COST OF CAPITAL

Cost of capital calculations are a very important part of finance. To value a project, it is important to discount the cash flows using a discount rate that incorporates the debt-equity mix of financing that the project will use. The discount rate should also incorporate discount rates on debt and equity that are appropriate for the project in terms of the risk of the project. The risk of the project is a function of both the assets of the project and how much leverage the project has. The discount rate that considers all of these factors as well as the tax deductibility of interest payments is called the Weighted Average Cost of Capital, or WACC for short, and is written r_{wacc}.

I.   Cost of Capital

The basic idea behind the cost of capital calculations is that the market value of the firm's assets must equal the market value of the firm's debt plus the market value of the firm's equity, i.e.,

Assets   =   Debt   +   Equity   =   Value of the firm

Please note that in finance, we are concerned with *MARKET VALUES* (unlike accounting, which is concerned with book values).

If the market value of the assets equal the market value of the debt plus the market value of the equity, then it must also be true that the returns have a similar relationship, where each return is weighted by its percentage of the value of the firm:

$$r_{assets} * (Assets/Value) = r_{debt} * (Debt/Value) + r_{equity} * (Equity/Value)$$

If you note above that the value of the firm is equal to the value of the assets, we get:

$$r_{assets} = r_{debt} * (D/V) + r_{equity} * (E/V)$$

II.   Weighted Average Cost of Capital

In the United States, interest on the debt is deductible from taxes, while dividends are not tax-deductible. Thus, while the firm may pay out r_{debt} in interest, it will be able to deduct this from its tax bill, reducing its taxes by the corporate tax rate (abbreviated T_c) times r_{debt}. Thus, the after-tax cost of interest is $(1-T_c) * r_{debt}$. So, for example, if the debt rate is 10% and the corporate tax rate is 34%, the after-tax cost of interest is $10\% * (1-.34) = 6.6\%$.

Therefore, the weighted average cost of capital should take into account the fact that interest is tax-deductible while dividends are not. So, adjusting the previous equation for taxes, we get

$$r_{wacc} = (1-Tc) * r_{debt} * (D/V) + r_{equity} * (E/V)$$

where the D/V and the E/V are *market values*, not book values!!

III.   The WACC MUST be Specific to the Project

A.   *The ratios must be for the project, not the firm*

If you look at the WACC formula, you will see that it uses the debt-to-value ratio and the equity-to-value ratio. These ratios should be for the project that you are trying to evaluate and NOT the r_{wacc} for the firm as a whole. So, if the firm as a whole has a debt-to-value ratio of 25%, but the project will be financed entirely by equity, then the debt-to-value ratio *of the project* is zero, and you need to put in zero and NOT 25% into the r_{wacc} formula.

B.   *The rates of return must be from the same industry as the project, not the firm*

Sometimes the project is not similar to what the firm currently does. If this is so, it may be that the r_{debt} and r_{equity} of the project may be *different* than the r_{debt} and r_{equity} of the firm. This situation may occur if the project is not scale-enhancing for the firm, i.e., the firm is doing a project in a completely different industry than its current industry – for example, if a car company starts making ice cream. The required rates of return for car companies might be quite different than the required rates of return for ice cream companies. Since the r_{wacc} formula came from the formula that was related to the return on assets, you need to use the r_{debt} and r_{equity} from the industry that has the same assets as the project, and NOT the industry of the overall firm. So, if a car company is going to make ice cream, the r_{debt} and r_{equity} in the r_{wacc} formula need to be related to the ice cream industry, not to the car industry.

C.   *Don't forget to lever / unlever rates of return to match the project's leverage ratios*

To make things even more complicated, just because the r_{debt} and r_{equity} numbers come from the same industry as the project doesn't mean that they are the correct numbers to use for analyzing the project. This is because both r_{debt} and r_{equity} (particularly r_{equity}) change if the debt/value ratio changes. For example, the r_{equity} of a firm that makes cars that has a 50% debt/value ratio should be higher than the r_{equity} of a firm that makes cars that has a 10% debt/value ratio, since there is more leverage and thus the equity is more risky. However, the r_{asset} will be the same since they are in the same industry and r_{asset} doesn't depend on the amount of leverage.

