

WACC Calculations in Practice: Incorrect Results due to Inconsistent Assumptions - Status Quo and Improvements

Matthias C. Grüninger¹ & Axel H. Kind²

¹ Lonza AG, Münchensteinerstrasse 38, CH-4002 Basel, Switzerland

² University of Basel, Peter Merian-Weg 6, CH-4002 Basel, Switzerland

Correspondence: Matthias C. Grüninger, Lonza AG, Münchensteinerstrasse 38, CH-4002 Basel, Switzerland. Tel: 41-61-316-8530. E-mail: matthias.grueninger@alumnibasel.ch

Received: February 2, 2012

Accepted: March 30, 2013

Online Published: April 17, 2013

doi:10.5430/afr.v2n2p36

URL: <http://dx.doi.org/10.5430/afr.v2n2p36>

Abstract

This paper argues that in practical applications the weighted average cost of capital (WACC) is often incorrectly estimated due to the simultaneous use of two inconsistent input parameters: (i) a beta of debt equal to zero when transforming asset betas into equity betas (beta levering) and (ii) a cost of debt above the risk-free interest rate when calculating the WACC. The paper discusses and quantifies the consequences of this inconsistency and offers viable solutions. By replacing the cost of debt with the risk-free rate, a more accurate WACC is calculated and the estimation of the cost of debt becomes obsolete. Furthermore, the paper presents a solution to obtain the correct WACC without increasing the calculation's complexity.

Keywords: WACC, Cost of capital, Cost of debt

1. Introduction

The weighted average cost of capital (WACC) is a discount rate used in the majority of project and company valuations that rely on entity-based discounted cash flow methods. This valuation method is generally recognized as suitable for determining the value of companies given a variety of assumptions about the future development of debt (e.g., Brealey et al., 2008, Koller et al., 2005). (Note 1) The pure WACC is simply the weighting of the individual cost of capital components (usually debt and equity) and does not dictate any specific rule in the calculation of the capital costs of debt, equity, and, possibly, hybrid instruments. However, in modern practical applications, certain aspects of the calculation appear to be almost standardized and are thus hardly questioned.

First, the WACC is most often calculated with an adjusted cost of debt that accounts for the tax deductibility of interest-rate costs. For this reason, it is often referred to as the after-tax WACC; it can be used to discount expected future after-tax cash flows to the firm, regardless of whether they will accrue to equity or debt investors.

Second, cost of equity calculations used in the WACC mostly rely on the capital asset pricing model (CAPM). While the exact estimation of the CAPM parameters (risk-free rate, risk premium, and equity beta) is subject to some degrees of freedom and even arbitrariness, the model itself is well established and accepted. For example, Graham and Campbell (2001) mention in a survey of Fortune 500 CFOs that “73.3% of respondents always or almost always use the CAPM” (p. 201).

Third, the equity beta required as input for the CAPM is usually computed by (re-)levering the asset beta (sometimes called industry beta, business beta, or unlevered beta) derived from comparable listed firms. The use of comparable companies is very common in practice because it reduces the standard error of beta and makes the beta estimation more

accurate. Further, in all situations when the firm to be valued is not traded, there is no viable alternative to relying on the betas of comparable companies. For the sake of simplicity, practitioners usually assume that the debt beta is equal to zero when levering and unlevering betas. This common practice is also backed by leading corporate valuation textbooks (e.g., Damodaran, 2002, p. 194).

Finally, in WACC calculations a cost of debt needs to be estimated. Interestingly, in spite of the previous zero-beta assumption, the (pre-tax) cost of debt is generally set higher than the risk-free interest rate, which implies a positive debt premium. However, only a (pre-tax) cost of debt equal to the risk-free interest rate is truly consistent with a debt beta of zero.

