rate but the tax rate eligible for the tax shield. In Italy for instance the Group's tax rate ranges from 35% to 45% but the tax rate for the tax shield is just the 27.5%.

4. The calculation of the Terminal Value: I believe that you should take with a cautious attitude the FCF at which the return on the capital employed is equal to the cost of the capital employed and not just the last FCF of my explicit year of DCF multiplied for (1+2%).

5. In the event of a very cyclical company (i.e. building construction company) the WACC should be in my view on a rolling basis year by year to reflect in the market risk premium component the different phases (ups and downs) of the cycle.

I simply don't have the time to review your critique of weighted average cost of capital and issue you raise on semantics. My views on cost of capital in pure exchange economies are contained in my 2007 article. The defect of the concept in a world of stochastic expected returns is identified in my 2009 paper.

I found this note to be interesting. Is it possible to define the cost of equity as the yield on the common stock? That is: the dividend divided by the market price. If the company needs to issue equity, is the yield the cost? I know that from talking to some management teams; that is how they view it.

First Sentence of the abstract is not clear to me. WACC is the weighted average of the costs of debt and equity capital. So, the word of "Equity Cash Flows" is not appropriate here.

Second sentence is not well defined. "Cost" and "Required Rate of Return" is the face and back of a coin. In other words, the component rate of the WACC is defined as "required rate of return" on debt or equity at which investors (equity or debt) are willing to provide their money to a company. Also, the rate is defined as "Cost" at which the company is willing to pay for borrowing the money from the investors. Therefore, it IS "cost" and "return."

For the third sentence, I have no idea what you mean by that sentence. If we accept that the goal of the modern firms is to maximize the shareholders' (more accurately speaking, common stockholders) wealth, then the cost should be discounted by the tax rate because dividends paid to the commons stockholders are not tax deductible.

I enjoyed reading your paper and with your permission would like to use it in my corporate finance class. I do have one point of disagreement, however. The shareholders' required rate of return is the cost of equity in equilibrium as can be shown in a simple arbitrage proof.

Thank you for sending this very interesting paper, I think it summarizes and analyses the key misconceptions quite well. Two points that have surprised me, though:

Firstly, you seem to put a lot of emphasis on the fact that WACC is NOT a cost of capital. In my view, return on equity can be regarded as a cost of equity in this context as it is represents the opportunity cost of equity capital as the equity could be invested at this yield in the market portfolio (+leverage to adjust beta).

Secondly, it did surprise me that your point 2.6 suggests that in the WACC calculation the amount of the tax shield should only reflect [Book value of debt times tax rate] and not [Market value of debt times tax rate]. In my models, I use market value of debt times tax rate as I assume that companies usually have to refinance their debt after 3-5 years or earlier and that at the moment of the refinancing the book value of debt will jump to equal market value. As in any DCF the period after t+5 is more important for enterprise value than the period before t+5, I have regarded [market value of debt times tax rate] as the better proxy (although the truth is in the middle).

The **weighted average cost of capital (WACC)** is the rate that a company is expected to pay on average to all its security holders to finance its assets.

Calculation: In general, the WACC can be calculated with the formula[2]:

$$\mathrm{WACC} = \sum_{i=1}^{N} \left(r_i \cdot \frac{MV_i}{\sum_{j=1}^{N} MV_j} \right)$$

N is the number sources of capital (securities, types of liabilities); r_i is the required rate of return for security i; MV_i is the market value of all outstanding securities i.

Purpose: The Weighted Average Cost of Capital (WACC) is used in finance for several applications, including Capital Budgeting analysis, EVA® calculations, and firm valuation.

Problem: WACC obtained by the standard formula leads to significant errors in Net Present Value of the Firm calculations; particularly in those that apply perpetual cash flow series.

