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READING + INTERACTIVE ILLUSTRATIONS

Cost of Capital

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Former Harvard Business School professor Timothy A. Luehrman developed this Core Reading with the assistance of writer Barbara Wall Lobosco, HBS MBA 1995.

1 INTRODUCTION

Starting and running a business requires capital: funds to rent space, buy or build equipment, pay employees, purchase materials from suppliers, undertake essential research and marketing, and so forth. Investors provide this capital to firms, but they expect a return on their investment. They won't provide funds for free. The return that firms promise to pay investors in exchange for the capital they provide is the firm's cost of capital. This is a good intuitive definition of the cost of capital, but it does not tell us how to calculate it. Just how much does capital cost? The answer becomes complicated because there are different types of capital—debt and equity, for example—and different types of firms and investors. In this reading we offer a specific definition of the cost of capital and show how a large company might go about calculating it.

We begin with a financial perspective, according to which a business is regarded as a sequence of uncertain future cash flows it is expected to generate. The value of the business is the present value of all these future cash flows, computed by discounting at the appropriate rate. The appropriate discount rate is the return on investment offered to the firm's owners—that is, its investors. This promised expected return is the cost of capital. This approach to valuing a business is very common and referred to as "discounted cash flow" (DCF) valuation. It uses the basic present-value relationship:

$$PV = \sum_{t=1}^{T} \frac{Cf_t}{(1+r)^t}$$

where PV denotes present value, Cf_t denotes cash flows at time t, the last such cash flow occurs at $t = T$, and r denotes the discount rate. In a business valuation, PV is the value of the firm, Cf_t is the firm's expected net cash flow at time t, and r is the firm's cost of capital. As a practical matter, the cost of capital in DCF analyses is commonly estimated as the ***weighted average cost of capital*** (***WACC***). The WACC is a specific combination of the costs of debt and equity capital, which we will examine in detail below.

To estimate the WACC, it helps to be familiar with the mathematics of discounting and the basic determinants of the costs of debt and equity. Several related Core Readings address these topics. *Core Reading: Time Value of Money* (HBP No. 8299) covers compounding and discounting. This reading presumes readers are already familiar with both the concept and the calculations of discounting. The ***cost of debt*** is considered in *Core Reading: Introduction to Bonds and Bond Math* (HBP No. 5170), and the ***cost of equity*** is covered in two readings: *Core Reading: Risk and Return 1: Stock Returns and Diversification*, and *Core Reading: Risk and Return 2: Portfolio Theory* (HBP Nos. 5220 and 8603). It is not essential, but certainly helpful, to study both these topics before beginning this reading.

This reading is organized in two main parts. The Essential Reading focuses first on the financial economics of the cost of capital, including the relationship between the WACC and formal models of risk and return. It then examines practical problems that arise in calculating the WACC and illustrates the calculations using data for the Coca-Cola Company. The Supplemental Reading offers cautionary advice to users of the WACC and describes some other approaches to discounted cash flow valuation that use alternative discount rates.

2 ESSENTIAL READING

2.1 Financial Economics of the Cost of Capital

In the context of a discounted cash flow (DCF) valuation, the term ***cost of capital*** refers to the discount rate being applied. The discount rate depends on the riskiness of the business or project being evaluated. Assuming investors and companies are value maximizers, the correct discount rate is the ***opportunity cost of funds*** associated with the business or project. The opportunity cost of funds is the expected return on a fairly priced alternative investment with the same investment horizon and identical risk. This is also called the investment's ***required expected return***. An investor should require the same expected return on a given project or business that he or she could earn on an alternative investment with the same horizon and identical risk. To settle for a lower return would not be value maximizing. To demand a higher return would be futile, since other investors satisfied with the correct return would outbid someone demanding too high a return.

By defining the cost of capital as an opportunity cost, we have drawn a distinction between it and other financial metrics with similar names. The opportunity cost of funds is not necessarily the same as the *supply cost of capital* or *all-in cost of funds* that a corporate treasurer might use to compare alternative funding sources. For example, suppose an investment project's opportunity cost of funds is 8%, but the corporate treasurer has found a bargain and can actually raise the needed funds at a cost of 5%. Which should be used as a discount rate? The correct discount rate is still 8%. If we discount the project's cash flows at 5%, we will overvalue it compared to alternative investments. If we overvalue it, we may overpay for it compared to alternative investments, which would not be value maximizing. The fact that the treasurer can raise cheaper funds is indeed valuable, but the difference between 5% (the supply cost) and 8% (the opportunity cost) represents value created or discovered by skillful treasury operations, not by the investment project. We may well want to give the treasurer a bonus, but we do not want to overpay for the project. The two costs of capital should not be confused.

Defining the cost of capital as an opportunity cost also implies that capital markets matter—not because the firm's treasurer uses capital markets to raise new funds. Some firms are self-financing and seldom if ever raise new external capital. Rather, it is because the capital markets are where we find the "fairly priced alternative investment with the same horizon and identical risk." The capital market represents, in large part, investors' opportunity set for competing investments: It embodies genuine opportunities to buy and sell all kinds of assets. When capital markets are in equilibrium, assets are neither over- nor underpriced but, rather, fairly priced.

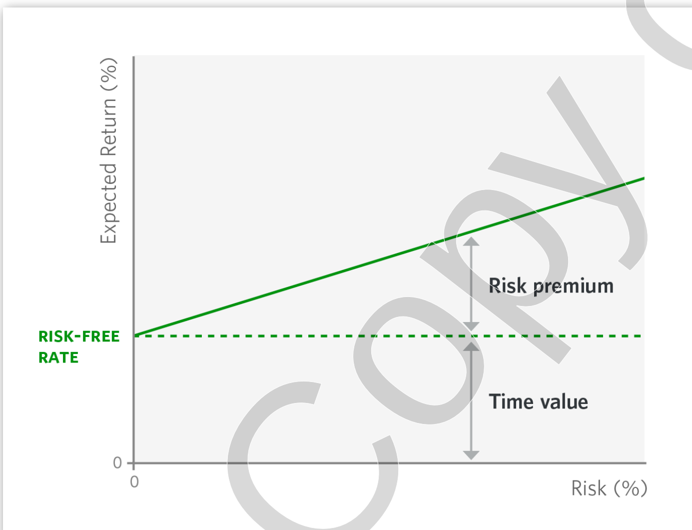
2.1.1 Time Value and Risk

The opportunity cost of funds comprises two fundamental parts: time value and a risk premium. Time value represents the return investors earn for being patient—that is, for being willing to defer consumption from today to some future date—but not accepting any risk. We'll denote the return on a risk-free investment as r_f, and we'll refer to it as the ***risk-free rate***, the return for just the "time value" portion. The ***risk premium*** is the additional expected return investors demand in exchange for taking risk; unless they are offered a risk premium (i.e., a higher expected return), risk-averse investors would not be willing to hold risky assets. We can express the opportunity cost of capital, k, for a risky asset, X, as

$$k_X = \text{required expected return on asset } X = r_f + (\text{risk premium})_X$$

In this expression for k_X, only the risk premium is asset specific. Time value is the same for every asset and every investor. The risk premium, on the other hand, depends on how risky asset X is: the riskier the asset, the higher the risk premium. This fundamental relationship is depicted as the upward sloping line in **Exhibit 1**. Note that the actual relationship between risk and expected return may or may not be linear, depending on how we choose to define and measure risk, but it certainly should be upward sloping. As you move from left to right in Exhibit 1, risk increases (the horizontal axis) and so does the associated risk premium, but time value (the risk-free rate) remains the same.

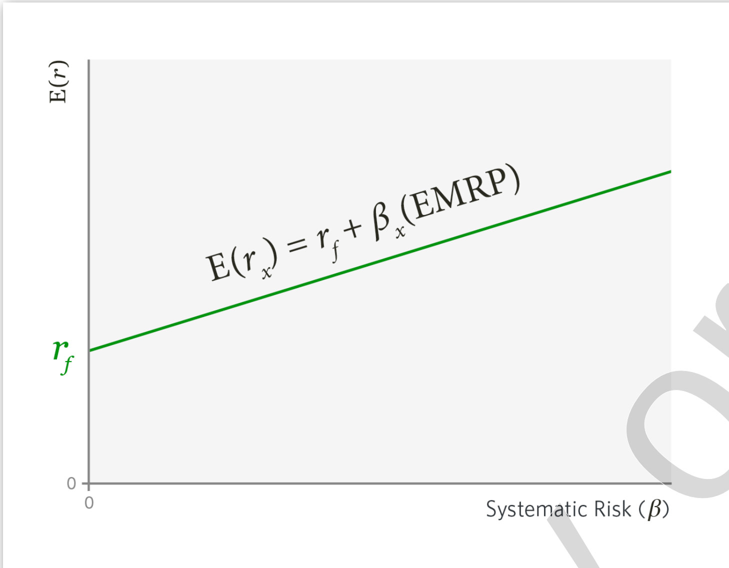
EXHIBIT 1 The Positive Relationship Between Risk and Expected Return



2.1.2 Capital Asset Pricing Model

Modern portfolio theory, summarized by and perhaps most widely applied in the form of the ***capital asset pricing model* (*CAPM*)**, gives us a particular way to define and measure risk. The CAPM tells us that value-maximizing investors will diversify, and, hence, the only risk for which they can earn a risk premium is nondiversifiable or ***systematic risk***—risk that investors cannot escape, no matter how much they diversify their portfolios. Systematic risk is measured statistically by the parameter ***beta***, which is the coefficient from a linear regression of a given risky asset's returns on market returns over matching holding periods.[1] The CAPM tells us that if we measure risk using beta, the relationship between risk and expected return is indeed linear, as shown in **Exhibit 2**.

EXHIBIT 2 The CAPM's Security Market Line



The line graphed in Exhibit 2, the ***security market line***, depicts the fundamental CAPM equation:

$$E(r_X) = r_f + \beta_X \left(E(r_{market}) - r_f \right) = r_f + \beta_X (EMRP)$$

where $E(r_X)$ denotes the expected return on risky asset X; β_X is the beta of asset X and estimates its systematic risk; $E(r_{market})$ is the expected return on the market portfolio; and EMRP denotes the ***equity market risk premium***—the expected return on the market portfolio over and above the risk-free rate (i.e., $E(r_{market}) - r_f$). By the *market portfolio* we mean a value-weighted portfolio composed of literally all assets one could invest in. In practice, a big, broad stock market index, such as the S&P 500 Index, is often used as a proxy for the market portfolio (hence the name "equity" market risk premium).

We noted above that the opportunity cost and the required expected return for asset X were the same. Therefore, the CAPM gives us a straightforward way to compute a discount rate for use in a DCF valuation: We find or estimate beta for the subject project or business, multiply it by the EMRP, and add the result to r_f. That is, once we know how risky the business is, the CAPM's security market line will tell us the opportunity cost of funds for the business. Systematic risk, measured by beta, is the only asset-specific determinant of the opportunity cost of funds and, hence, the discount rate.