This paper contributes an analysis of the WACC-based valuation practice just laid out. In particular, we provide an analysis of the common practice of using (i) a positive debt premium in the WACC formula together with (ii) a debt beta of zero in the (re-)levering step of equity betas. We show that whenever a debt beta of zero is assumed in the (re-)levering step, all efforts put into the estimation of an accurate debt premium are unnecessary and even detrimental to an accurate valuation. In a world without taxes (or no deductibility of interest costs), assuming a debt beta of zero will yield a correct WACC (and thus a correct valuation) as long as the cost of debt is also set equal to the risk-free interest rate. In this case, the downward-biased cost of debt will be exactly offset by the upward-biased cost of equity. (Note 2) In a world with taxes, the assumption of a debt beta of zero will generate an error in the WACC and will bias the valuation results, even if the cost of debt is replaced by the risk-free interest rate. However, we show that the magnitude of the error can be reduced if the debt premium is consistently set equal to zero. While at first glance it seems a priori unreasonable to assume corporate debt to be risk free, one has to keep in mind that this assumption is the only one that is truly consistent with the formula commonly used by practitioners for levering and unlevering equity betas. For practitioners reluctant to work with a cost of debt equal to the risk-free rate, we propose two viable solutions: either (i) calculate the after-tax WACC by using a more involved formula for (re-)levering betas or (ii) use an improved WACC formula. The latter WACC improvement is computationally equivalent to the WACC of Farber, Gillet, and Szafarz (2006) under the assumption of a constant debt ratio and a tax shield with the same risk as the firm's assets. However, the proposed formula builds on and extends the WACC that is most often used in practice.

The remainder of this paper is organized as follows. Section 2 lays out how the WACC is computed in practice; it discusses its inconsistencies and derives formulas for the errors it generates in the calculation of equity betas, the cost of equity, and after-tax WACC. Section 3 illustrates the theoretical findings of the previous section by means of a numerical valuation example. Section 4 proposes two ways to improve best practice of WACC calculations and discusses their advantages. Finally, Section 5 concludes with a summary of the major results and implications of this paper.

2. Correct and incorrect WACC calculations

The after-tax WACC (Note 3) of a company financed by debt and equity can be computed as

$$WACC = r_E \cdot (1-L) + r_D \cdot (1-T_C) \cdot L,$$

with

r_E : cost of equity,

L : leverage ratio, defined as the ratio of the market value of debt, D , to the enterprise value, $D+E$,

r_D : pre-tax cost of debt (at a specific leverage level L),

T_C : corporate tax rate.

The presence of T_C in the above formula reflects the existence of tax benefits due to the deductibility of interest costs (Modigliani and Miller, 1958, 1963; Scott, 1976). While the tax rate, T_C , and the leverage ratio at market values, L , are known quantities (Note 4), some care must be applied to the appropriate choice of a (pre-tax) cost of debt, r_D , and cost of equity, r_E .

2.1 WACC calculations in practice

Companies have developed a large variety of techniques to compute the cost of equity and cost of debt for use in WACC calculations. Since a thorough discussion of all the approaches is clearly unfeasible, we focus on one general approach that is widely used in practice and that can be considered a de facto standard in practical corporate finance.

According to this approach, which we will term Practitioner WACC ($WACC^P$), the cost of equity is computed by the following five steps.

First, an estimate of the asset beta, β_A , is obtained from comparable companies operating in the same business. According to a survey by Bancel and Mittoo (2012) based on 416 questionnaire responses from investment bankers, financial analysts, portfolio managers, and valuation experts, 85% of companies make use of comparable firms when calculating asset betas. The wide use of comparable companies can be explained by the lower standard errors of this approach compared to regression betas based on the stock returns of the company to be evaluated. Further, in all situations in which the company is not listed, there is no valuable alternative to comparable companies. For the sake of simplicity, we assume that the asset beta is correctly estimated and thus corresponds to the true unlevered beta of the company.

In a second step, the asset beta, β_A , is transformed into a company-specific equity beta, β_E^P , by applying the formula

$$\beta_E^P = \beta_A / (1-L),$$

where the superscript P in β_E^P indicates that the equity beta is a practitioner estimate that will likely differ from the true equity beta, β_E . The above levering formula is widely used in practice, although it implicitly assumes that the debt beta of the company, β_D , is equal to zero. According to the survey of Bancel and Mittoo (2012), the assumption of a debt beta of zero is made by as many as 82% of companies.

Third, the equity beta in Equation (2) is used in combination with the CAPM to estimate the company's cost of equity:

$$r_E^P = r_f + \beta_E^P \cdot RP,$$

where RP is the market risk premium and, again, the superscript P indicates that the so computed cost of equity capital, r_E^P , is a practitioner estimate that likely differs from the true cost of equity, r_E .

