WACC Misunderstandings

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Abstract

The Weighted Average Cost of Capital (WACC) has become a standard term and tool in finance. Given its broad acceptance and use, individuals are tempted to apply the WACC method without critically considering its theoretical foundation. Specifically, this study explains two common misunderstandings about the WACC method found in industry, literature and textbooks. First, decision makers view the WACC approach as valid only when the capital structure does not change. This is not a true restriction on the application of WACC. Second, many individuals and textbooks view WACC as the appropriate discount rate for NPV calculations if the project has the same risk and leverage as the mother firm without considering the investment horizon of the project. As shown, this can lead to faulty capital budgeting decisions. As such, this paper joins a small but growing stream of research in critically examining capital budgeting tools. It serves as a warning to practitioners in the use of WACC and wakeup call for academics in the instruction of WACC.

I. Introduction

The weighted average cost of capital (WACC) approach plays an important role in capital budgeting. It has been conveniently used in industry and academia in two major situations. First, when the present value of a firm is known, WACC serves as a steppingstone to back out the required return on equity r_E (or equity beta β_E) as a function of the current leverage ratio l and the opportunity cost of capital r_A (or the asset return if the firm were all-equity financed). WACC can estimate the new required equity return for changes in firm leverage or the interest on debt r_D. Second, if a new project or expansion of the firm with similar business risk and capital structure is proposed, the WACC of the mother firm would be the correct discount factor for finding the present value of the forecasted cash flows. Since these two applications are intrinsically consistent with each other, we will mostly focus on the second to explain two common pitfalls regarding the WACC.

In making capital budgeting decisions regarding a project, traditional methodologies include discounting the forecasted cash flows by the WACC and the adjusted present APV approach proposed by (Myers, 1974).[3] The APV approach is also referred to as the valuation-by-components method since it treats the total firm value as two components bundled together: the unlevered firm value (V) and the present value of the tax shields (Myers 1974; Brealey,

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[3] The adjusted present value (APV) method says that the levered firm's value is equal to the unlevered firm value plus the present value of the tax shields. It is the application of the value additivity principle.

Myers and Allen, 2005).[4] It is common wisdom that the APV method applies to constant debt level while the WACC method applies to constant leverage ratio situations (Brealey *et. al.*, 2005; Ehrhardt and Daves, 1999). Alternatively one can use the cash flow to equity (FTE) method to discount the cash flows to equity holders by the required equity rate of return and then add the debt value. Both the FTE and APV are the direct invocation of the fundamental principle of value additivity.[5]

(Booth, 2002) claims one can always find a WACC by discounting the relevant cash flows to get the known present value of the firm. In other words, WACC is a secondary concept which is useful only when the present value of the firm is known and a similar firm (or project) is to be priced. Thus, at least in capital budgeting decisions, one can use the existing firm's information to find the WACC and use it to price a proposed project.

Given the intuitive appeal of the WACC approach, however, one can easily fall victim to a few pitfalls. Apart from a few well elaborated pitfalls in (Booth, 2002), in this paper, we explain two common misunderstanding and misuse of the WACC approach found in industry, literature and textbooks.

II. The WACC Approach and Common Misunderstandings

The WACC plays a central role in capital budgeting for its convenience and conceptually straightforwardness. However, its application is far more complex than it appears on the surface. We begin this section by tackling the first misunderstanding. Namely, it is commonly believed and taught that the WACC method is valid only if the firm's capital structure is constantly rebalanced (Brealey *et. al*,. 2005). However, this concept is not entirely accurate.

1. Pitfall 1 – "the WACC approach is valid only when the capital structure does not change"

The understanding that the WACC approach is valid only when the firm constantly rebalances its capital structure is widely held in the research literature and by many popular textbooks. For example, see (Ruback, 2002), (Fernández, 2004), (Brealey *et. al.*, 2005), and (Brigham and Ehrhardt, 2004). However, this understanding is seriously flawed.

The role of WACC is similar to that of the bond yield-to-maturity which is a flat rate that generates the same market bond price when applied to every cash flows of the bond. Bond yield-to-maturity is actually the cash flow-weighted geometric average of the underlying spot rates. Since the spot discount rates are not observed, and in general, different cash flows are subject to different spot rates, bond yield-to-maturity becomes a convenient simple measure summarizing the spot rates. No matter how different the underlying spot rates are, given the cash flows (i.e., the weights), there always exits one corresponding yield-to-maturity to allow us to arrive at the

[4] Whether the APV approach is appropriate for growth firms is currently under debate (Fernández, 2004, 2005, 2006; Cooper and Nyborg, 2006; and Fieten *et. al.*, 2005). This ongoing debate centers on the correct method of estimating the present value of the tax shields.