2.1.3 Weighted Average Cost of Capital

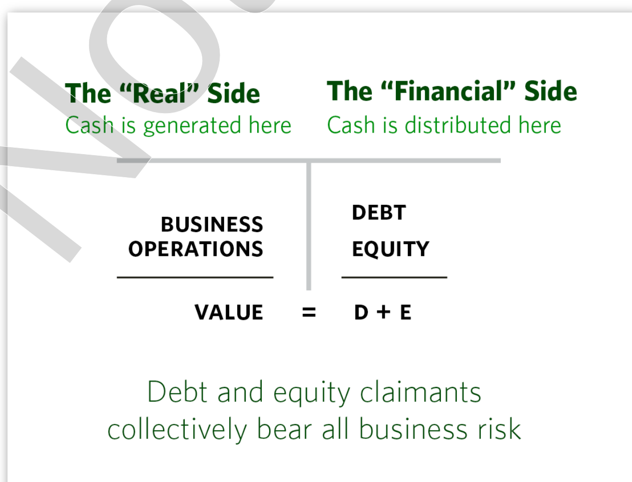
At this point, it might seem that we should be finished. But many practitioners estimate discount rates in a different way: they use the weighted average cost of capital (WACC) as the discount rate in DCF valuations. The expression for the WACC is

$$\text{WACC} = \frac{D}{V} k_d (1-t) + \frac{E}{V} k_e$$

where k_d and k_e are the costs of debt and equity, respectively; D and E are the market values of debt and equity, respectively; V is the value of the firm so that $V = D + E$; and t is the corporate tax rate. This expression looks nothing like “time value plus a risk premium,” nor does it resemble the CAPM equation. So can it be trusted to represent the opportunity cost of funds that theory requires?

To address this question, begin by considering a stylized balance sheet for a business we wish to value. The balance sheet in **Exhibit 3** shows business operations on the left side, and capital—debt and equity claims—on the right side. A few key relationships tie together the left and right sides. We can think of the left side as “Real,” where *cash is generated* by producing goods and services. The right side is “Financial,” where *cash is raised from and distributed to* the investors who provide capital to the firm as lenders or stockholders. The value of the business (left side) must equal the value of the claims issued against it (right side). Put another way, the value of the enterprise, V, must equal the value of invested capital, $D + E$.

EXHIBIT 3 A Stylized Balance Sheet
Separating the Real and Financial Sides of a Business



The same principle of equality must hold for the systematic risk of the business. That is, all the systematic risk of business operations on the left must also appear somewhere on the right—all the firm's risk must be borne by its investors. To see that the systematic risk of the business must equal the combined systematic risk of the debt and equity, suppose that a single investor owned all the debt and all the equity. He or she would, of course, bear all the risk of the business. Such an investor would receive an expected return on the debt and on the equity that together must equal the expected return on the business.

The risky business depicted in Exhibit 3 is analogous to the risky asset X we considered earlier. We can imagine a balance sheet for asset X that shows the value generated by the risky asset on the left side and debt and equity claims issued against it on the right. The debt on such a balance sheet is *less risky* than asset X, since it represents a fixed claim and is senior to equity. Accordingly, the equity, as a residual claim, must be *riskier* than asset X.[2] Required expected returns for all three are

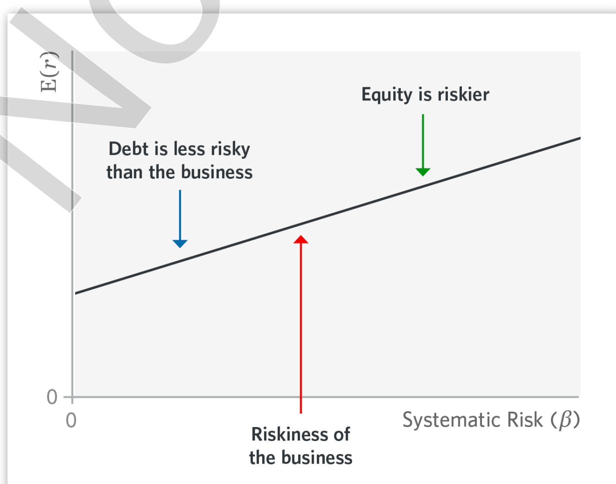
$$k_{dX} = r_f + (\text{debt risk premium})_X = \text{cost of debt}$$

$$k_{eX} = r_f + (\text{equity risk premium})_X = \text{cost of equity}$$

$$k_X = r_f + (\text{risk premium})_X = \text{opportunity cost for } X$$

where k_{dX} and k_{eX} equal required expected returns for the debt and equity, respectively, issued against asset X. These are opportunity costs of debt and equity for the particular set of claims being issued against asset X. As **Exhibit 4** shows, an average of the debt and equity risk premia, weighted according to the proportion of each on the balance sheet, must equal the entire risk premium for asset X.

EXHIBIT 4 The Business Risk Premium as a Weighted Average of Debt and Equity Risk Premium



To see this, recall that $D + E = V$. Therefore,

$$\left(\frac{D}{V}\right)\left(\text{debt risk premium}\right)_X + \left(\frac{E}{V}\right)\left(\text{equity risk premium}\right)_X = \left(\text{risk premium}\right)_X$$

The risk-free rate is not asset specific, so we can add r_f to both sides of the equation, and it becomes

$$\left(\frac{D}{V}\right)\left(\text{debt risk premium}\right)_X + \left(\frac{E}{V}\right)\left(\text{equity risk premium}\right)_X + \left(\frac{D+E}{V}\right)r_f = \left(\text{risk premium}\right)_X + r_f$$

or,

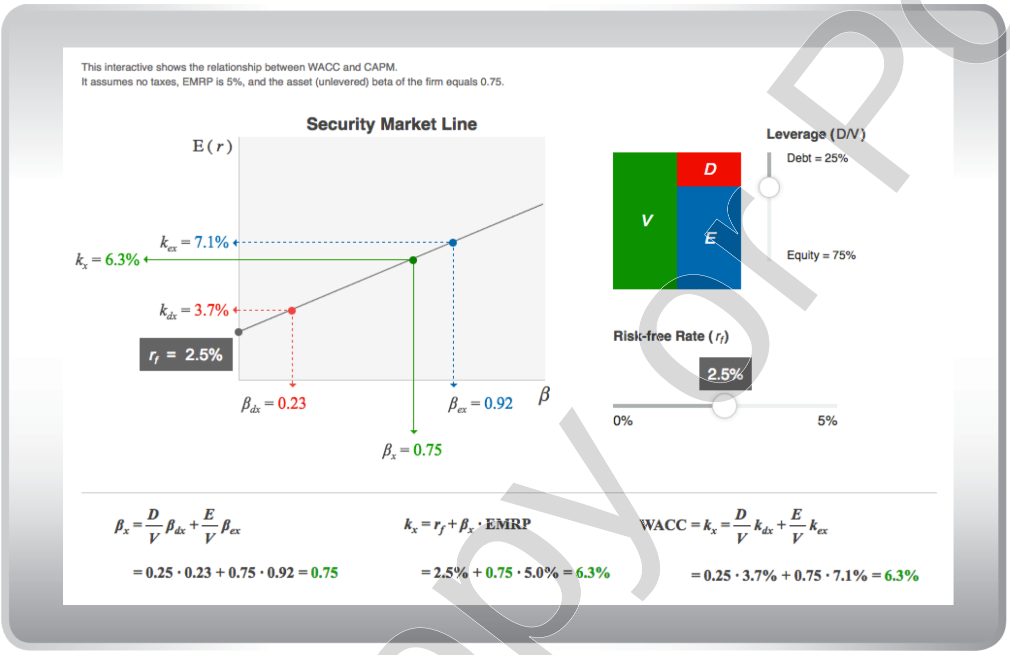
$$\frac{D}{V}k_{dX} + \frac{E}{V}k_{eX} = k_X$$

Interactive Illustration 1 allows you to observe this relationship as proportions of debt and equity change. It shows a firm with an initial capital structure of 25% debt and 75% equity, as shown on the right side of the illustration. With a risk-free rate of 2.5%, an EMRP of 5%, and an asset beta for the business of 0.75, the CAPM equation in the center below the graphs gives the cost of capital as 6.3% (= 2.5% + 0.75(5.0%)). Alternatively, we can get the same result using a weighted average of the costs of debt and equity (WACC). The costs of debt and equity equal 3.66% and 7.11%, respectively. Their value-weighted average is also 6.3%, shown below and in the equation in the bottom right of the illustration.

$$\frac{D}{V}k_d + \frac{E}{V}k_e = 0.25\left(3.66\%\right) + 0.75\left(7.11\%\right) = 6.3\%$$

INTERACTIVE ILLUSTRATION 1
Comparing WACC and the Unlevered Cost of Equity

Scan this QR code, click the image, or use this link to access the interactive illustration: bit.ly/hbsp2IROAKh



How do we know the costs of debt and equity? We know that the beta for the business equals 0.75 (by assumption). Therefore, the weighted average of betas for debt and equity must equal 0.75, as shown in the bottom-left equation in the illustration:

$$\beta_X = \frac{D}{V}\beta_{dX} + \frac{E}{V}\beta_{eX}$$

This weighted average beta, β_X, is also known as the ***asset beta*** (and denoted β_a) or sometimes as the ***unlevered beta*** (denoted β_u).

Now use the slider on the right side of the balance sheet in the illustration to raise the proportion of debt to 50%. What happens to the cost of capital? Nothing. It remains at 6.3%. (The business has not changed and its asset beta is still 0.75.) But the firm's costs of both debt and equity change. They rise to 4.6% and 7.9%, respectively. Both debt and equity are riskier because of the greater proportion of debt in the firm's capital structure. But their weighted average remains the same:

$$\frac{D}{V}k_d + \frac{E}{V}k_e = 0.50\left(4.6\%\right) + 0.50\left(7.9\%\right) = 6.3\%$$

Now use the slider in the illustration to lower the proportion of debt to 10%. What happens? The costs of debt and equity both fall (to 3.1% and 6.60%, respectively), but once again the weighted average remains constant at 6.3%, which is the same cost of capital we got by using the unlevered beta in the CAPM equation. It is the cost of capital for a firm that has no debt and is often called the cost of ***unlevered equity***, denoted by k_X or k_u.

Now try changing the risk-free rate using its slider. This changes the costs of debt and equity and the cost of capital by raising the time value of money; the vertical intercept of the graph moves up or down, directly affecting k_d and k_e and their weighted average.

In summary, the desired opportunity cost for asset X is a weighted average of the costs of debt and equity. Now note the expression we have called the "weighted average,"

$$\frac{D}{V}k_d + \frac{E}{V}k_e$$

is exactly the same as the WACC when there are no taxes (i.e., when $t = 0$). However, it is *not* simpler than the CAPM equation: $k_X = r_f + \beta_X$ (EMRP). So why use the WACC instead of the CAPM directly? Because if risky asset X happens to be a business or project instead of a security, it probably isn't traded as such on any exchange, so we can't observe or estimate its beta, β_X, directly. In contrast, many securities—debt and equity claims—*are* traded. We can use market data on stocks and bonds to directly estimate the costs of equity and debt. When k_{eX} and k_{dX} are known, k_X can be calculated using the WACC.

In short, because many projects and businesses are not traded, but securities are, we may either (1) use a weighted average of debt and equity betas to get an *asset beta*, then use the CAPM to compute k_X; or (2) use a weighted average of the *costs of debt and equity* and estimate k_X as the WACC.