Fourth, an estimate of pre-tax debt capital costs, r_D^P , is obtained either from the yield on the company's outstanding debt or as an average of yields on bonds issued by comparable companies of equal rating. For the sake of simplicity, this paper assumes that the estimated cost of debt is equal to the true cost of debt: $r_D^P = r_D$.

In the fifth and final step, all input parameters are used to compute a WACC estimate in accordance with Equation (1):

$$WACC^P = r_E^P \cdot (1-L) + r_D \cdot (1-T_C) \cdot L.$$

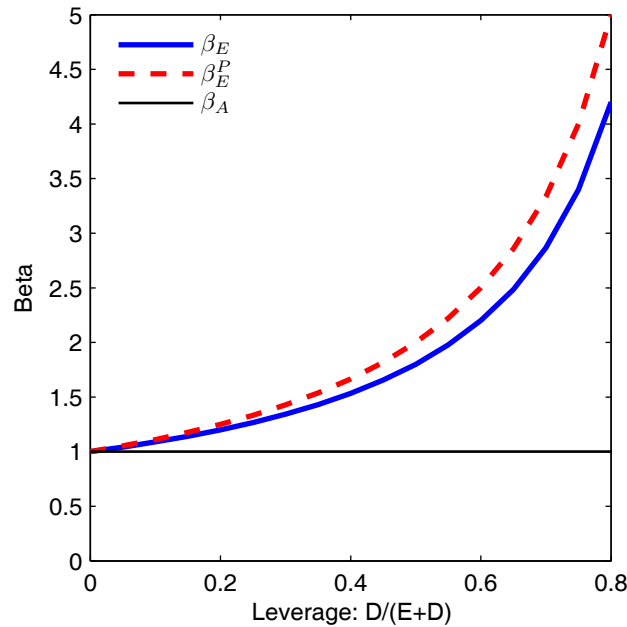
2.2 Accuracy of the Practitioner WACC

While care is needed in each of the above steps to avoid inaccurate results, in this paper we argue that the beta levering in step two of the above procedure (Equation (2)) introduces a systematic bias into the final WACC. In fact, as indicated by Harris and Pringle (1985) and Ruback (2002), among others, the correct levering formula (Note 5) for the equity beta is

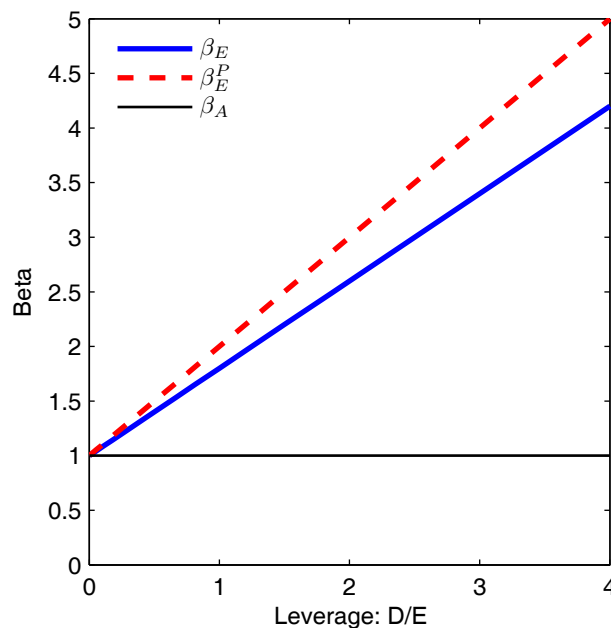
$$\beta_E = \beta_A + L/(1-L) \cdot (\beta_A - \beta_D).$$

Thus, by assuming a debt beta of zero, Equation (2) overestimates the true company's equity beta by an amount

$$\varepsilon(\beta_E^P) = \beta_E^P - \beta_E = L/(1-L) \cdot \beta_D.$$



Fig(a)



Fig(b)

Figure 1. Betas at different leverage ratios. The plots are generated by assuming a fixed asset beta, β_A , of 1.0 and a fixed debt beta, β_D , of 0.4. (a) Leverage is defined as $D/(E+D)$. (b) Leverage is defined as D/E . β_E is the true equity beta and β_E^P is the equity beta as calculated by practitioners.