Solution: Calculate the new WACC to make the NPV of a firm equal to the traditional way. NPV[WACC,E,D]=NPV[iE,iD]
E = Annual Free Cash Flow to Equity. iE = Annual cost of equity
D = Annual interest payments (before taxes). ID = Annual cost of debt. T = tax rate
Your paper just pointed out the right way to calculate the WACC for the NPV application. I think for different purpose, we can always use the same methods to make the traditional calculation equal to the WACC values. WACC is just an equivalent discounted rate for complex capital structures.

I think it is only in a loosely defined sense that WACC includes requisite returns for equity, as that is the only way to see the cost of equity - the expected return and not the committed return unlike in case of debt.

As for tax shields, I am of the view that the appropriate discounting rate is the cost of equity, as tax shields directly affect the equity holders.

2.3. If you discount operational free cash flow by WACC, what you get is the operational value which is supported by both debt and equity. If you discount equity cash flow by equity return, what you get is equity value which is different from the above.

2.3. WACC is a cost of capital from the point of corporate. I do not understand why you have to say it is not a cost.

Method 2: I agree: the WACC is normally a weighted average sum of return on debt (r_d) and return on equity (r_e); however, I think WACC means or illustrate more than its literal meaning. Let's say investor X who bought a specific number of shares in company ABC and investor X does not any directly shareholding except the shares that he or she has. In principle, the investor is not affected by the WACC measure but intuitively a WACC is a key measure for him or her and it has possible different meaning that its literal meaning.

This is all from the perspective of investor X, who owns only shares in company ABC: The return on debt illustrate whether the company would be able to meet its debt obligations while the return on equity exemplify the minimum returns that ordinary investors would ideally like to receive if they were invested in company ABC. If both measures $(r_e \ldots and \ldots r_d)$ are favourable to financial markets, the share price of company ABC is most likely to increase benefited investor X in return. Investor X's return was not directly affected by WACC measure; however, components of WACC were in favour of investor X's position. Therefore, investor X is likely to define WACC is some "return measure" but definitely not weighted average sum of returns of debt and equity. Although, I conquer with you that it is better to conform to the true meaning of WACC; however, looking a ratios from different angle can still be insightful to another person. Defining ratios in context is more informative than sticking to their true meaning, i.e. perspective of one owning shares, ordinary shareholders, etc.

In calculating WACC, we should know the company's value (D and E). For a listed company, especially for traders, E is the product of number of ordinary shares and prices, and real E (one contributed by true equity owners) is largely different from quoted E. Personally, I would use equity from true equity owners' contribution and change the real value periodically as per relevant economic variable changes. The same rule concept would be applied to debt. The reason is the true debt and equity are more real and changes of relevant economic variables changes are true ratio multipliers.

2. Some errors due to not remembering the definition of WACC

2.2 Recommend using real values than book values for reasons stated earlier on.

2.3 WACC should be calculated periodically using real values of debt and equity. WACC should not be forecasted but the driving variables (debt and equity) should be as economic variables affect debt and equity as opposed to WACC.

2.6 Personally, I think book values are right only for illustration purposes; however, real values are more insightful.

3. The WACC and the value of tax shields (VTS) Formula: $E+D=V_u+VTS$

I wouldn't regard VTS as value but more like a benefit such as depreciation. For me, a value would anything when added to existing project; it increases the current value by some extra amount. For me, VTS doesn't support the latter statement.

CONCLUSION WACC should be defined in context of the person whom the measure is undertaken, although, in the true sense WACC is the weighted average sum of returns on debt and equity.

As a valuation practitioner, your paper was very helpful for me to think of different perspective in WACC calculation. Based on discussions regarding your paper, here is our comment. In theory, your paper (calculating different WACC for each projection period based on effective tax rate, interest expense, debt, etc.) would be the appropriate way of calculating WACC. However, in practice, we usually use constant WACC for the projection period under the DCF method. The main reason would be because it is more simple (applying constant WACC) and DCF always involves many assumptions including forecasts.