2.1.4 WACC and Taxes

Our final problem relates to taxes. We noted above that the expression

$$\frac{D}{V}k_d + \frac{E}{V}k_e$$

is the same as the WACC when taxes equal zero (it sometimes is called the pretax WACC). But the version of the WACC that most practitioners use is *after-tax*:

$$\text{WACC} = \frac{D}{V} k_d (1-t) + \frac{E}{V} k_e$$

Why? The answer many appraisers would give is that "interest on debt is tax-deductible, so we need the after-tax cost of debt." But this is not a complete explanation. The important additional point is that not only are interest payments tax-deductible, *but the expected cash flows to be discounted do not include the tax shields created by corporate interest deductions.*

The conventional "recipe" for calculating a business's expected future cash flows—the cash flows intended to be discounted using the WACC—begins with earnings before interest and taxes (EBIT) for each period. It reduces EBIT for taxes and subtracts the net investment in fixed assets and working capital required by the business strategy. What's left is referred to as the ***free cash flows* (*FCF*)** generated by the business (see also the accompanying sidebar "Free Cash Flows"):

$$\text{FCF} = \text{EBIT}(1 - t) + \text{depreciation} - \text{increase in net working capital} - \text{capital expenditures}$$

The tax payment implicit in this calculation equals EBIT(t), which is an amount higher than a levered corporation would actually pay. A levered corporation's actual taxable income will be (EBIT – Interest) and its tax bill will be (EBIT – Interest)t. The difference between the two tax calculations is Interest(t), which is simply the ***interest tax shield*** for the year in question, and it is the amount by which the conventional FCF recipe overstates taxes. Because taxes are overestimated, the resulting FCFs are too low, and they therefore yield too low a concluded present value unless some other adjustment is made. There are two obvious possible adjustments. One is to adjust the *cash flows*—that is, correct the recipe for FCF by adding in interest tax shields (in other words, let taxes equal [EBIT – Interest] t). The other possibility is to adjust the *discount rate*, which is what the after-tax WACC formula does. Multiplying the cost of debt used in the WACC by (1 – t) reduces the resulting discount rate slightly, just enough to make up for the tax shields that are missing from the cash flows. The concluded value is "right" even though the cash flows are "wrong," thanks to the tax adjustment in the after-tax WACC formula. It is important to recognize that if we did *not* use the conventional recipe for free cash flow (i.e., suppose we used the "right" cash flows, including the interest tax shield) then the after-tax WACC would *not* be the correct discount rate; we would be counting the value of the interest tax shields twice. We must make one adjustment or the other; we may not make both.

Free Cash Flows

The cash flows in a DCF valuation analysis go by many names. In this reading we call them free cash flows (FCF), but elsewhere they may be called unlevered cash flows or enterprise cash flows. Whatever we call them, FCF are discounted at the WACC to give an estimate of the value of the entire business or project (sometimes called enterprise value). This must equal the sum of the values of all the claims issued against the firm, such as debt and equity. To capture the value of the entire business, FCF must include all the future cash flows: not merely cash operating profits (or losses) but also the required cash investments in working capital and fixed assets (such as plant and equipment).

We begin with projections from the income statement. Operating profit for a given period is calculated as

Revenue

LESS	Cost of goods sold (COGS)
EQUALS	Gross profit
LESS	Selling, general, and administrative expenses (SG&A)
EQUALS	Operating profit (EBIT)

Operating profit is also called EBIT (earnings before interest and taxes). It is an important component of FCF, but it has three shortcomings. First, it contains some noncash items; second, it is pretax, not after-tax; and third, it doesn't reflect cash investments in working capital and fixed assets.

The first item to address is taxes. To obtain an after-tax measure of operating profit, we multiply EBIT by $(1 - t)$, where t is the corporate tax rate. The result is often denoted simply as EBIT$(1 - t)$ but also sometimes as EBIAT (earnings before interest and after taxes). Why did we not add in depreciation to EBIT before applying the tax rate? Indeed, depreciation is a noncash expense included in COGS, and we do want cash flow, not accounting profit. The answer is that even though depreciation is noncash, it is tax deductible. It lowers taxable income, which reduces the firm's taxes; this reduction in taxes *does* affect cash flow, so the calculation must reflect it. By taxing EBIT before we add in depreciation (and any other noncash expenses), we capture the tax shield provided by depreciation.

(continued)

(continued)

This raises another question: Why does the calculation of EBIT($1 - t$) exclude interest expense? After all, interest expense is tax deductible, just like depreciation, so it must likewise reduce taxes. Moreover, unlike depreciation, interest is a cash expense. Nevertheless, we exclude interest because it is a *nonoperating* expense. It is paid to lenders, who are suppliers of capital rather than suppliers of parts or materials. Lenders are owners of the firm, just as shareholders are. The purpose of our analysis is to estimate total firm value, some of which is owned by lenders and some by shareholders. To use an analogy from personal finance, it is as though we are estimating the value of a house; the value of the house depends on its size, location, condition, and so forth, but not on how large a mortgage the homeowner has taken out. That still leaves the question of the tax shield created by the deductibility of interest, which is indeed a cash savings. This problem, however, is addressed by an adjustment to the WACC, as described in the text.

Returning to EBIT($1 - t$), the next adjustment is to add in noncash expenses that were subtracted as part of either COGS or SG&A. The obvious, and sometimes only, such expense is depreciation. In some countries, certain intangible assets are amortized in the same way that fixed assets are depreciated. If such amortization expense is tax deductible, it is treated just like depreciation. Noncash expenses that are *not* tax deductible are simply added to EBIT before multiplying by ($1 - t$).

Finally, we subtract cash investments in net working capital and fixed assets. Net working capital is the collection of current operating accounts, such as inventory, accounts payable, and accounts receivable. If these increase on a net basis during the period, we subtract the increase in net working capital as part of the FCF calculation. Similarly, capital expenditures on fixed assets such as land, buildings, and machinery also must be subtracted.

Putting everything together we have the recipe for free cash flow shown in the text:

EBIT($1 - t$)

PLUS	Depreciation
LESS	Increase in Net Working Capital
LESS	Capital Expenditures
EQUALS	Free Cash Flow (FCF)

2.2 Calculating the Cost of Capital: Practical Considerations

In this section we will compute the WACC for the Coca-Cola Company. We have two main purposes. One is to show how to calculate the WACC using actual corporate data. The other is to point out some practical problems and possible solutions to those problems along the way.

The Coca-Cola Company is the world's largest beverage company. It owns and markets more than 500 different nonalcoholic drinks, including many well-known brands of soft drinks, waters, energy and sports drinks, juices, and teas. The company's shares are traded on the New York Stock Exchange (NYSE) with the ticker symbol KO.[a] Its debt has been rated Aa3 by Moody's and AA– by Standard & Poor's. (These are comparable "investment-grade" ratings; both rating agencies regard Coca-Cola as a very strong borrower.)[3] Some of its debt has been issued to the public and is traded on the NYSE and other organized exchanges. Because Coca-Cola is a public company, it is required to make extensive, regular disclosures about its business and financial condition. Consequently, none of the information needed to estimate the company's WACC is confidential. A great deal of it is contained in Form 10-K, filed by the company each year with the US Securities and Exchange Commission. We will use Coca-Cola's Form 10-K for the year ending December 31, 2015.[4] **Exhibit 5** summarizes some of the financial information from Coca-Cola's Form 10-K.[b]

[a] The Coca-Cola Company's shares are traded on other stock exchanges as well. In addition, other companies with similar names, but different ownership and operations, include Coca-Cola Enterprises, Inc., and Coca-Cola Bottling Co. Consolidated. These, too, are public companies, but they should not be confused with the Coca-Cola Company.

[b] Readers familiar with accounting rules and practices in other countries will note some differences between the accounts and terms used in Exhibit 5, which reflect US GAAP, as compared to, say, IFRS accounts and terminology. Key differences are described in many online resources.

EXHIBIT 5 Coca-Cola Company Summary Balance Sheet (in millions USD)

The Coca-Cola Company
Summary Balance Sheet Items (in millions USD)

Net Operating Assets	**Dec. 31, 2015**
Net Working Capital:	
Accounts receivable	3,941
Inventories	2,902
Prepaid expenses	2,752
Assets held for sale, net	2,767
Total current operating assets	**12,362**
Accounts payable and accrued expenses	9,660
Accrued income taxes	331
Total current operating liabilities	**9,991**
Net working capital	**2,371**
Net fixed assets:	
Equity method investments	12,318
Other investments	3,470
Other assets	4,207
Net property, plant & equipment	12,571
Trademarks with indefinite lives	5,989
Bottlers franchise rights with indefinite lives	6,000
Goodwill	11,289
Other intangible assets	854
Less: Other LT liabilities	(4,301)
Less: Deferred taxes	(4,691)
Net fixed assets	**47,706**
Total Net Operating Assets	**$50,077**

Capital	**Dec. 31, 2015**
Net debt:	
Notes and loans payable	13,129
Long-term debt—current portion	2,677
Long-term debt	28,407
Total debt	**44,213**
Less: Cash and short-term investments	(15,631)
Less: Marketable securities	(4,269)
Net debt	**24,313**
Equity	
Total equity	**25,764**
Total Net Capital	**$50,077**

As we confront the various practical issues raised in the course of calculating a WACC, it will help to keep in mind the ultimate purpose of the calculation: Why are we computing the WACC? What do we plan to use it for? For present purposes, let's stipulate that we plan to use it as a discount rate in a forward-looking DCF valuation in US dollars, as of December 31, 2015, either of the Coca-Cola Company itself or of some other long-term project or business investment whose systematic risk is identical to that of the company as a whole. This may sound obvious, but it rules out many other possible uses of the WACC. For example, the WACC we calculate would not necessarily be suitable for valuing short-term assets or non–US dollar cash flows. Nor would it be appropriate even for some kinds of long-term asset valuations, such as valuing real estate that Coca-Cola owns or is considering buying or selling. Real estate investments are fundamentally different from investments in the beverage business and consequently would require a different opportunity cost. Our computed WACC also would not be appropriate as a benchmark for deciding what sort of securities Coca-Cola might want to issue—for example, whether to issue fixed- or floating-rate debt, in dollars or some other currency, secured or unsecured, long-term or short-term, and so forth. It helps to remember our purpose as we apply the equations given earlier using real data.

2.3 Capital Structure Ratios

Capital structure ratios are the weights in the WACC equation: D/V and E/V. They also may appear in formulas used to make leverage adjustments to the betas of any comparable companies we might be using.[c]

The first important requirement in the estimation of capital structure ratios is that they be expressed on a *market value* basis. Book values are not reliable because they are subject to distortions that can cause them to differ substantially from market values. While it is commonly assumed that book value equals market value for debt obligations, this is seldom true for equity. Sometimes it is quite obviously not true for debt, either (owing, for example, to changes in the interest rate environment or in a firm's risk of default), and then good practice demands that we estimate a firm's level of debt using market values.

Second, the leverage ratios used in the WACC formula must be consistent with the leverage implicit in the cost of equity and the cost of debt. Consider an analyst trying to estimate the effect of an increase in leverage on Company ABC's WACC. It would be wrong to put ABC's current costs of debt and equity in the WACC formula and then adjust the capital structure ratios to reflect the contemplated increase in leverage. As we saw in Interactive Illustration 1, if leverage changes, so do the costs of debt and

[c] In the case of public companies such as Coca-Cola, we have the company's beta. For nonpublic companies, we may need to rely instead on the beta(s) of one or more comparable traded companies.

equity. In other words, someone examining the effect on the WACC of a hypothetical change in capital structure must *re-estimate the costs of debt and equity in addition to changing the weights in the WACC formula.* One may not change only the weights.