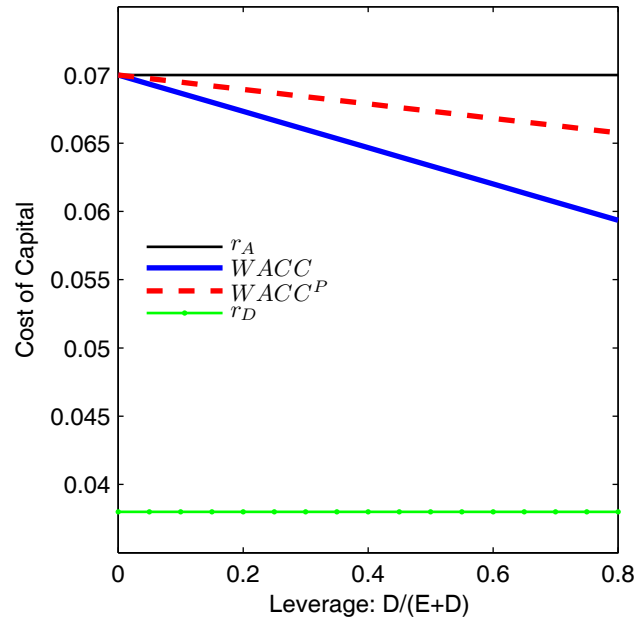
Figure 1 depicts β_E^P and β_E for different leverage values, with β_A and β_D fixed at 1.0 and 0.4, respectively. As already shown by Modigliani and Miller (1958, 1963), equity beta increases with leverage. If leverage is defined as $D/(E+D)$, the relation is convex (see Figure 1(a)). If, on the other hand, leverage is defined as D/E , this relation is linear (see Figure 1(b)). The graphs further show that the error in the equity beta is, all else being equal, larger for higher leverage ratios.

The upward-biased equity beta leads to an overestimation in the cost of equity of

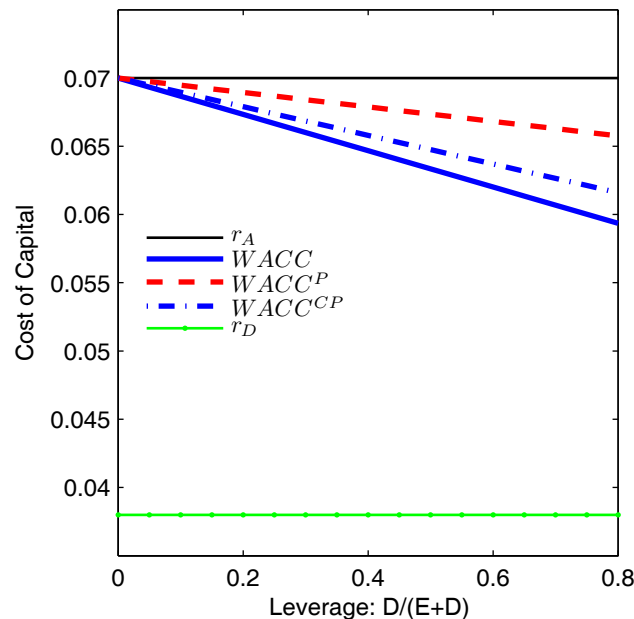
$$\varepsilon(r_E^P) = r_E^P - r_E = L/(1-L) \cdot \beta_D \cdot RP$$

and an overestimation of the after-tax WACC of

$$\varepsilon(WACC^P) = WACC^P - WACC = L \cdot \beta_D \cdot RP.$$



Fig(a)



Fig(b)

Figure 2. The WACCs for different leverage ratios. The plots are generated by assuming a fixed asset beta, β_A , of 1.0 and a fixed debt beta, β_D , of 0.4. Further, the graph is based on the assumptions $r_f = 0.03$, $T_C = 0.35$, and $RP = 0.04$, where r_A is the capital cost of the unlevered firm, WACC is the true after-tax WACC, $WACC^P$ is the Practitioner WACC, and r_D is the pre-tax cost of debt. $WACC^{CP}$ is an improved version of the Practitioner WACC as discussed in Section 4.1 of the paper.