There is one point which I cannot understand completely: Table 1 and 3 show the required return to levered equity (Ke) in line 5. The thing that confuses me is that although the financial leverage of the company varies from period to period, Ke remains constant. In my opinion Ke should be adjusted to the "new" financial leverage. Consequently this adjustment leads to a change in WACC.

1. The WACC you correctly define is the source of many financial disasters: if a company takes a decision to invest in a project based on a WACC for which the Ke is very high (e.g.: 40% for a VC expecting a 5X multiple over 5 years) and the Kd is a single-digit percent (e.g.: 7%), any change in the bank policy in terms of financial leverage (ratio debt / equity) immediately kills the return for equity providers. Might be useful to mention this somewhere because I saw too many decision based on a valuation but with the decision makers not looking at the parameters used to calculate the value.

2. Honestly, M&A decisions are indeed based on DCF valuation but as a guide to the final value effectively negotiated. In a, say, EUR 100 million transaction, a mistake in the calculation of the EV of, say, EUR 1 Mio will have no material impact on the ultimate negotiated price. In a few companies I worked with, the WACC was in fact the required return expected (or dreamed) by the shareholders: this was the value of the company. The ratio debt / equity is a decision by the shareholders and the Board but has no impact on the intrinsic value of the Company (if it would have, the value of the Company increase if you increase the level of debts ... but the Company is still the same, only an increased risk due to the financial leverage ... and the increased risk reduce the value due to the higher return expected by the shareholders to compensate the risk).

3. I am not sure that I fully agree with your definition of the FCF. For me, the FCF represents the cash that a company is able to generate after covering all his costs (i.e.: includes after paying its interest charges and its taxes) and laying out the money required to maintain or expand its asset base. The FCF is used to pay dividends, repay financial debts and reduce capital (not common). Bottom line, the cash generated by the company to tackle shareholder decisions (debt level, dividend, equity).

I am very interested in the area of valuations, particularly by way of discounted cash flows. I will study your note in more detail, but I could conclude already after a quick read through that I very much recognize the different errors you are pointing at.

Coming from a more practical and user oriented angle rather than academic, my opinion is that most DCF valuations I have come across have several errors.

One of the major problems is that most users of the different models have not built the models, but inherited them. This results in many users not really knowing what they calculate...

It is very common that you see calculations of WACC where the default capital structure used is 50 percent equity, regardless of how the actual or forecasted figures look. Another problem area is off course the tax shield effect. Most DCF models calculate the tax on the result after financial items, the tax effect of this is not later on adjusted for in the nominal cash flows, even though they have considered the tax shield effect when calculating the WACC.

I also find that people seem to have problems to establish if the valuation the come up with is a equity value or a enterprise value.

From a practitioner's viewpoint, there is another common error I see. Many financial departments of reputable companies 'inflate' their WACC in order to build some risk protection into the overall investment system. It is also done in some PE firms.

For example, if the true WACC is 9%, they will artificially adjust an input or perhaps even just add a point onto the final result to get to 10% WACC. I view this as an incorrect place to introduce risk protection. Perhaps a better place to build in that risk protection is in the actual cash flow projections from the investment. The use of scenarios or "Monte Carlo" style simulations can also help. But my view is that the artificial inflation of WACC is a wrong way of addressing project specific risk. The WACC is typically not at risk, the cash flows are at risk. Only if the WACC is at risk does it make sense to do a WACC sensitivity analysis (e.g. one expects debt interest rate to be reset next year).

I did not see artificially adjusting the WACC or using WACC scenarios for potential WACC changes addressed in the paper. Though I am not an expert in this area so certainly you may have valid reasons for that.

I basically agree with your statements and offer the following thoughts:

1. In my mind, difference can exists in all valuation approaches because all require estimates of cash flows, tax rates, required rates of return, etc. To argue that one method of forming "estimates" is better than another may require an empirical study for support.