[5] (Ruback, 2002) proposed the capital cash flow (CCF) valuation method. Ruback considers the case where debt varies in proportion with the total firm value (i.e., constant leverage), thus the discount rate for the risky tax shields is the asset rate of return r_A. He proved and showed with examples that valuation by WACC and CCF yields the same results. Thus, in this paper, we focus on the WACC and APV approaches.

same market bond price. The WACC serves exactly the same purpose when we deal with valuing a firm or a project.

Rather than depending on the changes in capital structure, the WACC actually depends on the future capital structures the investors are expecting. This understanding is important because it implies that a changing capital structure does not invalidate the WACC method if those changes are the consequences of the same debt policy.

To illustrate this point, we compare two different capital structure policies. In each case, the WACC method is valid when it is properly used. Suppose the firm's free cash flow FCF is perpetual, debt interest is r_D, corporate tax rate is τ, opportunity cost of capital is r_A, firm value is V_L and the debt's market value is D. Assuming away bankruptcy and financial distress costs, if the firm maintains a constant leverage ratio, then the WACC is (See Appendix A.1)

$$WACC = r_A - r_D \tau \times \frac{D}{D+E} = r_A - r_D \tau \times l \,, \tag{1}$$

and the implied expected rate of return on equity is given by

$$r_E = r_A + (r_A - r_D)\frac{D}{E}. \tag{2}$$

Eq. (2) is commonly called the MM Proposition II.

For firm following a constant debt policy, the proper discount rate becomes (See Appendix A.2)

$$r = r_A(1 - l\tau). \tag{3}$$

Eq. (3) was proposed by Modigliani and Miller. If we force $WACC = r$ in (3), then the unlevered expected equity return is given by

$$r_E = r_A + (r_A - r_D)(1-\tau)\frac{D}{E}. \tag{4}$$

Eq. (4) is sometimes referred to as the Hamada formula.

Formulae in (1) and (3) clearly mean that as long as the firm commits to the same capital structure (or debt) policy, the WACC approach is always valid. This claim holds true independent of whether the firm keeps a constant leverage ratio or not.

2. Pitfall 2 – Finite project life

The second WACC pitfall is a more serious inaccuracy. The WACC has been used to valuate a project independent of the project's life, e.g., (Ruback, 2002), which can lead to critical errors. To avoid this pitfall, one needs to understand the fundamentals of the WACC methodology.

When a new project with similar business risk is to be financed with the same capital structure policy as that of the mother firm, it is generally believed that the WACC method provides the correct pricing approach. In other words, the forecasted cash flows from the proposed project can be discounted at the mother firm's WACC to find the project's NPV. Applying the NPV rule, one makes a decision on the proposed project.

However, this is incorrect if the proposed projects have differing finite lives. In particular, we wish to show that the WACC and the APV methods normally do not agree with each other when the projects have finite lives. We use the following example to demonstrate our point.

Suppose ABC Inc.'s WACC is 9 percent and it follows constant debt policy. The firm decides to valuate a project of four years financed with constant debt D = \$50K at an annual interest rate $R_D = 6\%$. Further suppose that the opportunity cost of capital implied by Eq. (3) is $R_a = 12.8\%$. Table I shows the NPV of the project is \$0.9K. Both Panels A and B, with the WACC and APV methods, respectively, agree with each other.

However, with the same set of parameters, if the firm is to valuate another project with a different life, then the WACC and APV methods will diverge. Table II shows the results for a project of six years. The WACC approach (in Panel A) accepts the project with a positive NPV = \$0.3K, while the APV method (in Panel B) rejects the project with a negative NPV = – \$0.4K. Had the parameters been such that the two methods agree in Table II, then they would not have agreed in Table I.

The point we wish to make is twofold. First, the two valuation methods typically do not agree with each other as the project's life varies. Second, if the WACC method yields the correct answer (i.e., when it agrees with the APV method) for certain project horizon, then one can expect it to be invalid for other horizons. The second point is important because it does recognize that the WACC approach can be valid in a special case[6] even if the project's life is finite. Conceptually, this is in contrast with some traditional views, for example, (Arditti, 1973) claims that the WACC method is valid only for perpetuities.

