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The After-Tax Cost of Debt: A Consistent Approach

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Abstract

Discounted cash flow (DCF) method is an important cornerstone of modern finance. One of its most frequent applications is the cash flow implied interest rate (CFIIR) calculation. There are numerous instances in which the CFIIR calculation can be consistently applied. These instances include the calculation of the components cost of capital i.e. the cost of common and preferred equity and the cost of debt. However, in practice the components cost of capital are not often consistently calculated. That is the calculations of the components cost of common and preferred equity are performed in accordance with the CFIIR but the calculation of the after-tax cost of debt is not performed in accordance with the same approach. An examination of current finance textbooks provides an indication of the source of this inconsistency in approach.

ONE OF THE cornerstones of modern finance is the *discounted cash flow* (DCF) method. This paper highlights one of its most frequent applications i.e. the *cash flow implied interest rate* (CFIIR) calculation. There are numerous cases in which the CFIIR calculation can be consistently applied. These include the calculation of the components cost of capital i.e. the cost of common and preferred equity and the cost of debt. This paper argues that in practice the components cost of capital is not often consistently calculated. That is the calculations of the components cost of common and preferred equity are performed in accordance with the CFIIR but the calculation of the after-tax cost of debt is not performed in accordance with the same approach. The paper examines the current finance textbooks which point to the source of this inconsistency in approach.

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The solution lies in the consistent application of the DCF-based *cash flow implied interest rate* (CFIIR) calculation. This approach highlights the importance of focusing on the time profile of cash flows and calculating the implied interest rate. The mathematics involved is well-known. The contribution here is to discuss the CFIIR calculation and consistently apply it to all cases of components cost of capital calculation.

Section 1 introduces the CFIIR calculation. Section 2 applies the CFIIR calculation in a consistent manner to find the components cost of capital. Special emphasis is laid on the calculation of the after-tax cost of debt by working through a specific numerical example. This is because Section 3 notes that almost all textbooks when calculating the after-tax cost of debt deviate from the approach they use in calculating the cost of common and preferred equity. Section 4 concludes the discussion.

1.The CFIIR Calculation

The DCF method defines a mathematical relationship among four parameters: the present value of the cash flows, the future value of the cash flows, the number of time periods associated with each cash flow, and the appropriate interest rate. Based on this relationship, if the values for three of the four parameters are known, the value of the fourth parameter can be calculated. The CFIIR calculation is applicable when the three known parameters are: the present value of the cash flows, the future value of the cash flows, and the number of time periods associated with each cash flow; and the unknown parameter is the appropriate interest rate. The time profile of cash flows for the general case is depicted in Exhibit 1.

Technically, the CFIIR calculation requires one to set up the mathematical relationship among the present value of the cash flows, the future value of the cash flows, the number of time periods associated with cash flow, and the interest rate, as defined by the DCF:

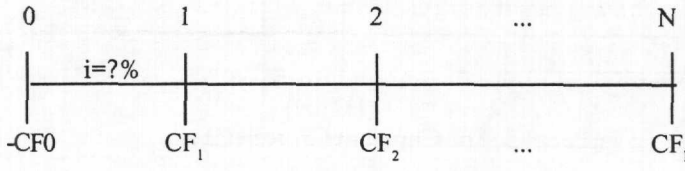
$$CF_0 = PV(CF_1) + PV(CF_2) + \ldots + PV(CF_N)$$

$$CF_0 = CF_1(PVIF_{i,1}) + CF_2(PVIF_{i,2}) + \ldots + CF_N(PVIF_{i,N})$$

where CF designates a *cash flow*, PV designates *present value*, i designates the appropriate periodic *interest rate*, a subscript for a cash flow designates the *number of time periods associated with a cash flow*, and PVIF designates the *present value interest factor*.

Then, given the values for the first three parameters, one can calculate the fourth parameter, i.e., the interest rate. In other words, the time profile of cash flows implies the interest rate, hence the *cash flow implied interest rate* (CFIIR). This scenario is common among all the components cost of capital calculations. In the next section, the CFIIR calculation is applied, in a consistent manner to find the components cost of capital.

Exhibit 1. The CFIIR Calculation: The General Case



2. Sources of Long-Term Capital and their Cost

The three major long-term sources of capital to corporations are common equity, preferred equity and long-term debt. The CFIIR calculation can be consistently applied to find each of the components cost of capital.

2.A. Common Equity

The two sources of common equity i.e. the retained earnings and the new common shares are treated here in turn.