Third, the capital structure ratios should reflect the company's *net* leverage. Many companies are both borrowers and lenders; their balance sheets normally carry debt on the liability side and "loans"—such as short-term cash balances or marketable securities—on the asset side. For some companies, cash balances are substantial, far in excess of what is needed to facilitate day-to-day operations and perhaps even more than their debt obligations. This "excess" cash reduces the company's effective leverage; in this sense, it may be considered "negative" debt. The company invests the cash, and, to that extent, it is lending rather than borrowing.

To compute a company's net leverage ratios, we define ***net debt*** as outstanding long- and short-term debt minus cash and marketable securities. Then the capital structure ratio D/V is computed as net debt divided by net debt plus equity, and likewise for E/V, which equals $1 - (D/V)$. Note that this convention allows for the possibility of negative net debt—when cash balances exceed outstanding debt—and, hence, a negative debt-to-value ratio. That, in turn, implies an equity-to-value ratio greater than one: $(E/V) > 1$.

Finally, we know that capital structure ratios can change. To compute the WACC, do we want the current leverage ratios? Some average over recent history? A forecast of future ratios? Here we need to recall the purpose we set for the WACC calculation. We stipulated it will be used in a *long-term, forward-looking* valuation exercise. Given that objective, the ratios used in the WACC formula should likewise be long-term forecasted or ***target ratios***.

To compute Coca-Cola's capital structure ratios we will assume that the company's current capital structure reflects its long-term target, that is, that the company is "on target" and will remain so. What if it isn't? In that case, we would need to ask management for long-term target ratios, or find some basis on which to infer them, which might not be easy. And, as we've noted, we would need to ensure that our estimates of Coca-Cola's costs of debt and equity properly reflect the leverage implicit in the long-term target ratios.

To calculate Coca-Cola's capital structure ratios we use data from Exhibit 5, which shows that all of Coca-Cola's debt—long- and short-term, fixed-rate and floating-rate, and so on—totals \$44,213 million. From this amount we subtract cash and marketable securities worth \$15,631 million and \$4,269 million, respectively, to obtain net debt of \$24,313 million (shown in Exhibit 5 and carried forward to

Exhibit 6). Note that this is book value, not market value, so we need to either confirm that the two are equal or find a way to make a market value adjustment. Fortunately, Coca-Cola is required to report estimates of the fair market value of its debt. The footnotes to its financial statements disclose that the book and market values are indeed very close; the estimated difference of $47 million disclosed by Coca-Cola is too small to significantly affect the ratios we are calculating.[d]

EXHIBIT 6 Capital Structure Ratios for the Coca-Cola Company

The Coca-Cola Company December 31, 2015			**Notes**
1.	Net debt	$24,313	From Exhibit 5, in USD millions
2.	Equity:		
3.	Stock price	$42.96	Closing stock price on 12/31/2015, in USD
4.	Shares outstanding	4,324	From Form 10-K, at 12/31/2015, in millions
5.	Market capitalization	$185,759	in USD millions [=3x4]
6.	Net capital	$210,072	Equals net debt + market capitalization [=1+5], in USD millions
7.	*D/V*	11.6%	Equals net debt/net capital [=1/6]
8.	*E/V*	88.4%	Equals market capitalization/net capital [=5/6]

To compute the market value of Coca-Cola's equity, we multiply its stock price per share by the number of shares outstanding as of our valuation date. At year-end 2015, Coca-Cola had 4,324 million shares outstanding and its closing stock price was $42.96 per share. Hence, the total market value of its equity (also known as its market capitalization) was $185,759 million.[e] Now we add net debt and equity to get total net capital of $210,072 million. From there it is easy to calculate that *D/V* equals 11.6% ($24,313/$210,072), so *E/V* equals 88.4%, as Exhibit 6 shows.

[d] You may wonder how Coca-Cola arrived at this conclusion. Recall that some of its debt consists of publicly traded bonds, for which it can obtain market prices. The remaining debt obligations must be valued analytically. Given the strength of Coca-Cola as a borrower, it is not surprising that the market value and book value of its obligations are roughly equivalent.

[e] Coca-Cola also had some employee stock options outstanding on December 31, 2015. These are valuable and should be included in the market value of the equity. In Coca-Cola's case, however, the value of outstanding options ($4.4 million, disclosed in Form 10-K) is immaterial to our calculations.

2.4 Cost of Debt

The cost of debt in a calculation of the WACC should be the expected return on a traded fixed-rate straight bond of a credit quality that is consistent with the capital structure ratios built into the WACC formula.[f] This cumbersome description raises several issues.

Why fixed-rate and not floating? Indeed, Coca-Cola actually had some floating-rate debt outstanding at year-end 2015. Once again, however, the key is our stated purpose: a long-term, forward-looking valuation. Floating-rate obligations have interest payments pegged to a *short-term* benchmark such as three-month US dollar LIBOR, for example.[g] When the yield curve is steep or inverted (or both), short-term benchmarks give an obviously misleading estimate of the expected cost of debt over a long, forward-looking horizon. A long-term, fixed-rate obligation is usually a better reflection of the cost of debt, even floating-rate debt, over a very long period. This is the approach we take here to estimate Coca-Cola's cost of debt.[5]

Coca-Cola had numerous fixed-rate debt issues outstanding at the end of 2015, denominated in a variety of currencies, with maturities ranging from 2017 to 2098 and coupons ranging from 0.00% to 3.20%. Would one or more of these give an indication of Coca-Cola's cost of debt? Possibly, but we cannot merely use the coupon rates as the cost of debt. They might tell us what Coca-Cola's cost of debt was in the past, when a given bond was issued (assuming it sold for its face, or "par," value at issue), but we want a *forward-looking* cost of debt. In other words, we want to know what the cost of debt would have been if Coca-Cola issued long-term, fixed-rate, dollar-denominated debt on our valuation date of December 31, 2015. One way to estimate this is to check market quotes—the market yield to maturity (YTM)—on Coca-Cola debt as of December 31, 2015. But even this approach has drawbacks. Most bonds do not trade very actively (with the exception of US Treasury bonds). So even though some of Coca-Cola's bonds are listed on the NYSE, the yields we observe might reflect little or no actual trading volume, or they could be "stale"—reflecting "most recent" trades, which actually took place quite a while ago. It also could be that the particular bond we are looking at has one or more special features that affect its YTM; without reading the fine print of the specific bond contract, it's not possible to determine if this is the case.

[f] A straight bond is not convertible into any other security. For our purpose, it is best if it lacks other special features, too, such as callability and putability. In effect, we want a "plain vanilla" fixed-rate bond.

[g] LIBOR denotes the London Interbank Offer Rate, the rate at which strong international banks lend to one another.

Because of these problems, many practitioners often base the cost of debt on a spread over US Treasury obligations for a given credit rating. The spread (sometimes called a yield or bond or default spread) is computed on the basis of current market yields for a basket of corporate bonds with similar terms and ratings, which helps overcome the problems of thin trading and special features for individual issues. For example, if a portfolio of A-rated bonds has a market yield of 4.25% on the same day that a Treasury bond with the same maturity is yielding 3.00%, then the spread is 1.25% or 125 basis points (a basis point is one one-hundredth of one percent). Coca-Cola's rating is AA–, and on December 31, 2015, the AA corporate bond spread was 181 basis points (1.81%)[h] and the yield on a 20-year Treasury bond was 2.17%.[6] So we can estimate Coca-Cola's cost of debt as 3.98% (= 2.17% + 1.81%). Because our calculation is derived from market yields that correspond to Coca-Cola's credit rating, both as of our valuation date, we believe 3.98% is consistent with the company's capital structure ratios calculated above as of the same date.

Finally, we should note the difference between promised and expected returns. Our WACC calculation should be based on expected returns on debt and equity, as stipulated above. But we just estimated Coca-Cola's cost of debt using bond spreads, which reflect bonds' YTMs. The YTM is a promised yield; it gives the return earned by a lender assuming no default by the borrower—that is, assuming all the promised payments of interest and principal are made as scheduled. When the probability of default is non-zero, the *expected* return on a bond must be lower than its *promised* return. In effect, we have overestimated Coca-Cola's cost of debt. How big a problem is this? For companies with investment-grade ratings, the error is typically small because the probability of default is small (and we will ignore the error in Coca-Cola's case). For lower-rated companies, however, the error can be significant, and we may need alternative ways to estimate the cost of debt. One possibility is to use a model of expected returns such as the CAPM. According to the CAPM, the cost of debt, k_d, is given by

$$k_d = r_f + \beta_d \left(\text{EMRP}\right)$$

where β_d denotes the beta of the debt. Unfortunately, betas for debt are not widely published and may be difficult to estimate directly because of the problems with bond prices mentioned earlier. For investment-grade debt, beta should be low because expected returns are not much higher than the risk-free rate. For example, our estimated cost of debt of 3.98% for Coca-Cola implies a beta for the company's debt

[h] In practice, spreads are quoted for broad rating categories, so we have to settle for the AA spread when we'd really like the AA– spread. Or we can interpolate between spreads for available adjacent categories. The spread quoted in the text was published by Bank of America Merrill Lynch, (index ticker C0A2), accessed May 2, 2016.

of 0.362, assuming an EMRP of 5.0% $((3.98\% - 2.17\%)/5.0\% = 0.362)$. As we have noted, this debt beta must be too high because 3.98% is too high: it is a promised return rather than the expected return on Coca-Cola's debt.

2.4.1 Tax Rate

As we discussed earlier, the tax rate appears in the WACC in the term

$$\frac{D}{V} k_d (1-t)$$

solely because of a presumption that the cash flows to be discounted do not reflect the tax savings generated by interest deductions. So the correct tax rate for the WACC is the rate at which future cash taxes will be reduced by interest deductions associated with the debt of the company or project in question. This may or may not be the same as the effective corporate tax rate. Some firms are not taxpayers for extended periods, or they have other ways to reduce their tax bills (e.g., net operating losses or some type of tax credit). For them the appropriate tax rate for the WACC could be low or even zero, even though the firm has positive leverage. Coca-Cola's effective tax rate in 2015 was 23.3%, even though its marginal rate may have been close to the US federal rate of 35%.[i] The correct rate depends on the cash flows being discounted. If we were valuing Coca-Cola in its entirety, the lower rate might be appropriate; if we were valuing a smaller Coca-Cola–like investment opportunity, the rate would depend on how the particular entity's future cash flows would be affected by the borrowing it enabled. For simplicity here, we'll apply the US federal rate of 35% in our calculations.

2.5 Cost of Equity

The CAPM equation has become the most common approach to estimating the cost of equity. As we saw earlier, the equation is

$$k_e = \mathrm{E}(r_e) = r_f + \beta_e(\mathrm{EMRP})$$

[i] This effective tax rate was computed from figures for pretax income and taxes shown in Coca-Cola's December 31, 2015, Form 10-K (www.coca-colacompany.com/content/dam/journey/us/en/private/fileassets/pdf/investors/2015-annual-report-on-form-10-k.pdf, accessed April 2016). In the United States, the *marginal* tax rate is the stipulated federal tax rate applied to each additional dollar of income above a certain threshold, whereas the *effective* tax rate is computed as taxes divided by pretax income.

where k_e denotes the cost of equity, equal to the required expected return on equity, $E(r_e)$, and β_e denotes the beta of the subject firm's stock. (We assign it the subscript *e* here to avoid confusion with the beta of debt, β_d, just mentioned, and the asset beta.) We'll examine each term in this equation separately.