So, in this case, if you have the r_{equity} of a firm that makes cars that has a 50% debt/value ratio, but your project to make cars will only have a 10% debt/value ratio, you will first need to *unlever* the r_{equity} of the firm that makes cars with a 50% debt/value ratio and solve for r_{asset}. Once you have calculated the r_{asset}, you now use the r_{asset} formula using the 10% debt/value ratio and solve for r_{equity} *for your project*.

IV.   Sample Question

Please note: This is a complicated question, but it is not really that hard, just intricate.

Assume that the Bank of Boston (BKB) wants to purchase Pizza Hut. Pizza Hut is a wholly-owned subsidiary of Pepsi, so there is no market price available for Pizza Hut. Pizza Hut will generate a net cash flow of $10 million a year (not including any interest charges) for forever. BKB has $100 million face value of seven-year 9% annual coupon bonds outstanding. The current price of BKB is $62.75 and it has 20 million shares outstanding.

Although Pizza Hut is not traded, Domino's Pizza (a direct competitor in the same industry) is currently traded. The price of Domino's Pizza is $38.125 per share with 10 million shares outstanding, and the Beta of Domino's Pizza is 1.5. Domino's Pizza has no debt.

Assuming that r_{debt} for all firms is 10%, the tax rate is 40%, the expected return on the market is 12% and the risk-free rate is 4%, what is the most BKB should be willing to pay for Pizza Hut assuming that it will finance the purchase using the same capital structure that BKB currently has?

<u>The Answer:</u>

This problem is not difficult, just complicated. To start off, we should remember that the value of anything is just the discounted present value of its cash flows. So, we can value Pizza Hut by discounting its cash flows by r_{wacc}:

Price   = $10 million / r_{wacc}

OK, so now we need r_{wacc} . Let's look at the formula:

r_{wacc} = $(1-Tc)* r_{debt} * (D/V)$ + $r_{equity} * (E/V)$

We will solve this by putting in each piece at a time as soon as we calculate it.

A.   First, put in any numbers directly given in the question

So far we know the tax rate is 40% and the r_{debt} is 10%, so we have:

r_{wacc} = $(1-.40)* .10 * (D/V)$ + $r_{equity} * (E/V)$

B. *Now get the D/V and the E/V*

We need to determine the D/V and the E/V for the project – which is buying Pizza Hut. Since the Bank of Boston has decided to purchase Pizza Hut using the same mix of debt and equity that the Bank of Boston currently has, we need to determine BKB's debt/value ratio.

To calculate BKB's D/V and E/V ratio, we first need to calculate the market value of the debt and the market value of the equity. The market value of the equity is easy – it is just the price per share times the number of shares outstanding:

$$
\begin{aligned}
\text{MV (equity)} \quad &= \quad \text{price per share * number of shares} \\
&= \quad \$62.75*20,000,00 \\
&= \quad \$1,255,000,000
\end{aligned}
$$

The market value of the debt is a little bit more tricky. Recall that the value of the debt is just the present value of the coupons plus the present value of the face value. In this case, the face value is $100,000,000. Since it is 9% coupon annually, every year BKB will have to pay $9,000,000 in interest. However, the current interest rate on debt (r_{debt}) is 10%, so we will have to use 10% as our discount rate. Since the debt matures in seven years, we have a seven-year annuity of $9 million and then $100 million in year seven, all of which should be discounted at 10%:

$$
\begin{aligned}
\text{MV (Debt)} \quad &= \quad \$9,000,000 \, A^{7}_{10\%} \quad + \quad \$100,000,000 / (1.1)^{7} \\
&= \quad \$95,131,581
\end{aligned}
$$