The internally generated funds, called retained earnings, belong to the current shareholders who decide to invest the funds in the corporation. In exchange, the corporation is expected to pay dividends. The rate of return the shareholder expects to receive equals the opportunity cost of the funds if the funds were invested in the stocks of a similar corporation i.e. investment in a similar corporation's shares at a similar share price of P_0 and with similar expected dividends of $D_1, D_2, \ldots$. The cost of retained earnings to the corporation, k_s, equals the cost of funds raised at a share price of P_0 with the expected dividends of $D_1, D_2, \ldots$ to be paid in exchange. The time profile of cash flows is depicted in Exhibit 2, Panel a.

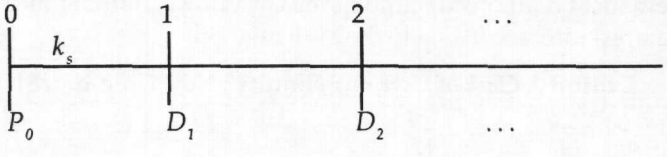
The CFIIR calculation can be used to find the interest rate. First, set up the mathematical relationship among the cash flows, number of time periods, and interest rate, according to the DCF method, then solve for k_s:

$$P_0 = PV(D_1) + PV(D_2) + \ldots$$

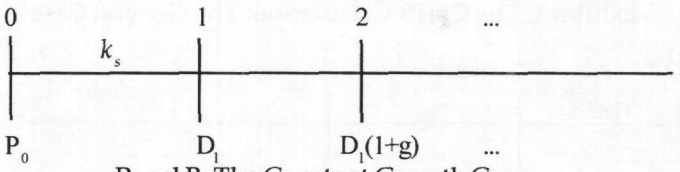
$$P_0 = D_1(PVIF_{ks,1}) + D_2(PVIF_{ks,2}) + \ldots$$

Where k_s designates the *cost of retained earnings* the time profile of the cash flows $P_0, D_1, D_2, \ldots$ is given and the cost of retained earnings can be calculated.

Exhibit 2. Cost of Common Equity : Retained Earnings



Panel A. The General Case



Panel B. The Constant Growth Case

Exhibit 2, Panel b shows the time profile of cash flows for the simpler case of the constant growth stock. The CFIIR calculation can be used to find the interest rate. First, set up the mathematical relationship among the cash flows, number of time periods, and interest rate, according to the DCF method:

$$P_0 = D_1/(k_s - g)$$

Where g designates the *expected rate of growth in dividends*. Then, given P_0, D_1, g, find k_s:

$$k_s=(D_1/P_0)+g$$

The external source of common equity i.e. new common shares can be dealt with in a similar manner. The only difference is that when the firm issues new common shares, it incurs flotation costs. The time profile of cash flows for the general case is presented in Exhibit 3, Panel a. The corporation incurs per share flotation costs equal to F and, therefore, receives P_0-F at time 0. The other cash flows are the same as the case of financing with retained earnings. The CFIIR calculation can be used to find the cost of new common shares. First, set up the mathematical relationship among the cash flows, number of time periods, and interest rate, according to the DCF method, then solve for k_e:

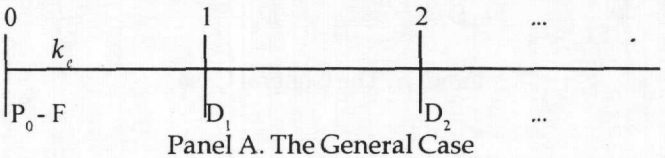
$$P_0 - F = PV(D_1) + PV(D_2) + \ldots$$

$$P_0 - F = D_1(PVIF_{ke,1}) + D_2(PVIF_{ke,2}) + \ldots$$

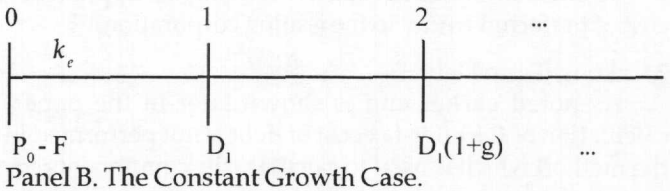
Where k_e designates the *cost of newly issued common shares*. Note that the time profile of the cash flows P_0 - F, D_1, D_2, . . . is given and the cost of new common shares can be calculated.