Figure 2(a) depicts the difference between the correct WACC and the Practitioner WACC. As expected, the correct WACC decreases with leverage because of the tax shield. While the Practitioner WACC also decreases with leverage, its upward bias increases as L gets larger.

2.3 Considering errors in the initial asset beta

So far, it was assumed that WACC calculations started with the correct unlevered beta, β_A . However, in practical applications the unlevered beta is estimated by computing the average of the de-levered equity betas of comparable companies obtained from market model regressions. If the assumption of a debt beta of zero is already used in this de-levering step, then the initial practitioner asset beta, β_A^P , that was previously assumed as correct will be biased downward ($\beta_A^P < \beta_A$). As illustrated in Figure 3, whether the re-levered practitioner equity beta, β_E^P , will over- or underestimate the true equity beta will critically depend on the leverage of the company in question relative to the (mean) leverage of comparable firms. If the leverage is higher (lower) than that of the comparable firms, then the practitioner equity beta will overestimate (underestimate) the true equity beta. To some extent, the two errors in the de- and re-levering steps cancel each other out. However, they will only offset each other if the two leverage ratios are identical. In this case, naturally, there is no need for de-levering and re-levering betas in first place because the equity betas of the comparable companies can be directly used to calculate the cost of equity, r_E .

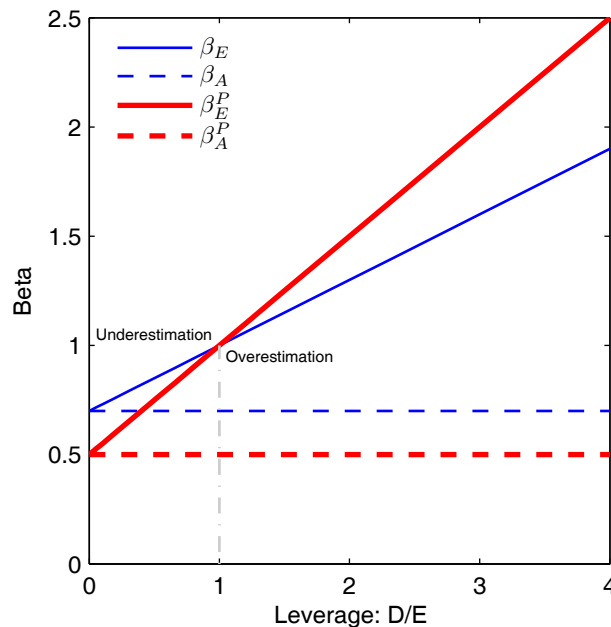


Figure 3. Betas at different leverage ratios. The plots are generated by assuming that comparable firms have an equity beta of one ($\beta_E^C = 1.0$), a debt beta of 0.4 ($\beta_D^C = 0.4$), and leverage of one ($L^C = D/E = 1$). The debt beta of the company, β_D , is assumed to be 0.4 at all leverage ratios. The correct asset and equity betas (β_A and β_E) are obtained by correctly de-levering and re-levering the equity beta of comparable firms. The practitioner asset and equity betas (β_A^P and β_E^P) are obtained by incorrectly assuming a debt beta of zero in both the de-levering and re-levering steps.

3. A numerical valuation example

3.1 Assumptions

To put the results in perspective, we value a company by using both the correct WACC approach and the Practitioner WACC. To keep the example as simple as possible but still economically meaningful, the following assumptions are made:

- The company generates constant yearly expected earnings before interest and taxes (EBIT) of \$100 million (perpetuity),
- The risk-free rate is equal to 2.5% per annum, $r_f = 0.025$,
- The market risk premium is equal to 4% per annum, $RP = 0.04$,
- The asset beta of the company is equal to one, $\beta_A = 1.0$,

- The company tax rate is equal to 35%, $T_C = 0.35$,
- The pre-tax cost of debt is equal to 6% per annum, $r_D = 0.06$,
- The observed leverage ratio at market prices is equal to 50%, $L = D/(E+D) = 0.5$,
- The tax shield (TS) is assumed to have the same risk as the firm (e.g., Harris and Pringle, 1985), $\beta_{TS} = \beta_A$,
- There are no changes in net working capital and capital expenditures are always equal to depreciation.