III. Conclusions

WACC has been and will continue to be a mainstay of corporate finance. This paper joins a small body of research examining the relationship between valuation approaches and their advantages/disadvantages. In particular, we documents two WACC misunderstandings. Namely, the viewpoint that WACC is limited in its application by the capital structure policy of the firm and the mother firm WACC can be applied to projects with differing finite lives. Going forward, practitioners and academics should be more measured in the application and instruction of WACC principles.

[6] In our case, the validity of the WACC approach requires not only the proposed project's business risk and capital structure policy match those of the mother firm, but also the horizon structure of the two must match as well.

Table I. Valuating a four-year project financed with constant debt. The numbers are in thousands of dollars. Panel A shows the valuation process using the WACC approach. Panel B shows the same analysis using the APV method instead. The parameters (i.e., WACC, R_D, R_a, debt level and corporate tax rate) are chosen such that the two methods yield the same result. In this case, both would accept the project with the same NPV = \$0.9K. In Table II, we show that with the same parameters, these two methods will normally give different answers. Tables I and II demonstrate that there is no single set of parameters that can make the WACC and the APV methods agree with each other as the project horizon varies.

Panel A. The WACC method.

			Forecast			
	Year		**1**	**2**	**3**	**4**
1	Sales		90	95	102	112
2	Cost of goods sold		62	64	65	72
3	Depreciation		9.9	10.6	11.3	11.8
4	EBIT (1-2-3)		18.1	20.4	25.7	28.2
5	Tax (EBIT * 35%)		6.3	7.1	9.0	9.9
6	Profit after tax (4-5)		11.8	13.3	16.7	18.3
7	Investment in fixed assets		14.6	15.5	16.6	15
8	Investment in working capital		0.5	0.8	0.9	0.5
9	Free cash flow (6+3-7-8)		6.6	7.6	10.5	14.6
10	PV Free cash flow, years 1-4	30.9	(discounted at WACC = 9%)			
11	Initial investment	30				
12	**Project's NPV** (10-11)	**0.9**				

Panel B. The APV method.

1	Free cash flow		6.6	7.6	10.5	14.6
2	PV Free cash flow, years 1-4	28.1	(discounted at Ra = 12.8%)			
3	Debt		50	50	50	50
4	Interest (at 6%)		3	3	3	3
5	Tax shield (interest * 35%)		1.05	1.05	1.05	1.05
6	PV of tax shields at Rd = 6%	2.8				
7	Initial investment	30				
8	**Project's NPV** (2+6-7)	**0.9**				

Table II. Valuating a six-year project financed with constant debt. The numbers are in thousands of dollars. Panels A and B show the valuation process using the WACC and APV approach, respectively. The parameters (i.e., WACC, R_D, R_a, debt level and corporate tax rate) are the same as in Table I. The initial investment is assumed to be $44.8K in this case. The WACC approach (in Panel A) results in a positive NPV while the APV method rejects the project with a negative NPV equal to – $0.4K (in Panel B). We use Tables I and II to show that there is normally no single set of parameters that can make the WACC and the APV methods agree with each other as the project horizon varies.

Panel A. The WACC method.

			Forecast					
	Year		**1**	**2**	**3**	**4**	**5**	**6**
1	Sales		90	95	102	112	123	135
2	Cost of goods sold		62	64	65	72	88	103
3	Depreciation		9.9	10.6	11.3	11.8	13.1	9
4	EBIT (1-2-3)		18.1	20.4	25.7	28.2	21.9	23.0
5	Tax (EBIT * 35%)		6.3	7.1	9.0	9.9	7.7	8.1
6	Profit after tax (4-5)		11.8	13.3	16.7	18.3	14.2	15.0
7	Investment in fixed assets		14.6	15.5	16.6	15	13.9	13.9
8	Investment in working capital		0.5	0.8	0.9	0.5	0.4	0.4
9	Free cash flow (6+3-7-8)		6.6	7.6	10.5	14.6	13.0	9.7
10	**PV Free cash flow, years 1-4**	45.1						
11	Initial investment	44.8	(discounted at WACC = 9%)					
12	**Project's NPV** (10-11)	**0.3**						

Panel B. The APV method.