2. As you know, the cost of capital determines how a company can raise money (through a stock issue, borrowing, or a mix of the two). This is the rate of return that a firm would receive if it invested in a different vehicle with similar risk. The WACC equation is the cost of each capital component multiplied by its proportional weight and then summing. A firm's WACC, therefore, is the overall required return on the firm as a whole and, as such, it is often used internally by company directors to determine the economic feasibility of expansionary opportunities and mergers. It is the appropriate discount rate to use for cash flows with risk that is similar to that of the overall firm. When the WACC is referred to as a cost of capital in an article or discussion of the WACC, the words "cost of capital" are often simply a short-hand notation for the full phrase "weighted average cost of capital" and hence are meant to be the same. Outside of a discussion of the WACC, when the words "cost of capital" are used they are generally specified as being the cost of equity, cost of debt or the weighted average cost of capital. Hence, any confusion is generally mitigated by the framework of the discussion.

What is important is the use to which WACC is put... you are correct in saying it is not a "cost of capital," but assuming a firm or a bank has more than one source of funds, say a mix of equity and borrowings, then the return payable on each element is different, so an average of this is worth knowing as one type of "hurdle rate" for projects to return.

So it's the use to which WACC is put that is the most important thing. I would suggest that as it is an average, it will not be the most appropriate hurdle rate for most projects, which should really return above the marginal cost of capital, not the weighted average cost of capital.

I like your investment banking valuation comparison and typical errors in valuation. That said, we must remember that bankers make their fees based off of price, not value. Most investment bankers do not carry WACC out to 2 decimal places and in fact tend to discount with whole percentages. Thus your tables would all be rounded to a 12% discount rate over the entire forecasting period. They typically do sensitivity analysis in whole percent for both the discount rate and terminal growth rate to get their matrix. They typically use the same discount rate as the initial rate over the forecast period since no one is paying them to unlever and relever the cost of equity and recompute WACC based on a changing capital structure. As your example shows, the magnitude of the difference in discount rates is insignificant in comparison to the standard error around their projected cash flows.

However, I would bring up one point of contention in your paper. I would contend that the opposite of return is cost. The creditors cost of debt is nothing more than their required return for the use of their capital and shareholder's required return on their equity is thus the same the cost of equity to the firm. Therefore, cost of capital is appropriately named "cost" in the sense of opportunity costs and economic profits.

Thank you for sharing your paper with me. I haven't gone over it in detail, but here are some quick thoughts. Using only the abstract terms, the first definition just doesn't make sense – most firms would defined WACC as a weighted average of debt and equity, and in which retained earnings would be valued at their opportunity costs. On the second definition of WACC, you are correct that it is not strictly speaking a cost in the balance sheet sense. However, it does incorporate relevant information on the opportunity cost of capital, in which case it does embody the general sense of the "cost of capital" that you are criticizing. I commend you for incorporating information on the value of tax shields, though, as this is often overlooked in estimates of the WACC. Finally, one might consider the extent to which markets efficiently incorporate risk premia. You have previously undertaken queries on what rate of discount one should apply in various contexts. The question here is the extent to which markets efficiently incorporate risk premia to arrive at a more accurate cost of capital, be that on the side of debt or equity. As we all now know all too painfully, market pricing, and even agency ratings, can be woefully inadequate in the presence of opaque information, particularly non-traded risk management assets such as swaps, thus compounding the difficulty of arriving at a more accurate WACC.

I found your definition of WACC confusing and misleading. WACC is the cost to the firm for raising funds by using debt or equity. For example, if a firm can borrow the funds required by issuing bonds, the cost to the firm of the bonds can be calculated as follows: After tax cost of debt = cost of debt (1-tax rate). For issuing common stock the CAPM should be used to find the cost of the stock.