Exhibit 3, Panel b shows the time profile of cash flows for the simpler case of the constant growth stock. The CFIIR calculation can be used to find the expected cost of new shares to the corporation. First, set up the mathematical relationship among the cash flows, number of time periods, and interest rate, according to the DCF method:

Exhibit 3. Cost of Common Equity : New Common Shares



Panel A. The General Case



Panel B. The Constant Growth Case.

$$P_0 - F = D_1/(k_s - g)$$

Then, given P_0 - F, D_1, and g, solve for k_e:

$$k_e = [D_1/(P_0 - F)] + g$$

In summary the CFIIR calculation can be applied to find out the expected cost of common equity to the corporation.

2.B. Preferred Share

In this long-term method of financing, the corporation promises to pay a constant amount of dividend per period to the preferred shareholders. The time profile of cash flows is depicted in Exhibit 4.

Often, the information available to the corporation consists of the market price for the preferred shares, Pps, and the expected dividend per period, D. What is not known is the component cost of preferred shares, kps. This is the usual scenario in financial markets where market prices and expected cash flows are taken as inputs, and, on this basis, the interest rate is calculated. This situation applies to all cases considered in this paper and consequently the CFIIR is used.

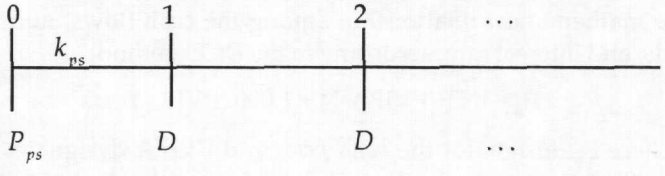
The CFIIR calculation can be applied to the time profile of cash flows to find the interest rate. First, set up the mathematical relationship among the cash flows, number of time periods, and interest rate, according to the DCF method:

$$P_{ps} = D/k_{ps}$$

Then, solve for the interest rate:

$$k_{ps} = D/P_{ps}$$

Exhibit 4. Cost of Preferred Share



The calculation of the cost of preferred shares with flotation costs is similar to the case of common equity with flotation costs. That is, the corporation incurs per share flotation costs equal to F and, therefore, receives P_0-F at time 0. Applying the CFIIR results in:

$$k_{ps} = D/(P_{ps} - F)$$

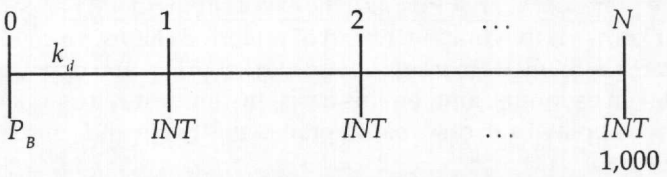
In nutshell the CFIIR calculation may be applied to find the expected cost of preferred equity to the issuing corporation.

2.C. Long-Term Debt

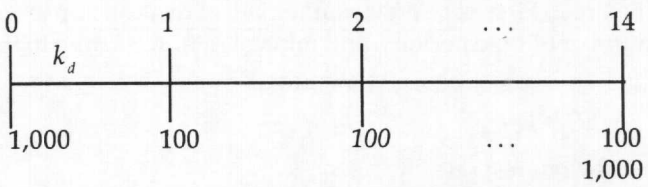
As noted earlier and is shown later in the paper, in practice, the calculation of the after-tax cost of debt is not performed in accordance with the method which is used to calculate the components cost of common and preferred equity. To show how the after-tax cost of debt can be calculated in a manner consistent with the calculations of the components cost of common and preferred equity, three scenarios are examined and numerical examples are performed. In the first scenario, which is the basic framework of analysis, there are no taxes and flotation costs. In the second scenario, there are taxes but no flotation costs. In the third scenario there are both taxes and flotation costs.

2.C.i. Debt with No Taxes and No Flotation Costs: In this long-term method of financing, the corporation promises to pay to the bondholders a constant amount of interest per period, INT, and the par value, US $1,000, at maturity, N. The time profile of the cash flows is depicted in Exhibit 5, Panel a.

Exhibit 5. Cost of Debt: No Taxes and No Flotation Costs



Panel A. Debt with No. Taxes and No. Flotation Costs.



Panel B. Debt with No Taxes and No Flotation Costs: A Numerical Example

The CFIIR calculation can be used to calculate the interest rate. First, set up the mathematical relationship among the cash flows, number of time periods, and interest rate, according to the DCF method:

$$P_B = \text{INT}\ (\text{PVIFA}_{i,N}) + 1{,}000\ (\text{PVIF}_{i,N})$$

Where P_B designates the *bond price* and PVIFA designates the *present value interest factor annuity* the interest rate can be calculated, since in this equation all cash flows (P_B, INT, and the par value of US $1,000) are known.

