Teaching the Weighted Average Cost of Capital using a Capital Structure Approach

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Abstract

The weighted average cost of capital is one of the fundamental building blocks for understanding many corporate financing decisions. In this paper, we explain a method showing the dynamic nature of the weighted average cost of capital. We begin with a discussion of the firm's cost of capital in a tax-free environment and incorporate taxes. Following the introduction of the tax shield involving debt, we demonstrate that as the firm's capital structure changes the returns demanded by both the debt holders and equity holders of the firm change as well. We have used this method for several years and find that students develop the necessary understanding to progress in future finance courses.

Keywords: WACC, Weighted Average Cost of Capital, Hamada Equation

1. Introduction

The Weighted Average Cost of Capital (WACC) is integral to students' understanding of many of the concepts discussed in finance courses. While WACC, mechanically, does not require complex calculations, students sometimes struggle with some of the intricacies involved in the component parts of the calculation. The weighted average cost of capital is defined as:

$$WACC = w_d r_d(1 - T) + w_p r_p + w_e r_e \quad (1)$$

where *WACC* represents the firm's weighted average cost of capital, w_d represents the percentage of debt in the firm's capital structure, r_d represents the firm's cost of debt, T represents the firm's tax rate, w_p represents the percentage of preferred stock, r_p represents the return provided to preferred shareholders, w_e represents the percentage of common equity in the firm's capital structure, and r_e represents the expected return on common equity for shareholders. While two forms of equity (common and preferred) contribute to the cost of capital, limiting the cost of capital discussion to including only debt and common equity avoids a level of complexity that may confuse students. If choosing to go this route, it can be pointed out that when the weight of preferred stock is zero ($w_p = 0$), the middle component of the equation ($w_p r_p$) falls out.

Textbooks suggest that WACC is a weighted average of the firm's costs of debt and equity, with the weights determined by the ex-post capital structure (e.g., see Brigham and Houston, 2020). Students, generally and somewhat naively, perceive the cost of capital as a static calculation that might change with changes in the mix of debt and equity or their yields rather than a dynamic model that shifts with the changes of each. Students tend to memorize the components and the meaning of each to calculate an "answer" for a project or exam.

The method presented in this paper aims to provide a holistic approach to teaching WACC by examining the relationships between the inputs. As the student learns to calculate the component costs of debt and equity, additional subtleties and layers are added to facilitate a more complete understanding of the relationships of the model. From teaching this method for several years and many sections, we have seen this method prove to be very successful.

2. Background and Prior Literature

Generally, textbooks introduce the cost of capital through a discussion of funding projects through the returns foregone to provide capital to a project (an opportunity cost of capital) or the various sources of funds (e.g. see, Brealey, Myers, and Marcus, 2017). Framing the source of funds as a tradeoff between keeping funds with an existing project versus reallocating capital to a new project suggests the scarcity of funds encountered by most firms. The scarcity concept allows students to see that all projects cannot be funded. The decomposition discussion frames for students the costs of raising funds rather than reallocation of resources.

Examining the different sources of funds available for projects, we can compare and contrast the use of debt versus equity and infer that firms cannot exclusively fund projects using debt or equity. The discussion typically begins with the issue of debt or the current return on debt. Using bond data (either synthetic or actual bonds) students can determine the current yield demanded by investors for debt. Alternatively, Damodaran suggests that a firm's Interest Coverage Ratio (or TIE Ratio) suggests a firm's default spread. When we combine the risk-free rate, any adjustments for country risk, and the default spread, we have an estimate of the firm's cost of debt (Damodaran,

2021). As the student begins considering equity, the discussion inevitably moves to CAPM (Sharpe 1964; Lintner 1965) as a means of approximating the cost of equity as suggested in Equation 2.

$$r_e = r_f + \beta(r_m - r_f) \tag{2}$$

By definition, r_e is the cost of equity, r_f is the risk-free rate, r_m is the market return and β describes the co-movement of the equity security and the market. More technically, Jensen, Black, and Scholes (1972) define beta as the "systematic" risk of the asset, r_i, where r_m is the return on the market portfolio as expressed in Equation 3.

$$\beta_i = \frac{cov(r_i, r_m)}{var(r_m)} \tag{3}$$

The weights of debt and equity are often considered as given elements and WACC is calculated using Equation 1.

3. The Method

3.1 Introducing WACC

Before introducing WACC, students should have a working understanding of how the yield to maturity on debt suggests the future yields required for current debt and that CAPM provides an approximation of the firm's cost of equity. If students are unfamiliar with these topics, a short introductory discussion should occur prior to Step 1.