I have a question about your assumptions which may constitute a disagreement with you on this paper. I understand you're choosing to value the debt and equity in terms of the cash flows from both securities, but does this not require at least three additional assumptions:

1. Risk neutrality so that all debt and equity securities can be considered equivalent substitutes.

2. All earned cash flows are paid out, for example, the retention ratio for equity is zero.

3. The only value in the firm is obtained from operations and are in the form of cash flows.

I do not see how your description can apply to a firm unless these three assumptions are held. For example, without risk neutrality there would be different rates for different securities, both across types, and across time. This would break the link between earned cash flows from operations, and the amount paid to security holders. That is, given a level of risk and a price of risk, the amount earned from operations could be above or below the present value calculation to security holders, which would mean a deviation between the firm value, and the value to the security holders. (Note that this is primarily a problem for debt holders.)

In addition, the debt tax shield affects only the equity holders. This seems to imply a myriad of problems for this valuation method, in that it creates an incentive to hold more debt in order to maximize the tax shield. I believe it was Miller 1977 (I don't have the reference in front of me) that avoided this problem by making the level of debt in the macro economy a demand driven function. Without that assumption it is possible for firms to overload on debt and transfer wealth to shareholders. This problem is made worse by risk neutrality because bondholders would be indifferent to risk; the firm therefore should have all but the smallest amount of value in the form of debt, thereby maximizing the value of the firm. (I had recently written a review of many of the corporate capital structure papers, and the gist of my review was that the tax

shield was an order of magnitude larger than any associate cost to the firm of issuing debt. Under risk neutrality, all capital structure arguments are subsumed by the value of the tax shield.)

Basically, I am arguing that there is a meaning to the word 'cost' in the term 'cost of capital.' The cost is the amount paid to security holders. Differences in risk, the valuation of assets, the payout of cash flows, and incentives to shift risk all can result in the cost of capital to the firm being different from the value of cash flows paid to security holders. Some of this would accrue to shareholders; some would be wasted by excessive perquisite consumption. Restricting assumptions (e.g. no corporate taxes) get rid of the conflicts, but also reduce the argument to the original Modigliani and Miller arguments.

Your analysis is correct that assuming constant wacc doesn't serve purpose. Change in capital structure should be taken into account while calculating wacc even when we are forecasting future cash flows. We should consider debt repayments of past loan taken which will reduce debt and subsequently tax shield on account of reduction in debt. So, the process of valuation using Free Cash Flow and cost of capital should be dynamic.

I don't however agree with your comment that cost of equity is not a real cost, because it is an opportunity cost, so I think it is conceptually correct to call the required return on equity the cost of equity.

To estimate the cost of debt (to estimate the WACC) we must have regard only the cost of bank debt or should we add another debts, such as suppliers?

In fact, you could have gone further. The WACC is not blend of cost and required return – it is all required return. The reason is that the appropriate cost of debt is the YEILD on the debt, not the COUPON.

When I teach this, I emphasize that the WACC is really just a proxy for the required rate of return adjusted for tax effects in a rudimentary manner.

I am always telling my students that WACC is a faulty concept, and now I have something for them to read!

What worries me from the beginning is this phrase: "The WACC is neither a cost nor a required return: it is a weighted average of a cost and a required return."

First - the phrase is constructed wrongly - look I have highlighted this in red.

Second, it is true that WACC is not a required return. RRR (required rate of return) sometimes can be equal to WACC, but not necessarily.

WACC – is namely the weighted average of cost – but that stems from abbreviation. and clearly we compare WACC with ROACE, to verify is value is created or destroyed.

You might wish to argue that your definition of the WACC is the discount rate that should be used to evaluate capital budgeting expenditures, but it is not the only possible definition. "A rose by any other name smells as sweet."

Your synopsis that referring to WACC as "the cost of capital" may be misleading as it is not a cost is an interesting thought, and revolves partly around the definitions of "cost" and "capital." In different markets the term "capital" has different underlying meanings – debt,

equity or combinations there of. The term "cost" can also have different interpretations (ie, the cost to who). Therefore, in common practice in my experience, WACC is generally accepted as theoretical formula that best achieves a combination between the cost of debt (the cost to the company) and the required return to equity (by equity holders) – as you point out in your paper.