2.5.1 Risk-Free Rate

Just as we saw in the calculation of the cost of debt, the risk-free return for US dollar cash flows is conventionally given by market yields on US Treasury obligations. Ideally, the maturity of the benchmark T-bond should match the term of the subject cash flows. Note that, in theory, this implies that we should use a *different* risk-free rate (and, hence, a different discount rate) for each year's cash flow whenever the yield curve is not flat. We could derive appropriate rates using the zero-coupon Treasury yield curve over the horizon corresponding to the cash flows to be discounted. This may become standard practice someday (the necessary data and computations are not difficult to incorporate into standard spreadsheet software), but it is not yet. A far more common practice for corporate applications is to use a single discount rate for all future cash flows. To compute it, most practitioners simply take the yield to maturity on a long-term Treasury bond as the risk-free rate. The long-term rate is appropriate even when the forecast period for annual cash flows is short—say, five years—because we stipulated we are valuing a long-lived asset. A DCF analysis of such a business will include a terminal value that reflects the value derived from cash flows that occur beyond the forecast period. Such cash flows would be significantly over-discounted if, for example, we used a short-term, risk-free rate drawn from an inverted yield curve.

In the case of Coca-Cola, our choice of a risk-free rate doesn't depend on the identity of the company, but it does depend on our valuation date, December 31, 2015. As we saw earlier, on that date the market yield on a 20-year US Treasury bond was 2.17%.

2.5.2 Equity (Levered) Betas and Asset (Unlevered) Betas

It is important to ensure consistency between the target capital structure reflected in the WACC's leverage ratios and the degree of leverage actually present in the sample period used to compute the subject company's equity beta. For example, if the company's beta was computed using data from the past two years, we would need to confirm that the company's leverage during that period was the same as the target capital structure incorporated in the WACC formula. If it is not, then the historical equity beta must be "unlevered" to remove the effect of the old leverage ratio, then "re-levered" to reflect the target ratio used in the WACC.

Unlevering and Re-Levering Beta

To unlever a historical equity beta, we use the formula

$$\beta_u = \frac{D}{V}\beta_d + \frac{E}{V}\beta_e$$

where β_u is the unlevered beta, β_d is the historical debt beta, and β_e is the historical equity beta for the same firm.[j] A common simplifying assumption is that the debt is riskless, so the beta of debt, β_d, equals zero, which gives us

$$\beta_u = \frac{E}{V}\beta_e$$

In words, the unlevered beta equals the historical equity beta times the historical equity-to-value ratio measured on a market value basis.[k] To re-lever the unlevered beta, we use the same formula in reverse:

$$\beta'_e = \frac{\beta_u}{\left(\frac{E}{V}\right)_{target}}$$

where β'_e is the re-levered equity beta and $(E/V)_{target}$ is the target equity ratio used in the WACC formula. (We append the prime symbol to β_e to distinguish a re-levered beta from a historical equity beta.)

To illustrate the process of unlevering and re-levering, let's work a numerical example for a hypothetical company whose target leverage ratio exceeds its historical leverage: In other words, it is planning to boost leverage in the future. We'll use the following assumptions:

[j] This expression assumes a static capital structure with a constant D/V ratio. Note, since the ratio is expressed in market value terms, that this assumption implies the company constantly adjusts its debt level as the market value of its equity fluctuates.

[k] The assumption that $\beta_d = 0$ is obviously troublesome for companies with high leverage. In such cases, some practitioners use a non-zero debt beta or, alternatively, simply recognize that the assumption that $\beta_X = 0$ results in a biased-low estimate of β_u, which must be examined in subsequent sensitivity analyses.

Historical equity beta, β_e = 1.20

Debt beta, β_d = 0.0

Historical equity ratio, E/V, measured on a market value basis = 75%

Target E/V = 60%

To obtain the unlevered, or asset beta, we multiply the equity beta of 1.20 by the historical equity ratio of .75:

$$\beta_u = \left(\frac{E}{V}\right)\beta_e = (0.75)1.20 = 0.90$$

To re-lever to the new target, we divide the asset beta by the target equity ratio:

$$\beta'_e = \frac{\beta_u}{\left(\frac{E}{V}\right)_{target}} = \frac{0.90}{0.60} = 1.50$$

Note that the re-levered equity beta of 1.50 is higher than the historical beta of 1.20. Nothing about the company's operations has changed; the difference is due solely to a contemplated increase in leverage (the debt-to-value ratio is rising from 25% to a target of 40%), which should raise the company's equity beta in the future.

An Alternative Formula for Unlevering an Equity Beta

Some readers may be familiar with an alternative formula for unlevering an equity beta:

$$\beta_u = \frac{\beta_e}{1 + (1-t)\frac{D}{E}}$$

The difference between this expression and the simpler one used above lies in the assumption each makes about the riskiness of the tax shields associated with debt financing. The first formula we presented assumes a constant debt *ratio*, which implies that debt levels (and therefore tax shields) fluctuate with the value of the company's operations; in effect, the beta of the tax shields is the same as the beta of the operations (the asset beta). The second formula assumes the beta of the tax shields is zero, which is consistent with a constant debt *level*, rather than a constant debt *ratio*. Both assumptions are simplifying, and it is likely that neither reflects the real world perfectly. We cannot say with much confidence that one formula is always, or even usually, better than the other; which if either is more appropriate depends on systematic riskiness of a given firm's tax shields. We can say, however, that for moderate amounts of leverage, the practical difference between the two is not substantial. To see an example of the difference it makes, we can recompute the asset beta in our numerical example using the second formula. The historical *D/E* ratio is 0.333 (= 25%/75%) and we'll use a tax rate t = 35%. Then the implied asset beta is 0.986 instead of 0.900 (= 1.20/(1+(0.65)(0.333))). If this seems like a significant difference, remember that we still have to re-lever to the new target leverage ratio, also using the second formula. The target value for *D/E* is 0.667 (= 40%/60%). To re-lever using the second formula,

$$\beta'_e = \beta_u \left[1 + (1-t)\left(\frac{D}{E}\right)_{target} \right]$$

$$\beta'_e = 0.986\left[1 + (0.65)\left(\frac{0.40}{0.60}\right)\right] = 1.41$$

This re-levered beta of 1.41 is not so different from the value of 1.50 we got above. The difference of 0.09 lowers the risk premium in the estimated cost of equity by 45 basis points (assuming an EMRP of 5%).

Unlevered Betas by Industry

Exhibit 7 presents average asset betas computed for a sample of different industries. Note that asset betas vary significantly across industries (and often within industries as well, it should be acknowledged); the lowest unlevered beta is 0.36 for utilities (this is indeed low: about the same as the implied debt beta we computed for Coca-Cola's debt) and the highest, 1.63 for tobacco, is more than four times higher. The unlevered beta for the equity market as a whole is somewhere in between, at 0.69, shown at the bottom of Exhibit 7. (Readers familiar with the CAPM may be surprised by this, recalling that the beta of the market must be 1.0 by construction; note, though that it is the *levered* beta for the market that equals 1.0. The market as a whole has positive leverage, so its unlevered beta is lower, at 0.69.)

EXHIBIT 7 Average Asset Betas for Selected Industries

Industry Name	Number of Firms	Unlevered Beta
Utility (General)	20	0.36
Hospitals/Healthcare Facilities	58	0.44
Auto & Truck	19	0.44
Telecom (Wireless)	19	0.62
Diversified	26	0.68
Metals & Mining	114	0.84
Electronics (General)	167	0.87
Information Services	70	0.89
Household Products	134	0.89
Retail (General)	19	0.90
Drugs (Pharmaceutical)	157	0.90
Computer Services	118	0.94
Building Materials	39	0.94
Entertainment	84	0.94
Beverage (Soft)	43	0.95
Real Estate (General/Diversified)	12	0.99
Publishing & Newspapers	39	1.01
Drugs (Biotechnology)	411	1.12
Transportation	21	1.13
Machinery	130	1.16
Chemical (Diversified)	9	1.18
Software (System & Application)	241	1.19
Oil/Gas (Integrated)	7	1.33
Retail (Online)	39	1.46
Tobacco	20	1.63
Subtotal	2016	
Total Market	**7480**	**0.69**

Source: "Current Data," Damodaran Online, http://people.stern.nyu.edu/adamodar/New_Home_Page/datacurrent.html, accessed April 27, 2016.

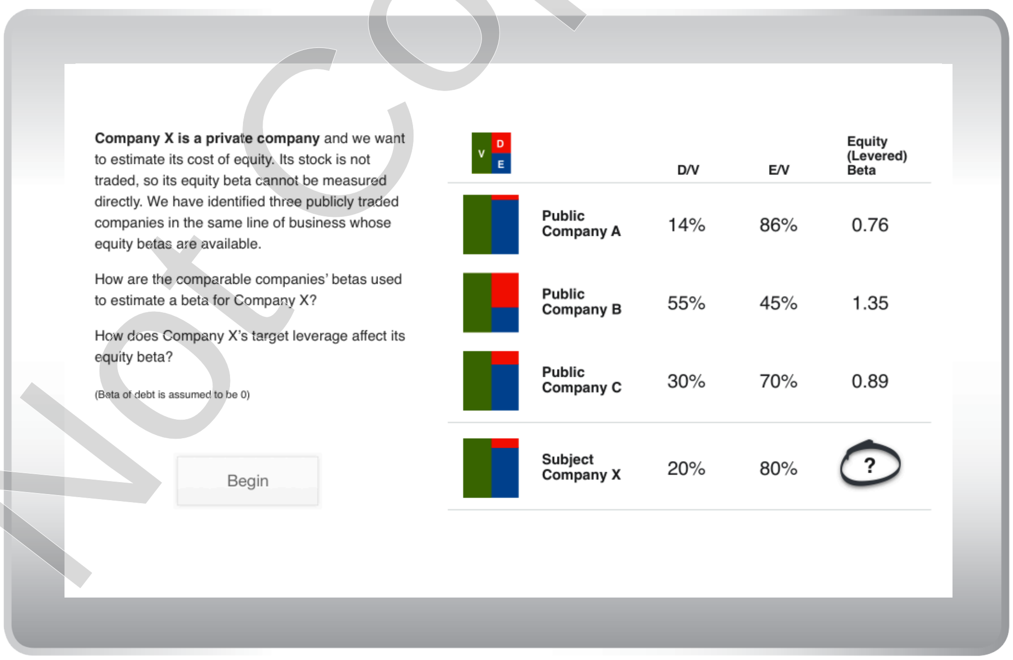
Estimating Beta for a Nontraded Asset

Sometimes the subject company or project simply does not have an equity beta (e.g., if it is privately held or is a division or subsidiary of a larger company). In that case, the common practice is to collect equity betas from a sample of publicly traded companies expressly selected to be comparable to the subject business. Since these may differ in their leverage, each company's equity beta must be unlevered, using its own leverage ratio. This gives a sample of unlevered betas, which is used to infer an unlevered beta for the subject company (e.g., by computing a median or an average). The unlevered beta is then re-levered using the subject company's target capital structure.