The first step in discussing WACC is to describe the returns to the firm as the returns demanded by each group (debt holders and equity holders) relative to the amount of debt and equity of the firm (total value of the firm). After explaining that the firm's cost of capital is equaled to the returns demanded by debt holders, r_d, and equity holders, r_e, scaled by the mix of debt and equity, we can suggest to students that a firm's cost of capital can be seen as Equation 4.

$$Cost\ of\ Capital = w_d r_d + w_e r_e \tag{4}$$

The next factor contributing to the overall cost of capital (WACC) is a reminder to the students that debt provides a tax shield for firms and thus debt's impact on the cost of capital ought to be reduced by the tax rate paid by the firm to get Equation 5.

$$WACC = w_d r_d (1 - T) + w_e r_e \tag{5}$$

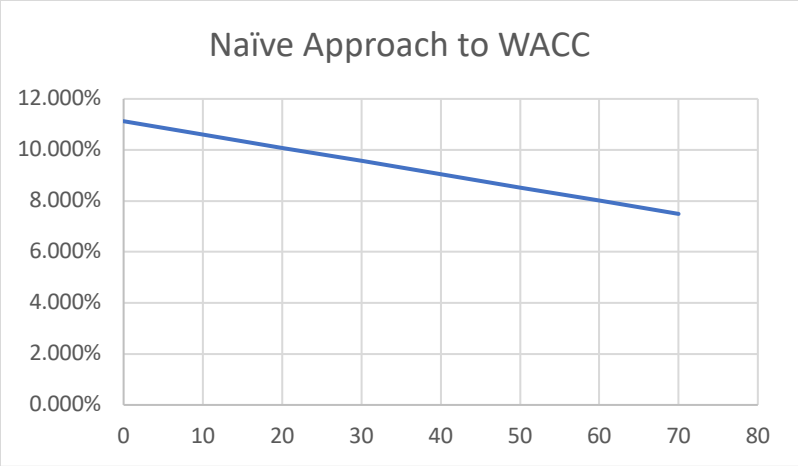
It can often be valuable to provide a simple example of why the (1 – T) component is necessary. For instance, discuss a scenario where the firm has $100 of corporate debt with a 10% coupon rate. The students should easily be able to recognize that this results in $10 of interest per year. However, now point out that the entire $10 is tax deductible for the firm, meaning that their taxable income is reduced by $10. Ask them how much the firm would save if the corporate tax rate was, for example, 30%. The students should be able to recognize that the firm would save $3 in taxes. Point out that this implies that the true, after-tax cost of the debt was actually $7, which would result in a 7% cost on the $100 of debt. This 7% is, therefore, the after-tax cost of debt, which is what is being

calculated in the WACC equation and is why the (1 – T) is needed to make the cost of debt in the equation represent the after-tax cost of debt.

3.2 Risk Effects on a Firm's WACC

Once students are comfortable with the basic equation, students will benefit by introducing the implications of changes to the components of Equation 1. The easiest means of discussing changes to WACC is to query students regarding changes to the capital structure. Prompt the students as to what changes would occur if a firm were to take on more debt to take advantage of the tax shield implications of WACC. Students taking a somewhat naïve approach to the cost of capital will allow the returns to remain constant and change the weights of debt and equity to generate something similar to the curve shown in Figure 1.

Figure 1: WACC Holding the Returns to Debt and Equity Constant



The approach shows a mechanical decrease to the WACC by overloading the firm with debt.