3.2 Correct WACC

Given the above information, it is possible to compute the correct WACC according to Equation (1). The only missing input parameter is the cost of equity, r_E , which can be computed by levering the asset beta according to Equation (5) and applying the CAPM formula:

$$\beta_E = \beta_A + L/(1-L) \cdot (\beta_A - \beta_D) = 1.0 + 0.5/(1 - 0.5) \cdot (1.0 - 0.875) = 1.13.$$

Note that 0.875 corresponds to the debt beta implied by a pre-tax cost of debt of 6% according to the CAPM, $\beta_D = (r_D - r_f)/RP = (0.06 - 0.025)/0.04$. The equity beta can now be used to compute the cost of equity capital:

$$r_E = r_f + \beta_E \cdot RP = 0.025 + 1.13 \cdot 0.04 = 7.0\%.$$

The WACC formula in Equation (1) then yields capital costs of 5.45%:

$$WACC = r_E \cdot (1-L) + r_D \cdot (1-T_C) \cdot L = 0.07 \cdot (1-0.5) + 0.06 \cdot (1-0.35) \cdot 0.5 = 5.45\%.$$

Since after-tax free cash flows to the firm are a constant perpetuity, the value of the company can be computed simply by dividing the after-tax cash flows by the WACC:

$$\text{Correct enterprise value} = EBIT \cdot (1-T_C) / WACC = 100 \cdot (1-0.35) / 0.0545 = \$1,193 \text{ million}.$$

3.3 Practitioner WACC

As shown above, in typical WACC-based valuations, the levering of the initial asset beta is performed by assuming a debt beta of zero:

$$\beta_E^P = \beta_A / (1-L) = 1.0 / (1 - 0.5) = 2.0.$$

The resulting equity beta is overestimated by 0.875 (or 77.8%). The magnitude of the error can be directly computed by using Equation (6): $\varepsilon(\beta_E^P) = L/(1-L) \cdot \beta_D = 0.5/(1-0.5) \cdot 0.875 = 0.875$. The overestimated equity beta leads to an upward-biased cost of equity:

$$r_E^P = r_f + \beta_E^P \cdot RP = 0.025 + 2.0 \cdot 0.04 = 10.50\%.$$

The estimated cost of equity is 3.5 percentage points higher than the correct cost of equity of 7%. It further translates into a Practitioner WACC of

$$WACC^P = r_E^P \cdot (1-L) + r_D \cdot (1-T_C) \cdot L = 10.5\% \cdot (1-0.5) + 6\% \cdot (1-0.35) \cdot 0.5 = 7.20\%.$$

Finally, the enterprise value of the company with the Practitioner WACC is calculated as

$$\text{Practitioner enterprise value} = EBIT \cdot (1-T_C) / WACC^P = 100 \cdot (1-0.35) / 0.0720 = \$903 \text{ million}.$$

In this example, the use of the Practitioner WACC leads to an undervaluation of the company by \$290 million, or 24.3%.

4. Improvements of the Practitioner WACC

4.1 Better WACC with lower effort

As argued so far, the Practitioner WACC has two important problems. The first one lies in the assumption of a debt beta of zero and thus risk-free debt in the levering step (see Equation (2)). The second and more serious problem relates to the inconsistent use of this assumption. While company debt is assumed to be risk free in the levering step, it is also assumed to yield a positive risk premium in the calculation of the WACC (see Equation (4)). Thus, one way to improve on the current practice of WACC calculation is to operate consistently with a risk-free corporate debt. In particular, consistency dictates the use of a pre-tax cost of debt equal to the risk-free interest rate ($r_D = r_f$) in the WACC formula:

$$WACC^{CP} = r_E^P \cdot (1-L) + r_f \cdot (1-T_C) \cdot L,$$

where the superscript *CP* indicates a consistent practitioner version of the WACC. The error of $WACC^{CP}$ can be easily computed as

$$\varepsilon(WACC^{CP}) = WACC^P - WACC = L \cdot \beta_D \cdot RP \cdot T_C.$$

By comparing the error of the Practitioner $WACC^P$ (Equation (8)) with that of the Consistent Practitioner $WACC^{CP}$ (Equation (10)), it is evident that the latter is smaller than the former by the factor $(1-T_C)$. Thus, the overestimation of the cost of equity is partially counterbalanced by the underestimation of the cost of debt. Figure 2(b) shows that the $WACC^{CP}$ is always closer to the true WACC than the Practitioner WACC.