Interactive Illustration 2 depicts this procedure in a sequence of steps. Even before the unlevering procedure can begin, however, the analyst must identify a set of comparable companies. In theory, the more comparable companies one can find, the better, since doing so increases the sample size in a noisy statistical exercise. In practice, there is often a trade-off between the available number of comparable companies and the degree of comparability: That is, one has a larger sample if one is willing to settle for rough comparability; insisting on a high degree of comparability results in a smaller sample size. Sometimes analysts look at both: a larger sample of roughly comparable companies and a smaller one of more highly comparable companies. Interactive Illustration 2 uses a set of three—Public Companies A, B, and C, each with its own leverage ratio and equity beta. Note that historical equity betas for the comparable companies cover a wide range, from 0.76 to 1.35. At the same time, however, they have quite different historical leverage ratios. The point of the unlevering process is to remove the effect of leverage from the historical equity betas. To start the process, click "Begin."

INTERACTIVE ILLUSTRATION 2 Unlevering and Re-levering Beta

Scan this QR code, click the image, or use this link to access the interactive illustration: bit.ly/hbsp2unHuKv



In step 1, the publicly traded comparable companies are unlevered: each equity beta is unlevered using its own historical leverage ratio. Click the right arrow in the upper right corner to unlever the comparable companies one by one. In step 2, the average of the unlevered betas is computed (it equals 0.63). This average will be adopted as the unlevered beta for the subject company. At this point, we could simply apply the CAPM with the unlevered beta to obtain a discount rate for the subject company. Using the unlevered beta in the CAPM directly gives a cost of capital, k_X. As we noted previously, this equals k_u, the cost of unlevered equity, so called because it is computed from an unlevered beta and represents the cost of capital for a firm that has no debt in its capital structure—such a firm is itself "unlevered."

If, instead of using the CAPM directly, we wish to compute a WACC, we need to proceed in the illustration to step 3. In step 3 the average unlevered beta from the comparable companies is re-levered using the subject's target leverage ratio, D/V, initially set at 20%. The re-levering is accomplished using the same unlevering formula, in reverse. The unlevered beta, denoted β_u in the illustration, is divided by the subject firm's target equity ratio of 0.80 (= 1 – 0.20) to obtain a re-levered equity beta of 0.79 (= 0.63 / 0.80). Try using the slider to set a higher target leverage ratio for the subject company, say D/V = 50%. What happens to the re-levered beta? It goes up, from 0.79 to 1.26. This is due solely to the higher target leverage; the comparable companies (and the estimated unlevered beta) have not changed.

Sources for Equity Betas

Where do historical equity betas come from? Most practitioners do not run their own regressions to obtain betas. Rather, they rely on one or more published sources, such as Bloomberg, Value Line, and Capital IQ. Most such services use daily, weekly, or even monthly data over a two- to five-year period to estimate beta from a linear regression. (More frequent observations produce a given number of data points in a shorter period.) Even though methodologies for estimating beta are fairly standardized, quoted stock betas for a given company may vary by source, owing to differences in sample periods, observation frequencies, or other statistical practices—or a combination of these.

Ideally, a forward-looking estimate of beta should be used when discounting future cash flows. Beta is typically estimated using historical returns, however, an approach that is reasonable if the beta is stable over time. Note, though, that major corporate events such as mergers, acquisitions, divestitures, recapitalizations, and so forth may have significant effects on systematic risk and, hence, a company's beta. In such situations it may not be reasonable to suppose that a historical beta is a reliable measure of future risk.

2.5.3 Computing Coca-Cola's Unlevered Beta

Let's compute an unlevered beta for Coca-Cola. On December 31, 2015, Coca-Cola's equity beta was 0.80. Using the simplest expression used earlier ($\beta_u = (E/V)\beta_e$), we multiply the equity beta by the company's equity ratio of 88.4% to obtain an unlevered beta of 0.71, as **Exhibit 8** shows. Comparing this to the industry betas in Exhibit 7, we see it is about in the middle, near the unlevered beta of the market as a whole, but lower than the unlevered beta shown for soft (nonalcoholic) beverage makers of 0.95. Exhibit 8 shows two additional calculations for Coca-Cola's unlevered beta, using each of the other formulas we have described. If we assume the beta of the tax shields is equal to the beta of the assets and that the debt beta is 0.36 (computed using the cost of debt estimated above), then Coca-Cola's unlevered beta equals 0.75. If we assume the beta of tax shields and the beta of debt both equal zero, then Coca-Cola's unlevered beta is 0.74. Which is correct? Unfortunately, none of them, exactly—each formula adopts different simplifying assumptions. Fortunately, though, they are all roughly correct (assuming the equity beta of 0.80 is roughly correct) and they are close to one another.

EXHIBIT 8 Unlevering Coca-Cola's Beta

		Notes
D/V	11.6%	From Exhibit 6
E/V	88.4%	From Exhibit 6
D/E	13.1%	Calculated
t	35%	Assumed; *see text*
β_d	0.36	$= (k_d - r_f)/\text{EMRP}$
β_e	0.80	From Capital IQ

Three ways to unlever the equity beta using three different formulas

1. β_u	0.71	$= (E/V)\,\beta_e$
2. β_u	0.75	$= (D/V)\,\beta_d + (E/V)\,\beta_e$
3. β_u	0.74	$= \beta_e/(1+(1-t)\cdot(D/E))$

Since we have assumed Coca-Cola's actual leverage equals its target, we have no immediate need for the unlevered beta and no need to re-lever it; we will simply use Coca-Cola's equity beta of 0.80 in our cost-of-equity calculation on the way to computing Coca-Cola's WACC.

2.5.4 Equity Market Risk Premium

A complete treatment of the EMRP is beyond the scope of this reading. Many thorny issues arise in estimating the EMRP, and experts disagree about how best to address them. As a practical matter, most businesses and their professional advisers adopt a view concerning the various issues, and they announce a preferred point estimate for the EMRP that everyone in the organization is then expected to use. In other words, most practitioners are simply told what value to use.

A fairly concise review of research and practice on the EMRP is presented in Pratt and Grabowski's recent work; they examine a wide variety of methods and data to support a range for the EMRP of 3.5% to 6.0%, and conclude on a point estimate of 5.0%.[7] This range is consistent with premia currently used by many auditors, appraisers, investment bankers, consultants, and other valuation specialists in real-world settings. In our calculations for Coca-Cola, we'll use an EMRP of 5.0%.

2.5.5 Coca-Cola's Cost of Equity

Finally, we have all the inputs we need to compute a cost of equity for Coca-Cola using the CAPM:

$$k_e = r_f + \beta_e(\text{EMRP})$$
$$k_e = 2.17\% + 0.80(5.0\%) = 6.17\%$$

2.6 Putting the Pieces Together: Coca-Cola's WACC

Exhibit 9 puts all the pieces together to compute a WACC for Coca-Cola. The concluded WACC, Coca-Cola's cost of capital, is 5.76%. How should we interpret it? It is the discount rate we would use to discount Coca-Cola's future expected operating cash flows to obtain an estimate of the value of the Coca-Cola enterprise as a whole as of December 31, 2015. We also may think of it as the required expected return on Coca-Cola's operations. Equivalently, it is an estimate of the expected return from investing in a "strip" of Coca-Cola securities—a pro rata share of all the debt and equity instruments Coca-Cola had outstanding as of December 31, 2015. It is important to understand that this is not the same as the expected return on an investment in Coca-Cola's stock; that is the cost of equity, shown above and in Exhibit 9 as 6.17%. The expected return on equity is somewhat higher than the WACC because of leverage in the capital structure.

EXHIBIT 9 Computing WACC for the Coca-Cola Company

$$\text{WACC} = \left(\frac{D}{V}\right)k_d(1-t) + \left(\frac{E}{V}\right)k_e$$

		Notes
D/V	11.60%	From Exhibit 6
E/V	88.40%	From Exhibit 6
k_d	3.98%	Calculated in the text
r_f	2.17%	20-year T-bond yield on 12/31/2015
β_e	0.80	From Capital IQ
EMRP	5.00%	Assumed; *see text*
k_e	6.17%	CAPM
t	35.00%	Assumed; *see text*
WACC	**5.76%**	Calculated

These returns may strike some readers as low. Shouldn't returns on the world's largest beverage company be higher than 5.76%? Not when interest rates ("returns") in general are so low. Recall that the return on a 20-year US Treasury bond at year-end 2015 was only 2.17%. Coca-Cola's WACC of 5.76% is about 3.6 percentage points higher. Is that enough? According to our model, yes. Coca-Cola may be the world's biggest beverage company, but its consolidated operations are not terribly risky, and long-term interest rates are low. One way to see this is to use Coca-Cola's unlevered (asset) beta in the CAPM directly, as we discussed at the beginning of this reading. Earlier we computed unlevered betas for Coca-Cola (see Exhibit 8) and they ranged from 0.71 to 0.75. Applying the CAPM, we can compute a cost of unlevered equity for Coca-Cola, which should be close to its WACC. Using the high end of the range for asset betas,

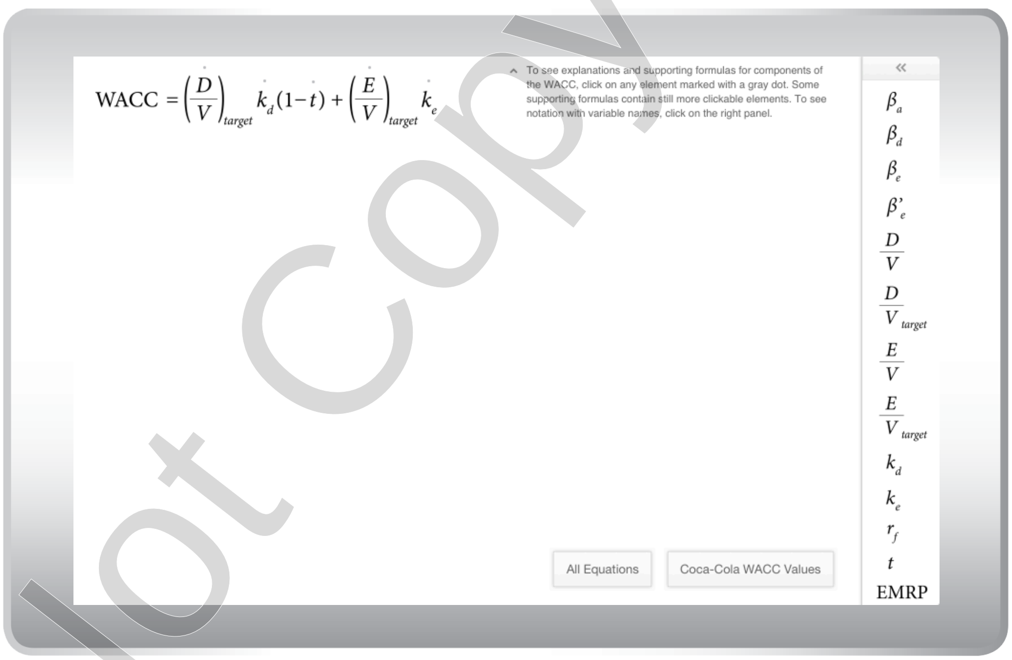
$$k_u = r_f + \beta_u(\text{EMRP})$$
$$k_{Coca-Cola} = 2.17\% + 0.75(5.0\%) = 5.92\%$$

This is close to the WACC of 5.76%. What is the difference? The cost of unlevered equity does not reflect the benefit of tax shields from Coca-Cola's leverage. Obviously, the tax shields' effect on the WACC is small, only 16 basis points. Why? Because Coca-Cola doesn't have a lot of leverage (only about 11% of the capital structure) and interest rates were low at year-end 2015. When leverage and interest rates are low, tax shields must be low, too.