Suppose a corporation borrowsUS $1,000. In exchange, it promises to pay $100 as interest per year and the face amount of US $1,000 at the end of the 14th period, i.e., the maturity. The time profile of the cash flows is depicted in Exhibit 5, Panel B.

The CFIIR calculation can be used to calculate the interest rate. First, set up the mathematical relationship among the cash flows, number of time periods, and interest rate, according to the DCF method:

$$1{,}000 = 100\ (PVIFA_{i,14}) + 1{,}000\ (PVIF_{i,14})$$

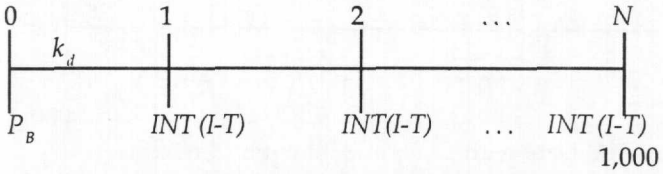
Then, solve for i:

$$i = 10\%$$

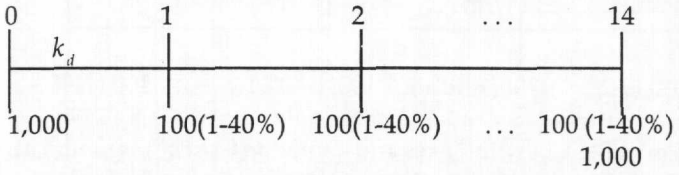
That is: $i = YTM = k_d = 10\%$, where YTM is the *yield to maturity*, and k_d is the *cost of debt*.

2.C.ii. Debt with Taxes but No Flotation Costs: The calculation of the after-tax cost of debt is very similar to the above scenario except that the after-tax cash flows should be considered. Suppose the corporate tax rate is T. Then, the after-tax interest expense to the corporation becomes INT(1-T). The time profile of the cash flows is depicted in Exhibit 6, Panel A.

Exhibit 6. Cost of Debt: With Taxes but No Flotation Costs



Panel A. Debt with Taxes but No Flotation Costs



Panel B. Debt with Taxes but No Flotation Costs: A Numerical Example

The CFIIR calculation can be used to calculate the interest rate. First, set up the mathematical relationship among the cash flows, number of time periods, and interest rate, according to the DCF method:

$$P_B = INT\ (1 - T)\ (PVIFA_{i,N}) + 1{,}000\ (PVIF_{i,N})$$

Then, the interest rate can be calculated, since in this equation all cash flows (PB, INT, T, and the par value of $1,000) are known.

Suppose a corporation borrowsUS $1,000. In exchange, it promises to pay US $100 as interest per year and the face amount of US $1,000 at the end of the 14th period, i.e., the maturity. The corporate tax rate is 40%. The time profile of the cash flows is depicted in Exhibit 6, Panel B.

The CFIIR calculation can be used to calculate the interest rate. First, set

up the mathematical relationship among the cash flows, number of time periods, and interest rate, according to the DCF method:

$$1{,}000 = 100\,(1 - 40\%)\,(PVIFA_{i,14}) + 1{,}000\,(PVIF_{i,14})$$

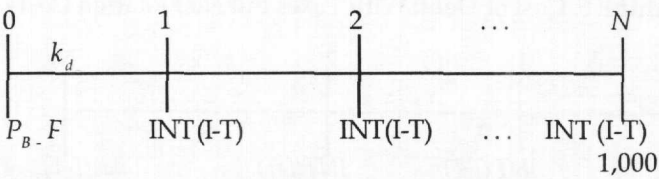
Then, solve for i:

$$i = 6\%$$

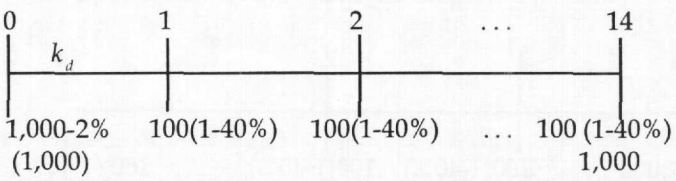
That is: $i = YTM = k_d = 6\%$.