The common errors you raise are something we note when doing valuations – particularly determining the appropriate debt/equity for the valuation. This can be quite a challenge in reality in determining the most appropriate ratio and cost of debt (particularly when there is little comparable industry data in certain sectors or developing markets to benchmark against).

The issues regarding tax shields also play out in practice, and are closely linked with the debt assumptions referred to above. The theoretical analysis and conundrums presented are probably less relevant in practice due (in our markets at least) due to the constraints in determine future debt ratios and needs in forecasts, and costs of debt. However, done incorrectly, the compounding effects of these errors will certainly result in a less correct valuation being determined.

I gather you turn WACC into the IRR relating FCF to the market value of the firm. I like the idea. But, consider the data problem: in one approach, the analyst must form estimates of FCF. In the other, the analyst must form an estimate of the required return on debt (for which the market yield on bonds may be a good enough estimate) and the required return on equity (for which the parameters of the market security line and beta of the firm's stock may provide a good enough estimate). (There are other approaches.)

I agree with you that, correctly measured, WACC is misnamed. It is not a backward-looking cost measure, but a forward-looking hurdle rate (identifying which projects increase the market value of the firm).

No problem with the point that Equity must be measured at market value. As to whether Debt must be, or if book value is adequate, I can say that during a time of rising prices, debt at book value is definitely not. See my paper Tobin's Q and Measurement Error in the 1996 *Journal of Economics and Business*.

You should distinguish the WACC from the MCC (marginal cost of capital) for liquidity-constrained firms (i.e., fast-growing firms, that do not pay dividends, which must bear the substantial cost of issuing new shares of stock, SPOs, which is infrequently observed). For these companies, WACC is indeed a cost, and not a prospective return, since there are many projects whose IRR exceed WACC which cannot be funded. The firm must, therefore, select only the most profitable projects as allowed by the capital budget. In is an empirical equation as to whether WACC is informative for liquidity-constrained firms. Perhaps it can be when supplemented by additional information.

I'm not in academia any more but I will give you my thoughts on WACC: If WACC is calculated using the market values and market rates of the equity and debt using an optimal capital structure, it is the correct discount rate to discount expected operating cashflows to get the enterprise value. Any deviation from using either the optimal capital structure or the required rates of return of capital at the optimal capital structure will produce WACC that could be different from the correct WACC. As such, any valid 'errors' or 'mistakes' in estimating or using WACC should be related to or traceable back to one of the deviations from how it should be derived (or using with enterprise cashflows).

I agree that the WACC is frequently mischaracterized and its firm definition is not as widely understood as that for, say, Beta.

I am not sure, however, that I completely agree that WACC in all cases is an average of the required rate of return on equity and cost of debt. For instance, when analysing a public company we often need to arrive at the actual return on equity. The first step in this analysis is the derivation of the WACC, which here would be an average of the cost of debt and the actual rate of return on equity. In another case, such as the one I use in my paper on SERM, treats WACC as an average of cost of capital and cost of debt in order to arrive at the required rate of return on equity. Both of these cases represent needed uses of weighted averages of returns.

To summarize, the definition of WACC as it is currently understood is capacious enough to accommodate its use in a variety of ways. This may be problematic, because in order to prevent serious misreadings common terminology should have a common frame of understanding. Perhaps a new set of definitions for the various averages is necessary, one of which is the one you set out in your work.

The misconception is in the model itself (the discounted cash flow model) that purports to tell us the "the true value" of the firm using free cash flow and the WACC. What cash flow estimate yields TRUE VALUE, and what WACC helps us arrive at it. If the firm is using only equity, then WACC is equal to the cost of equity (arrived at typically through the CAPM which has its own problems]). If not, then the WACC is nothing more than the weighted average of all sources of funds that may be market driven and not very specific to the firm. If the firm does in fact plan to use these sources of funds, then the WACC is in fact a real cost of funds assuming the proportions hold.