In the numerical valuation example presented in Section 2.3, the Consistent Practitioner WACC generates capital costs of 6.06%:

$$WACC^{CP} = r_E^P \cdot (1-L) + r_f \cdot (1-T_C) \cdot L = 10.5\% \cdot (1-0.5) + 2.5\% \cdot (1-0.35) \cdot 0.5 = 6.06\%.$$

Based on this WACC, the company's enterprise value equals \$1,072 million. This corresponds to an undervaluation of 10.1%, which represents a clear improvement over the undervaluation of 24.3% resulting from the Practitioner WACC.

The no-tax case ($T_C = 0$) deserves comment. Whenever there are no taxes, the Consistent Practitioner WACC generates the exact cost of capital because the overestimated cost of equity is perfectly counterbalanced by the underestimated cost of debt. This also means that by setting $T_C = 0$, one can use the Consistent Practitioner WACC to compute the correct pre-tax WACC or the cost of capital of the unlevered firm, r_A :

$$\text{Pre-Tax WACC} = r_A = r_E \cdot (1-L) + r_D \cdot L = r_E^P \cdot (1-L) + r_f \cdot L.$$

Overall, the proposed improvement of the Practitioner WACC is based on the consistent use of the zero-debt-beta assumption. It is valuable because it increases the accuracy of the cost of capital estimation without requiring additional input parameters. On the contrary, the improved WACC formula does not require the estimation of a debt premium and is therefore even easier to calculate than the Practitioner WACC.

In practical applications the cost of debt is often approximated by yields of bonds issued by the same company or by firms with a comparable rating. Since bond yields are usually higher than the cost of debt, the error in the WACC calculation is further aggravated. This case should be viewed as an additional argument for replacing the cost of debt with the risk-free interest rate.

4.2 Rethinking the WACC: A second improvement

The WACC formula in Equation (1) can be easily rewritten as

$$WACC = r_E \cdot (1-L) + r_D \cdot L - (T_C r_D L).$$

The first two terms of this equation, $r_E \cdot (1-L) + r_D \cdot L$, correspond to the pre-tax WACC, or the WACC of the unlevered firm. By exploiting the identity in Equation (11), we can rewrite the WACC formula as

$$WACC = r_E^P \cdot (1-L) + r_f \cdot L - (T_C r_D L).$$

This WACC formula has several advantages. First, it delivers the correct WACC. Second, it does not require the fully fledged re-levering formula (Equation (5)) that practitioners seem so reluctant to use. Third, the formula provides in its third term $(-T_C r_D L)$ an explicit expression of the impact of the tax shield on the after-tax cost of capital. Thus, it shows transparently how the tax shield affects the WACC. (Note 6) Fourth, use of the Practitioner WACC in the calculation of the pre-tax WACC mitigates the impact of estimation errors in the cost of debt: Possible errors in the estimation of the debt premium do not distort the entire pre-tax WACC but only the capital cost discount triggered by the tax shield. The above formula is computationally equivalent to the WACC formula proposed by Farber et al. (2006) under the assumption of a constant debt ratio and a tax shield with the same risk as the firm's assets: $r_A - T_C r_D L$. However, Equation (13) provides a specific way to calculate r_A that builds on the Practitioner WACC. For this reason, the proposed formula may have a higher chance of being used by practitioners.

5. Conclusions and implications

If one uses the after-tax Practitioner WACC—which assumes a debt beta of zero in the levering of betas but uses a cost of debt above the risk-free interest rate in the WACC formula—one should be aware of its inner inconsistency and the errors this approach generates.

This paper derives closed-form solutions for the errors in beta, the cost of equity, and the cost of capital caused by the Practitioner WACC and provides consistent numerical valuation examples.

A better estimate of the after-tax WACC can be derived through a minor change in the WACC formula; specifically, the cost of debt should be set equal to the risk-free interest rate. This small adjustment has several advantages:

- First, it preserves inner consistency with respect to the assumption of a zero debt beta.
- Second, it delivers more accurate WACC estimates—which turn out to be exact in the no-tax case—and thus also better project and company valuations.