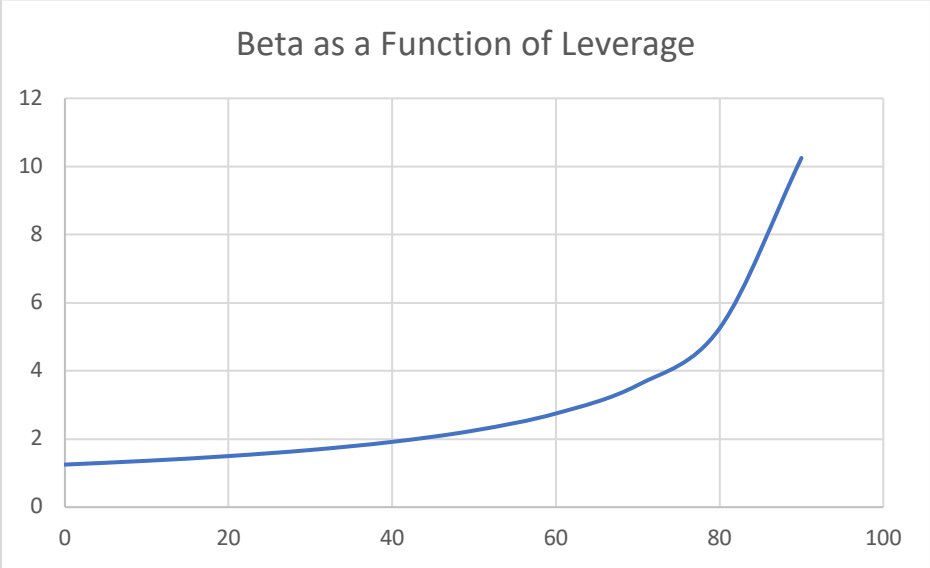
The discussion can take an informal or formal approach. If taking the informal approach, query students regarding their preference for returns were they debt holders, noting that as the firm accumulates more debt, the risk of the firm failing to repay debt increases. Using a more formal approach, an explanation regarding how increases in leverage cause changes in debt ratings and the spreads required by lenders can be provided. Many factors including: cash flows relative to debt, credit ratings of the firm, and the concavity/convexity of the yield curve contribute to a firm's cost of debt. Students can be shown a cost of debt approximation that maps directly with increasing default risk using the firm's decreasing TIE Ratio and risk-free rates (e.g., see Damodaran, 2025).

Given our earlier discussion regarding risk and returns demanded by debt holders to debunk the naïve approach to returns, we can plausibly suggest that yields required to debt holders should move similarly to equity holders. While maintaining that returns on equity can be approximated by CAPM, we can relate the leverage impact on returns demanded through the Hamada equation (Hamada 1969). From Equation 6, β is the beta of the firm with leverage, β_u is the unlevered beta, T is the firm's tax rate, and $\frac{D}{E}$ is the ratio of debt to equity for the levered firm.

$$\beta = \beta_u \left[1 + (1 - T)\left(\frac{D}{E}\right)\right] \quad (6)$$

To better understand the relation between beta and leverage, the student should be given the opportunity to both lever and un-lever a firm's beta using the firm's capital structure. As part of the exercise, different corporate events (stock issuance/repurchases or debt issuance/retirement) can be considered to reinforce the relationship. After calculating the firm's unlevered beta, the student should realize the convex relation between leverage and the value of beta for any capital structure as illustrated by Figure 2.

Figure 2: Beta as a Function of Leverage



4. How Students Respond

We have used similar techniques in both undergraduate and graduate courses. Throughout both co-authors' academic careers, this form of teaching WACC has been utilized, and modified to continually improve, to teach hundreds of students. Most of these students had little to no prior understanding of how a firm's cost of capital was calculated, or even what it represented. While developing a strong understanding of WACC, its calculation, uses, and interpretation is not made easy by this technique, we have found that it allows students of all backgrounds to get to the level needed in an introductory finance course without overcomplicating the topic.

5. Conclusion

The intent of this article is to provide details on a technique for teaching the Weighted Average Cost of Capital (WACC) to both undergraduate and graduate students in introductory finance courses. The method presented here has been found to provide students with a strong understanding of WACC and the relationship between the inputs, without overcomplicating the topic. We begin by defining WACC and its inputs to build to the formal equation, including

additional time on the tax implication to arrive at the after-tax cost of debt. We then cover the implications of shifts in capital structure and risk and the impact these have on the WACC. This allows students to gain a better understanding of the dynamic nature of the firm's cost of capital.

While this article only covers WACC at the level appropriate for most introductory-level courses, it can be expanded for courses with more advanced students (such as a finance core course in a finance master's program). For example, if the course has already included a discussion of capital budgeting (such as Net Present Value and Internal Rate of Return analysis), a follow-up discussion on the use of WACC as the starting point for the discount (or hurdle) rate is a valuable next step. This conversation should include discussion on the need to adjust the discount rate in order to capture risk that differs from the average risk of the firm. We like to include a focus on the fact that the WACC is based on the average risk that an investor might expect when investing in the firm, so any project that represents greater risk should naturally be judged against a higher required rate of return (and vice versa for projects with risk that is lower than the firm's average). Another potential follow-up discussion can focus on the concept of optimal capital structure and how shifting capital structure can potentially lead to minimized WACC, and therefore, an increased firm value.

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