To cement your understanding of the various elements of the WACC and how they are calculated, **Interactive Illustration 3** provides a "tour" of the WACC calculation. To take the tour, click on one of the terms in the WACC equation to open a box explaining how it was calculated in the preceding text. The boxes, in turn, contain elements you can click on to drill deeper into the calculation. To see it all at once, in a printable format, click "All Equations." To see the formulas in the illustration used in calculations for Coca-Cola, click on "Coca-Cola WACC Values."

INTERACTIVE ILLUSTRATION 3 Decomposing WACC

Scan this QR code, click the image, or use this link to access the interactive illustration: bit.ly/hbsp2DYpLbS



3 SUPPLEMENTAL READING

3.1 Using the WACC: Cautionary Observations

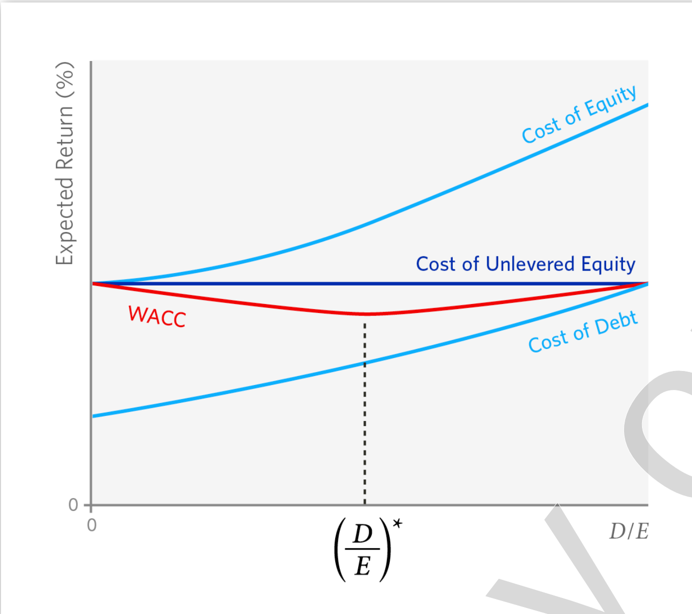
The WACC has limitations. For example, we said earlier that multiplying the cost of debt by $(1 - t)$ lowers the WACC "by just the right amount" to account for the value of tax shields missing from the free cash flows. Not surprisingly, achieving "just the right amount" requires some simplifying assumptions, not all of which reflect reality very well. Among other things, it requires an exceedingly simple tax system—one that is almost fully captured by the single parameter "t"—and it requires leverage ratios to remain constant. Because of its limitations, it is not always ideal to use the WACC as a discount rate. In this section we mention some of the pitfalls users should be aware of.

3.1.1 WACC and Leverage

As leverage rises, the cost of debt and the cost of equity both rise, as we saw in Interactive Illustration 1. What should happen to the WACC? This is actually a question about capital structure theory, not the WACC per se.[8] In fact, the WACC could go up or down, depending on whether the degree of leverage under consideration is higher or lower than the optimum. This is shown in **Exhibit 10**. As the optimal degree of leverage, designated D/E^*, is approached from below, the WACC falls (firm value rises) because the benefits of additional tax shields exceed the additional ***costs of financial distress*** **(*CFD*)**. As we pass the point of optimal leverage, the WACC rises (firm value falls) because costs of financial distress exceed the benefits of tax shields.[1]

[1] Exhibit 10 depicts the WACC according to the static trade-off theory of optimal capital structure, the most common but certainly not the only possible model.

EXHIBIT 10 WACC as a Function of Leverage (*D*/*E*)

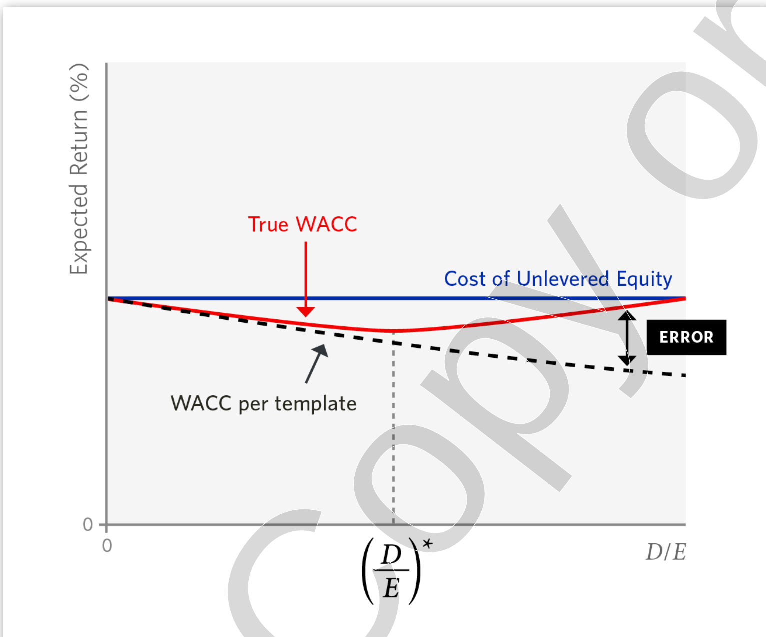


The other important characteristic of the curve representing the WACC in Exhibit 10 is that it is *shallow*. In other words, although WACC changes as leverage changes, it doesn't change all that much. We saw why in the Coca-Cola calculations. Recall that we computed a WACC of 5.76% for Coca-Cola and an unlevered cost of equity of 5.92%, a difference of only 16 percentage points. This should not be surprising. As Exhibit 10 shows, the red curve (WACC) and the dark blue line (the cost of unlevered equity) aren't very far apart. Put another way, over a wide range of leverage choices, the WACC changes relatively little. The important implication is that if an analyst calculates a large change in the WACC that is due solely to a change in leverage, he or she has probably made a mistake somewhere.

3.1.2 WACC Templates

One common cause of such mistakes lies in the preprogrammed WACC spreadsheet templates commonly used by corporations, consultants, appraisers, auditors, and other professionals. According to most such templates, the WACC decreases monotonically with leverage. This is because the formulas built into spreadsheet-based templates adjust the WACC for the effect of interest tax shields as leverage changes, *but not anything else*. In particular, they make no adjustment for costs of financial distress. Accordingly, the higher the leverage, the more negatively biased is the standard estimate of WACC: It overstates the tax advantage of leverage and understates the corresponding costs of financial distress owing to leverage. While this may be understandable—there is no generally accepted model for calculating costs of distress—it can lead to significant distortions of the WACC. **Exhibit 11** is a stylized representation of the difference between the "True WACC" and the WACC as calculated by most templates. It shows the magnitude of the error increasing as leverage rises, and becoming large at leverage ratios significantly above the theoretical optimum of D/E^*.

EXHIBIT 11 How Standard Templates Miscalculate the WACC



More broadly, the WACC is often relied on in DCF analyses as if it contained all the adjustments required to make up for anything that may be missing from the cash flows on account of complex capital structures. In fact, the way most practitioners use it, the WACC adjusts for nothing other than tax shields.

3.1.3 Benchmarking the WACC

The preceding two points lead to a clear recommendation for a benchmark for WACC calculations: the unlevered cost of equity. This is easily computed using the CAPM equation:

$$k_u = r_f + \beta_u \left(\text{EMRP}\right)$$

where β_u is the unlevered, or asset, beta. In simple models of capital structure, the difference between the cost of unlevered equity and the WACC is due to the effects of interest tax shields and costs of financial distress. Exhibit 10 shows that the difference should be modest. And Exhibit 11 shows that the difference can be distorted by commonly used tools. Accordingly, a helpful benchmark is a calculation that *ignores* these effects and instead uses just the cost of unlevered equity. Over a wide range of leverage ratios, the cost of unlevered equity is a reliable upper bound for the WACC. We saw in the calculations for Coca-Cola that the WACC and the cost of unlevered equity were close to one another. We can add now that the cost of unlevered equity was *greater than* the WACC (5.92% > 5.76%), just as the graphs in Exhibits 10 and 11 imply.[m]

The cost of unlevered equity is a helpful benchmark for another reason as well: It is less prone to error than standard WACC calculations because it has so few moving parts—it contains only one project-specific variable, the asset beta. In fact, this leads to a further helpful observation, that the most substantive determinants of the discount rate (and of the WACC) in a basic DCF analysis are the *risk-free rate* and the *asset beta,* or, in non-CAPM terms, time value and systematic risk. Not target leverage ratios. Not the tax rate. Not even, narrowly speaking, costs of debt and equity. Thus, improving the estimate of the asset beta is worth some analytical effort.

3.1.4 Dynamic Leverage

We mentioned above that for WACC to reflect the value of interest tax shields correctly, the leverage ratios must be constant, or at least the *target ratios* should be constant, even if the company misses its target from time to time. But what if the target is not constant? Surveys of executives reveal that many mature companies adopt some sort of target, and for most of these, the target is "sticky"—it seldom changes by much. But this is not the case for younger companies, or for many special situations such as leveraged buyout (LBO) transactions and project financings.

For LBOs, changes in leverage are not only expected, but actually "programmed"—that is, they are built into the structure of the transaction. Most LBOs, for example, begin with relatively high leverage, which is then swiftly reduced during the first few years of operations after the deal closes. Typically, deal terms include incentives to reduce leverage and penalties for failing to do so. Such programmed changes in leverage make the WACC cumbersome to use; one must recompute it every period or accept the errors caused by not doing so.

[m] A finding that the WACC exceeds the cost of unlevered equity suggests one of two things: either the company's capital structure is suboptimal (it would be better off unlevered), or one of the simplifying assumptions built into unlevering/re-levering calculations is causing trouble. The figures in the text use a debt beta inferred from the same cost of debt being used in the WACC calculation ($\beta_d = 0.749$) to ensure internal consistency.

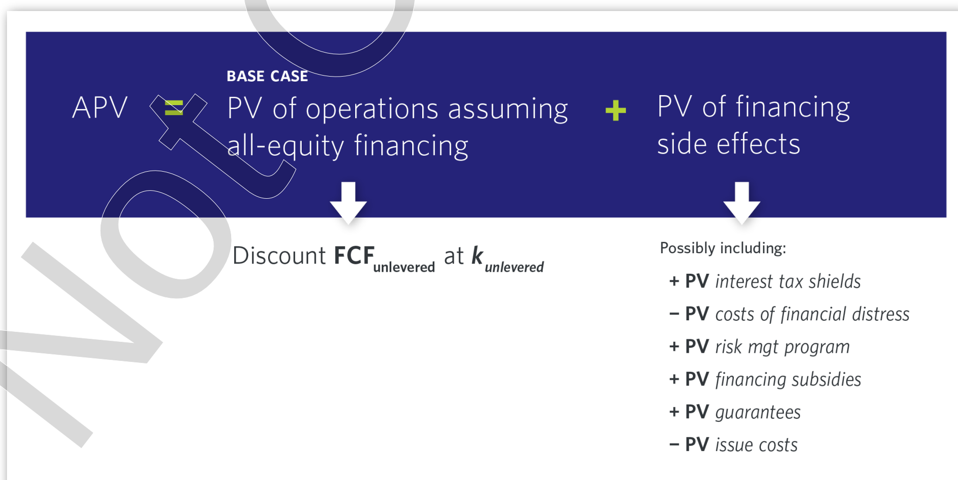
More broadly, when capital structure is dynamic, depending on what measure of value an analysis is focused on (e.g., enterprise value, equity value, or sponsor's equity value), there is almost surely an alternative to the WACC that will serve the analysis better. Some are beyond the scope of this reading, but we mention two in particular here.