- Third, it reduces the costs of the approach because it renders the estimate of a debt premium unnecessary.

In a second refinement of the Practitioner WACC, we show how to separate the tax shield effect and obtain the correct WACC. While this second formula requires an estimate of the debt premium, possible errors in this estimate distort the tax-shield effect, but not the cost of capital of the unlevered firm (r_A).

References

- Bancel, F., & Mitto, U. (2012). Valuation practices and CAPM implementation. Available at <http://www.cfasociety.org/switzerland/Lists/Events%20Calendar/Attachments/318/Valuation%20practices%20Sep%2027,%202012.pdf>, last accessed January 25, 2013.
- Brealey, R.A., Myers, S.C., & Allen, F. (2008). *Principles of Corporate Finance*, 9th edition, McGraw-Hill. New York, NY. PMID18616820
- Damodaran, A. (2002). *Investment Valuation – Tools and Techniques for Determining the Value of any Asset*, 2nd edition, New York, John Wiley & Sons.
- Farber, A., Gillet, R., & Szafarz, A. (2006). A general formula for the WACC, *International Journal of Business* 11(2), 211–218.
- Fernandez, P. (2005). Equivalence of ten different methods for valuing companies by cash flow discounting, *International Journal of Finance Education* 1(1), 141–168.
- Graham, J.R., & Campbell, R.H. (2001). The theory and practice of corporate finance: Evidence from the field, *Journal of Financial Economics* 60, 187–243. [http://dx.doi.org/10.1016/S0304-405X\(01\)00044-7](http://dx.doi.org/10.1016/S0304-405X(01)00044-7)
- Harris, R.S., & Pringle, J.J. (1985). Risk-adjusted discount rates – Extensions from the average-risk case, *Journal of Financial Research* 8(3), 237–244.
- Koller, T., Goedhart, M., & Wessels, D. (2005). *Valuation – Measuring and Managing the Value of Companies*, 4th Edition Hoboken, John Wiley & Sons.
- Modigliani, F., & Miller, M. (1958). The cost of capital, corporation finance and the theory of investment, *American Economic Review* 48(3), 261–297.
- Modigliani, F., & Miller, M. (1963). Corporate income taxes and the cost of capital: A correction, *American Economic Review* 53, 433–443.
- Ruback, R.S. (2002). Capital cash flows: A simple approach to valuing risky cash flows, *Financial Management* 31(2), 85–103. <http://dx.doi.org/10.2307/3666224>
- Scott, J.H. (1976). A theory of optimal capital structure, *Bell Journal of Economics*, 7, 33–54. <http://dx.doi.org/10.2307/3003189>

Notes

Note 1. Some authors (e.g., Koller et al., 2005; Damodaran, 2002) argue that it is preferable to use the Adjusted Present Value (APV) approach instead of a WACC-based model for companies that are expected to experience a significant change in their capital structure. In fact, the APV approach has the very practical advantage of calculating the value of the tax shield and thus also the effects of changes in leverage separately from the rest of the valuation.

Note 2. This is only true when the unlevered beta is correctly estimated (see Section 2.3).

Note 3. If not otherwise stated, in this paper the term *WACC* indicates the after-tax weighted average cost of capital.

Note 4. To obtain correct valuations, leverage, L , must be iteratively updated after each equity valuation until convergence is reached. In fact, as mentioned by Fernandez (2005), different valuation methods (e.g., WACC, equity cash flow, or economic value added, EVA) yield the same results only if this iteration is performed.

Note 5. This formula effectively assumes that the tax shield has the same risk as the firm's operating assets, that is, $\beta_{TS} = \beta_A$ (see Koller et al., 2005, for an overview of appropriate leveraging formulas under different assumptions). As for Harris and Pringle (1985), for the sake of simplicity, the analyses carried out in this paper are based on this assumption.

Note 6. The presence of a separate tax shield term in the WACC formula offers valuable flexibility. Specifically, it allows one to account for the fact that tax benefits are often determined by effective interest rate payments (e.g., coupons) than by the cost of debt.