Now that we know the MV (Debt) and the MV of Equity, we know the MV of the firm:

$$
\begin{aligned}
\text{MV(Firm)} \quad &= \quad \text{MV(Debt)} \quad + \quad \text{MV(Equity)} \\
&= \quad \$95,131,581 \quad + \quad \$1,255,000,000 \\
&= \quad \$1,350,131,581
\end{aligned}
$$

So:

$$
\begin{aligned}
\text{D/V} \quad &= \quad \$95,131,581 / \$1,350,131,581 \\
&= \quad 7\%
\end{aligned}
$$

$$
\begin{aligned}
\text{E/V} \quad &= \quad \$1,255,000,000 / \$1,350,131,581 \\
&= \quad 93\%
\end{aligned}
$$

So now we have almost all of our WACC equation:

$$
r_{wacc} \quad = \quad (1-.40)* .10 *(.07) \quad + \quad r_{equity} * (.93)
$$

(Please note that the Bank of Boston could have decided to use a *different* debt/value ratio for its purchase of Pizza Hut. Had it done so, we would have to use this different D/V ratio and NOT BKB's current D/V ratio in the WACC formula – in fact, in that case, BKB's D/V ratio would be *irrelevant!*)

C.   *Now get the R_{equity} and calculate R_{WACC}*

Now, we come to the difficult part. We need to calculate the r_{equity} for the project. We cannot observer the r_{equity} for Pizza Hut directly since it is not traded. However, we know the Beta for Domino's pizza, which is in the same industry as Pizza Hut and therefore has similar assets. We also know that

$$\text{Beta}_{assets} \quad = \quad \text{Beta}_{debt} * (D/V) + \quad \text{Beta}_{equity} * (E/V)$$

Since Domino's and Pizza Hut are in the same industry, they must have the same Beta for their assets -- since they have the same r_{assets} (since they are in the same industry), they have to have the same Beta for their assets. So, if we make the simplifying assumption that the Beta of debt is zero, we will get for the Beta of assets in the pizza business:

$$\text{Beta}_{assets} \quad = \quad 0 * (0) \; + \quad 1.5 * (1)$$
$$= \quad 1.5$$

since the Beta for Domino's equity was 1.5 and it had no debt (so debt/value = 0 and equity/value =1). Now that we know that the Beta of the assets in the pizza business is 1.5, we can use the formula again to get the Beta of the equity for Pizza Hut, recalling that BKB will finance the purchase of Pizza Hut using the same mix of debt and equity that BKB currently has, i.e., 93% equity and 7% debt:

$$1.5 \quad = \quad 0 \,(.07) \quad + \quad \text{Beta}_{equity} * (.93)$$
$$1.5 \quad = \quad \text{Beta}_{equity} * (.93)$$
So,
$$\text{Beta}_{equity} \quad = \quad 1.5 / 0.93$$
$$= \quad 1.61$$

So, if the Beta_{equity} for Pizza Hut (if it is purchased with 93% equity and 7% debt) is 1.61, we can use the CAPM to get the r_{equity} for Pizza Hut:

$$r_{equity} \quad = \quad r_f \quad + \quad \text{Beta}_{equity} * (E[r_{market}] - r_f)$$
$$= \quad 4\% \quad + \quad 1.61 * (12\% - 4\%)$$
$$= \quad 16.88\%$$

So, substituting $r_{equity} = 16.88\%$ into the WACC equation above, we get:

$$r_{wacc} \quad = \quad (1-.40) * .10 * (.07) \quad + \quad .1688 * (.93)$$
$$= \quad 16.12\%$$

D.   *Now just use R_{WACC} to discount the cash flows and get a price*

$$\text{Price} \quad = \quad \$10 \text{ million} / r_{wacc}$$
$$= \quad \$10,000,000 / .1612$$
$$= \quad \$62,034,739$$

So the Bank of Boston should not pay more than $62 million if it buys Pizza Hut and finances the purchase with 93% equity and 7% debt.