3.2 Alternatives to the WACC

3.2.1 Adjusted Present Value

Adjusted Present Value (APV) exploits the principle of value additivity to customize the elements of a DCF valuation of a company or business (i.e., of a whole enterprise valuation as opposed to the valuation of a particular security or ownership interest). The basic idea is to split the problem into pieces, each of which is evaluated separately with an appropriate tool, and then add up the pieces. Usually the pieces are separated into two broad categories: the unlevered business on the one hand, and all the side effects of whatever capitalization (financing) arrangements are actually being used on the other. This basic division of value is depicted in **Exhibit 12**.

EXHIBIT 12 APV's Reliance on Value Additivity



The first part of an APV analysis—the "base case" value of the unlevered enterprise—entails an exercise much like what we described earlier, except that the discount rate applied to the free cash flows is not the WACC but k_u, the cost of unlevered equity. For most businesses and projects, this base case is where most of the value is. The rest of the APV analysis consists of separate analyses of all the side effects associated with the actual financing program: tax shields, costs of financial distress, security issuance costs, financing subsidies (e.g., from governments), risk management activities, and so forth. Because each sub-analysis is separate, each can employ whatever methodology (and discount rate) is most appropriate for that part of the entity. In particular, APV easily accommodates situations in which leverage is not constant; whatever the leverage in a given year, we simply estimate the associated tax shields, for example, and discount them at an appropriate rate. (The appropriate rate for tax shields is not the WACC, but more likely the cost of unlevered equity or the cost of debt.)

An APV analysis is more complicated than a WACC analysis, but spreadsheet software makes it relatively easy to keep track of multiple analyses and even link them together. The added effort is generally worthwhile. APV also suggests ways to allocate analytical energy—to focus time, effort, data, and scrutiny where it matters most. There will remain thorny issues—for example, there still will be no generally accepted way of incorporating costs of financial distress—but at least APV provides a "bucket" for the analysis of each issue. Even if the "bucket" contains no more than a "straw man"—a flawed or incomplete analysis intended to provoke ideas and discussion—it may nevertheless draw managerial attention to issues for further consideration or research.

3.2.2 Capital Cash Flows

The capital cash flows (CCF) method addresses the problem of missing tax shields in free cash flows by adjusting the cash flows rather than the discount rate. This method adds the interest tax shield to each cash flow, and then discounts at the cost of unlevered equity rather than the WACC. Thus adjusted, the cash flows are called capital cash flows to distinguish them from free cash flows:

$$\text{Value} = \sum_{t=1}^{T} \frac{\text{CCF}_t}{(1+k_u)^t} = \sum_{t=1}^{T} \frac{\text{FCF}_t + (\text{interest tax shield})_t}{(1+k_u)^t}$$

where k_u is the cost of unlevered equity, CCF denotes capital cash flows, FCF denotes free cash flows computed as usual, and t is the time period. The cost of unlevered equity is sometimes called the pretax WACC. Indeed, it may be calculated as such, with the usual WACC formula and the tax rate t set equal to zero. Or, as is usually simpler, it may be calculated using the CAPM and an unlevered beta.

The CCF method is obviously simpler (but also less flexible) than APV. Compared to the WACC, CCF has the same virtues and faults, but it doesn't require that the leverage ratio remain constant. Instead, just as they are in APV, tax shields are computed each period as cash flows and, hence, reflect the true complexity of the company's tax situation. This is more complicated than the WACC if the tax situation is complicated. The cost of unlevered equity itself is almost always simpler to compute than the WACC, however, having fewer elements. In short, we might say CCF has more complicated cash flows than the WACC, but a simpler discount rate.

4 KEY TERMS

asset beta The beta for a project or business. Often the asset beta is estimated as a weighted average of debt and equity betas. *See also* unlevered asset beta.

beta A statistical measure of the systematic risk of an asset. Betas for traded assets such as stocks and bonds may be estimated using linear regression of asset returns on market returns.

capital asset pricing model (CAPM) A model that relates the expected return on a risky asset to the expected return on the overall market. *See also* security market line (SML).

cost of capital The return promised to investors in exchange for capital. In this reading, the cost of capital is formulated as a discount rate comprising both the time value of money and a risk premium appropriate for the risk inherent in investing in a particular project. *See also* opportunity cost of funds; weighted average cost of capital (WACC).

cost of debt The expected rate of return required by a firm's lenders.

cost of equity The expected rate of return required by a firm's shareholders.

costs of financial distress (CFD) The direct and indirect costs that arise when a company is unable to meet all its obligations.

equity market risk premium (EMRP) The expected return on the market portfolio over and above the risk-free rate; EMRP = $E(r_{market}) - r_f$.

free cash flow Net cash flow generated by a business or a project, including both earnings and required investments in net fixed assets and net working capital, but excluding interest payments.

interest tax shield The reduction in corporate taxes due to the deductibility of interest.

net debt The sum of short-term and long-term debt, reduced by the value of cash and marketable securities.

opportunity cost of funds In the context of capital budgeting, the opportunity cost of funds equals the expected return that can be earned on an alternative project with the same risk and time horizon and for which net present value (NPV) = 0. *See also* required expected return.

required expected return The lowest expected return at which investors are willing to undertake a risky investment. *See also* opportunity cost of funds.

risk-free rate The rate of interest earned on a security for which promised cash flows are certain to be paid or received; that is, the interest rate associated with default-risk-free securities.

risk premium The portion of a risk-adjusted discount rate that compensates investors for bearing risk. The risk premium equals the difference between the risk-adjusted discount rate (or expected return) and the risk-free rate.

security market line (SML) In the CAPM, the SML relates an asset's expected return to its systematic risk, or beta. According to the SML, an asset's expected return equals the risk-free rate plus a premium; the premium equals the asset's beta times the EMRP.

systematic (nondiversifiable) risk Risk that cannot be eliminated through diversification—that is, market risk. *See also* beta.

target ratios The proportions of debt and equity a company intends for its capital structure over the long term.

unlevered (asset) beta Reflects the systematic risk for an unleveraged business or project; may be calculated by unlevering the business's equity beta.

unlevered equity Equity of a firm that has no debt obligations.

weighted average cost of capital (WACC) A weighted average of a company's cost of debt and its cost of equity; the weights are proportions of debt and equity (respectively) in the capital structure.

5 NOTATION

APV	adjusted present value
β_a	an asset (or unlevered) beta
$\beta_{d,}$ (β_{dX})	the beta of debt (issued to finance asset X)
$\beta_{e,}$ (β_{eX})	the beta of equity (issued to finance asset X)
β_X	the beta of asset X with respect to the market; also the slope of the best-fit line in a linear regression of the asset with the market
β_u	an unlevered (or asset) beta
β'_e	an equity beta obtained by re-levering an unlevered (or asset) beta
CAPM	capital asset pricing model
CCF	capital cash flows
CFD	costs of financial distress
D	market value of debt
DCF	discounted cash flow
E	market value of equity
EBIT	earnings before interest and taxes
EMRP	equity market risk premium
E(r_X)	the expected return of risky asset X
FCF	free cash flow
$k_{d,}$ (k_{dX})	cost of debt (for asset X)
$k_{e,}$ (k_{eX})	cost of equity (for asset X)
k_u	cost of unlevered equity
k_X	expected return on asset X
r_f	risk-free rate
r_{market}	return of the market
t	corporate tax rate
V	firm market value (V=D+E)
WACC	weighted average cost of capital

6 PRACTICE QUESTIONS

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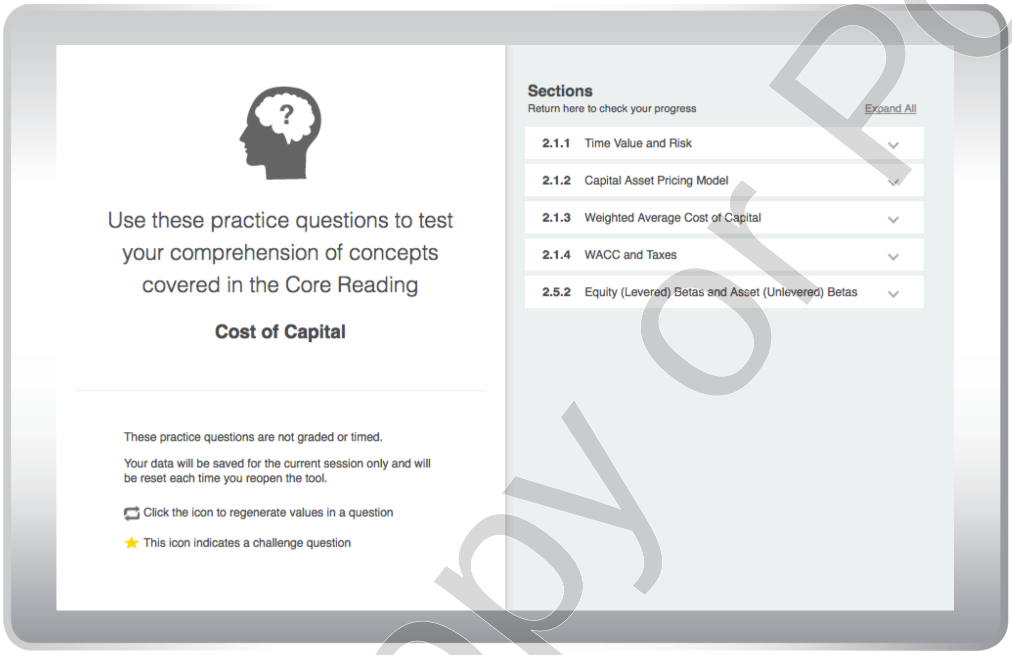

7 ENDNOTES

1 For a full treatment of this topic, see *Core Reading: Risk and Return 2: Portfolio Theory* (HBP No. 8603).

2 A fuller discussion of the distribution of risk to equity and debt is covered in *Core Reading: Capital Structure Theory* (HBP No. 5187).

3 "Rating Action: Moody's Rates Coca-Cola Bonds Aa3, Outlook Stable," Moody's Investors Service, October 22, 2015, https://www.moodys.com/research/Moodys-rates-Coca-Cola-Bonds-Aa3-Outlook-Stable--PR_329110, accessed April 2016; Coca Cola Company, December 31, 2015, Form 10-K (filed February 25, 2016), www.coca-colacompany.com/content/dam/journey/us/en/private/fileassets/pdf/investors/2015-annual-report-on-form-10-k.pdf, accessed April 2016.

4 Coca-Cola Company, December 31, 2015, Form 10-K (filed February 25, 2016), www.coca-colacompany.com/content/dam/journey/us/en/private/fileassets/pdf/investors/2015-annual-report-on-form-10-k.pdf, accessed April 2016.

5 For an introduction to types of debt and related analyses, see *Core Reading: Introduction to Bonds and Bond Math* (HBP No. 5170).

6 See "Resource Center," www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=longtermrateYear&year=2015, accessed April 7, 2016.

7 Shannon Pratt and Roger Grabowski, *Cost of Capital: Applications and Examples*, 5th ed. (New York: John Wiley & Sons, 2014), pp. 110–176.

8 For an introduction to capital structure, see *Core Reading: Capital Structure Theory* (HBP No. 5187).

8 INDEX