2.C.iii. Debt with Taxes and Flotation Costs: To make the case more realistic, consider both taxes and flotation costs. The calculation of the after-tax and flotation costs of debt is very similar to the above scenario except that the net proceeds from the sale of bonds should be considered. Suppose the flotation cost is F. The time profile of the cash flows is depicted in Exhibit 7, Panel a.

Exhibit 7. Cost of Debt: With Taxes and Flotation Costs



Panel A. Debt with Taxes and Flotation Costs



Panel B. Debt with Taxes and Flotation Costs: A Numerical Example

The CFIIR calculation can be used to calculate the interest rate. First, set up the mathematical relationship among the cash flows, number of time periods, and interest rate, according to the DCF method:

$$P_B - F = INT\,(1 - T)\,(PVIFA_{i,N}) + 1{,}000\,(PVIF_{i,N})$$

Then, the interest rate can be calculated, since in this equation all cash flows (P_B, F, INT, T, and the par value of $1,000) are known.

Suppose a corporation borrows US $1,000 and incurs a flotation cost of 2%. In exchange, it promises to pay US $100 as interest per year and the face amount of US $1,000 at the end of the 14th period, i.e., the maturity. The corporate tax rate is 40%. The time profile of the cash flows is depicted in Exhibit 7, Panel B.

The CFIIR calculation can be used to calculate the interest rate. First, set up the mathematical relationship among the cash flows, number of time

periods, and interest rate, according to the DCF method:

$$1{,}000 - 2\%\,(1{,}000) = 100\,(1 - 40\%)\,(PVIFA_{i,14}) + 1{,}000\,(PVIF_{i,14})$$

Then, solve for i:

$$i = 6.2181\%$$

That is: $i = YTM = k_d = 6.2181\%$.

In summary, the CFIIR calculation may be applied to find the cost of debt, kd, with or without taxes and flotation costs.

3.Textbook Treatment of the Components Cost of Capital

Current introductory finance textbooks consistently calculate the cost of common and preferred equity - with or without flotation costs - and in accordance with the CFIIR calculation. However, they deviate from their approach when calculating the after-tax cost of debt. A summary of the findings is reported in Exhibit 8.

Thirty-two current introductory finance textbooks, supplied by major publishers, are reviewed. The textbooks are: Besley-Brigham (1999), Block-Hirt (2000), Brealey-Myers (2000), Brealey-Myers-Marcus (1999), Brigham-Gapenski (1996), Brigham-Gapenski-Ehrhardt (1999), Brigham-Houston (1998), Chambers-Lacey (1999), Damodaran (1997), Dickerson-Campsey-Brigham (1995), Eakins (1999), Emery (1998), Emery-Finnerty (1997), Emery-Finnerty-Stowe (1998), Gallagher-Andrew (2000), Gitman (1995), Gitman (1997), Hickman-Hunter-Byrd (1996), Kaen (1995), Keown-Petty-Scott-Martin (1999), Kolb-Rodriguez (1996), Lee-Finnerty-Norton (1997), Levy (1998), Moyer-McGuigan-Kretlow (1998), Pinches (1996), Pinches (1994), Ross-Westerfield-Jaffe (1999), Ross-Westerfield-Jordan (1999), Scott-Martin-Petty-Keown (1996), Van Horne (1998), Van Horne-Wachowicz (1998), and Weston-Besley-Brigham (1996).

Among the 32 textbooks reviewed 28 deal with the cost of common equity with no flotation costs; 17 with the cost of common equity with flotation costs. (Their approach being in accordance with the CFIIR calculation); seven with the cost of preferred equity with no flotation costs; and 19 with the cost of preferred equity with flotation costs. (Their approach also in accordance with the CFIIR calculation).

As for the after-tax cost of debt calculation, all current introductory textbooks - except for one - deviate from the way they approach the calculation of the components cost of common and preferred equity.

Ten of the 32 textbooks state that since interest is tax-deductible the after-tax cost of debt equals $k_d(1-T)$, where kd is the *interest rate on the debt* and T is the *corporate tax rate*. This statement may be applicable to the case of a perpetual bond or a par bond. However, this is not applicable to bonds in general. This is because bonds are not generally traded at par and that they have limited maturities.

Three of the 32 textbooks find the before-tax cost of debt in accordance with the CFIIR calculation. However, they do not calculate the after-tax cost of debt.