1	Free cash flow		6.6	7.6	10.5	14.6	13.0	9.7
2	PV Free cash flow, years 1-6	40.0	(discounted at Ra = 12.8%)					
3	Debt		50	50	50	50	50	50
4	Interest (at 6%)		3	3	3	3	3	3
5	Tax shield (interest * 35%)		1.05	1.05	1.05	1.05	1.05	1.05
6	PV of tax shields at Rd = 6%	4.4						
7	Initial investment	44.8						
8	**Project's NPV** (2+6-7)	**– 0.4**						

Appendix

A. WACC, APV and Capital Structure Policy

A.1. Constant Leverage

Assume the firm follows a debt policy of maintaining a constant leverage ratio forever. The tax shield each year $r_D D\tau$ shall fluctuate with firm value V_L, given the debt policy.[7] As argued in (Ruback, 2002) in the spirit of the APV approach, the proper discount rate is the opportunity cost of capital r_A (also referred to as the asset return) for both *FCF* and the tax shields. Therefore, the firm value is given by

$$V_L = \frac{FCF}{r_A} + \frac{r_D D\tau}{r_A}. \qquad \text{(A1)}$$

Since the cash flows are not constant, it is important to view them as the expected amounts. According to the WACC methodology, we have

$$V_L = \frac{FCF}{r_A} + \frac{r_D D\tau}{r_A} \equiv \frac{FCF}{WACC}. \qquad \text{(A2)}$$

Eq. (A2) says that instead of valuing each cash flow stream separately, one can gross up the tax shields in an overall discount factor called WACC such that we will arrive at the same firm value V_L. Therefore, to satisfy Eq. (A2), WACC must take the following form,

$$WACC = r_A - r_D\tau \times \frac{D}{D+E'} = r_A - r_D\tau \times l. \qquad \text{(A3)}$$

where $l = \frac{D}{V_L}$ is the leverage ratio. According to the definition of WACC,

$$WACC = r_D(1-\tau)\frac{D}{E'+D} + r_E\frac{E'}{E+D}, \qquad \text{(A4)}$$

where E is equity value and r_E is the required rate of return on equity. Eqs. (A3) and (A4) imply that the equity holders would require a rate of return given below,

$$r_E = r_A + (r_A - r_D)\frac{D}{E'}. \qquad \text{(A5)}$$

Eq. (A4) and (A5) are (1) and (2) in the paper, respectively. Eq. (A5) is the familiar MM proposition II. As long as the firm does not deviate from its capital structure policy, the debt-equity ratio will remain constant, and thereby r_E will remain the same as time goes.

A.2. Constant Debt

If the firm maintains the same debt level D in dollar amount, then the debt and the associated debt tax shields are certain cash flows. The proper discount rate for the tax shields becomes the cost of debt r_D. Following the APV spirit, the firm value is given by

$$V_L = \frac{FCF}{r_A} + \frac{r_D D\tau}{r_D} = \frac{FCF}{r_A} + D\tau. \qquad \text{(A6)}$$

Rewrite Eq. (A6),

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[7] The firm can lose part of or the entire tax shield if it does not have enough income to deduct tax interest payments.

$$V_L\left(1-\frac{D\tau}{V_L}\right)=V_L(1-l\tau)=\frac{FCF}{r_A}. \tag{A7}$$

And by the definition of the WACC methodology,

$$V_L=\frac{FCF}{r_A(1-l\tau)}\equiv\frac{FCF}{WACC}, \tag{A8}$$

Thus the proper discount rate is

$$r=WACC=r_A(1-l\tau). \tag{A9}$$

Eq.(A9) was proposed by Modigliani and Miller. Combining Eqs. (A4) and (A8), we have

$$r_E=r_A+(r_A-r_D)(1-\tau)\frac{D}{E'}. \tag{A10}$$

Eqs. (A9) and (A10) are (3) and (4) in the paper, respectively. Eq. (A10) is sometimes referred to as the (Hamada, 1972) formula. Comparing Eqs. (A5) and (A10), one can see that r_E is higher in the constant leverage ratio case given everything else being equal. This is because the present value of the tax shields is worth less when discounted by r_A in Eq. (A2) rather than a lower rate of r_D in Eq. (A6),[8] and equity holders bear this reduction in firm value, implying a higher expected equity required rate of return.

A major difference between Eqs. (A5) and (A10) is that r_E in (A10) changes over time due to a changing debt-equity ratio because the firm does not continuously rebalance its capital structure.

[8] See (Cooper and Nyborg, 2006).

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