WACC = Ka = WdKd + WpKp + WeKe where sum of Ws = 1 from market value weightings if available and where Kd = i(1-t), Kp = Dp/Pp, and Ke = De/Pe + g, with i as interest rate on bonds, t is the tax rate, D and P are dividends and prices for p(referred) and e(quity), and g is the growth rate of equity. Note that g = br for most firms where b is the retention rate of reinvested equity dividends and r is the rate of return achieved by the firm. Ka is cost in the ex ante NPV valuation sense...and could be used as a reinvestment rate for the modified internal rate of return (free cash flows are reinvested [not at the internal rate of return] toward a single terminal wealth value), but that would be "putting the cart before the horse."

Your treatment of the example in 2.7 is, I think, basically correct. I would perhaps go a little further and point out that the terminal value calculation assumes, I think, a constant WACC and therefore that the borrowings can grow with the equity. This may not be realistic if gearing were to start off too high - perhaps not the case in this example but may well be so in many other examples.

I have thought myself for a long while that these calculations should build in decreasing gearing to a target 'sustainable' level of gearing which is lower than many starting levels.

However in practice this may be seen as allowed for by using high costs of equity.

1. You make too much of calling debt costs a cost rather than a return - not really relevant, and from the perspective of a debt holder it is a return.
   Technically the only differences with cost of equity is tax.
   It may be that there are nuances to do with management interests aligned with equity holders rather than debt holders, but you do not discuss this.

2. There are three general approaches to valuation on DCF on cashflows (on top of discounting equity flows):

   - "Classic," WACC using tax adjusted cost of debt, applied to cashflows with tax at zero debt.
   - WACC using tax unadjusted cost of debt, applied to cashflows with tax at actual debt.
   - Discounting cashflows with tax at zero debt, with cost of equity at zero debt, then adding tax shield.

   All three will give same answer.
   First method is that traditionally used.
   Second method mirrors approach United Kingdom regulators apply to water and energy distribution/transmission.
   Third method is useful if "gearing" levels are projected to vary – as well as get around having to re-calculate cost of equity in iterations (as gearing changes).
   [Also as a general warning, always be aware of the WACC you are using – real or nominal. Eg errors in UK regulatory approach in applying tax adjustment to real cost of debt – though only important in numbers quoted, since in calcs use tax unadjusted WACC].

3. On using cost of equity at zero debt, vs cost of debt to calculate tax shields - no correct answer. Depends on market perceptions at time, of riskiness of tax shields.

   Interesting phenomenon of course, is that if cost of equity at zero debt is used, then the tax unadjusted WACC (second method above), collapses to cost of equity at zero debt, and is constant with changing gearing.
   The tax adjusted WACC always changes with gearing, irrespective of discount rate.
   Might be interesting to see if there is a discount rate of tax shields that keeps the tax adjusted WACC constant (I have not looked into this).

4. Whole area you did not explore is how WACC equations vary with differing assumptions on debt betas.

This may be an inaccurate observation, but I notice none of your calculations take into consideration the market price of the debt. Yes, I know the company has an obligation to pay interest, amortisation and principal on time and in full – however there are many cases where discounted debt might lead to non-normal corporate behavior . e.g. deep discounts might prompt the company to buy its debt back, may indicate a pending delinquency or might lead to another debt structure in a reorganisation (smaller EV, different ratios of D and E etc.). Similarly, the volatility of equity would be another second order consideration.

In other words, does it make sense that two identical companies, one with debt trading at par and a steady equity price, the other whose bonds trade at 50 cents and the equity is all over the map, have an identical WACC?

I am familiar with equity and free-cash methods of valuation, but I am not enough of a scholar of such matters to critique your paper. I prefer in theory to use another method related to free cash, and that is to discount earnings or ebitda estimates for the future. What I do in venture

capital practice is to take a projection of earning statements and growth rates and try to predict a market valuation for the company.

My business experience is from the "school of hard knocks." So, it is not something I understand.

I never considered WACC very useful because too easy to mismanage.