The remaining 18 textbooks calculate the before-tax cost of debt in accordance with the CFIIR calculation. However, in order to calculate the after-tax cost of debt, they multiply the before-tax cost of debt by the (1-T) factor. As noted in Sub-Section 2.C, the after-tax cash flows should be used for the calculation of the after-tax cost of debt.

Only one of the 32 textbooks calculates the after-tax cost of debt consistently and in accordance with the CFIIR calculation.

4. Conclusion

This paper introduced the CFIIR calculation and showed how it underlies the components cost of capital calculations and how it should consistently be used in practice. Textbook authors and teachers need to reinforce the CFIIR calculation in the calculation of each of the components cost of capital so that the students clearly see the connection and have a better intuitive grasp of the underlying method. Such students, when confronted with a practical situation, would be able to consistently apply the underlying method without confusion.

Exhibit 8 : Summary of Findings

Textbook Author(s)	Common	Common & Flotation	Preferred	Preferred & Flotation	Just k_d(I-T)	CFIIR k_d	(CFIIR k_d) (I-T)	CFIIR After-Tax Cost of Debt
Besley-Brigham	Y	Y	N	Y	N	Y	Y	N
Block-Hirt	N	Y	N	Y	N	Y	Y	N
Brealey-Myers	Y	N	N	N	Y	N	N	N
Brealey-Myers-Marcus	Y	N	Y	N	N	Y	Y	N
Brigham-Gapenski	Y	Y	N	Y	N	Y	Y	N
Brigham-Gapenski-Ehrhardt	Y	N	N	Y	Y	N	N	N
Brigham-Houton	Y	Y	N	Y	Y	N	N	Y
Chambers-Lacey	N	N	N	N	Y	N	N	N
Damodaran	Y	N	Y	N	Y	N	N	N
Dickerson-Campsey-Brigham	Y	Y	N	Y	Y	N	N	N
Eakins	Y	Y	N	Y	N	Y	Y	N
Emery	N	N	N	N	N	N	N	N
Emery-Finnerty	Y	N	N	N	N	Y	Y	N
Emery-Finnerty-Stowe	Y	N	N	N	N	Y	Y	N
Gallagher-Andrew	Y	Y	N	Y	Y	N	N	N
Gitman (1)	Y	Y	N	Y	N	Y	Y	N
Gitman (2)	Y	Y	N	Y	N	Y	Y	N
Hickman-Hunter-Byrd	Y	Y	Y	N	N	Y	Y	N
Kaen	Y	Y	Y	Y	N	Y	Y	N
Keown-Petty-Scott-Martin	Y	Y	N	Y	N	Y	N	N
Kolb-Rodriguez	N	N	N	N	Y	N	N	N
Lee-Finnerty-Norton	Y	Y	N	Y	N	Y	Y	N
Levy	Y	N	Y	N	Y	N	N	N
Moyer-McGuigan-Kretlow	Y	Y	N	Y	N	Y	Y	N
Pinches (1)	Y	N	N	Y	N	Y	Y	N
Pinches (2)	Y	Y	N	Y	N	Y	Y	N
Ross-Westerfield-Jaffe	Y	N	N	N	Y	N	N	N
Ross-Westerfield-Jordan	Y	N	Y	N	N	Y	N	N
Scott-Martin-Petty-Keown	Y	Y	N	Y	N	Y	N	N
Van Horne	Y	N	N	Y	N	Y	Y	N
Van Horne-Wachowicz	Y	N	Y	N	N	Y	Y	N
Weston-Besley-Brigham	Y	Y	N	Y	N	Y	Y	N

Notes : 1. Abbreviations
N : No
Y : Yes

2. Column Heading
Common : Cost of Common Equity Calculated in Accordance with the CFIIR
Common & Flotation : Cost of Common Equity with Flotation Costs Calculated in Accordance with the CFIIR
Preferrd: Cost of Preferred Equity Calculated in Accordance with the CFIIR
Preferred & Flotation : Cost of Preferred Equity with Flotation Costs Calculated in Accordance with the CFIIR
Just K_d ((1-T): After - Tax Cost of Debt Calculated just as the Interest on Debt Multiplied by (1-T)
CFIIR k_d: Cost of Debt Calculated as the CFIIR applied to Before - Tax Cash Flows
(CFIIR k_d)(1-T): After - Tax Cost of Debt Calculated as the CFIIR applied to Before-Tax Cash Flows, then multiplied by (1-T)
CFIIR After-Tax Cost of Debt : After-Tax Cost of Debt Calculated as the CFIIR applied to After-Tax Cash Flows

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