Dissecting the Cost of Capital

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Abstract

In order to be capable of confronting the increasingly complicated conditions and tangled circumstances, especially in the aftermath of the economic turmoil of the latest financial crisis, and the growing trends of downsizing and outsourcing, it became critical for the firm's management to assess the cost of its potential investment projects among many alternatives. This is where the firm's cost of capital comes to play in the firm's investment dynamics, as well as in other capital avenues such as mergers or acquisitions, or even in valuing individual securities. Appreciating the crucial role of cost of capital, and having the knowledge and tools to correctly estimate it became one of the most tenacious managerial tasks that a firm can undertake. Here, we go back to the classic theoretical reasoning of the topic in order to provide the necessary clarity to treat the cost of capital factor as compared to the active role of the generic interest or discount rates traditionally used in the calculations of cash flow under the doctrine of the time value of money.

Keywords:cost of capital, equity capital, debt capital, capital budgeting, CAPM

1.Introduction and Rationale

Investment capital is often raised by firms either through internal or external sources. The major, and sometimes the only internal source available,is the allocation of a growth fund out of the firm's own past profits. However, there are many external sources that can be available at any time such as borrowing money either from the public in terms of issuing corporate bonds or from commercial banks in terms of short and long term business loans. Another major external source is to share the business equity with investors in terms of issuing common and preferred stocks. Generally speaking, firms commonly fund their investment projects by a certain combination of debt and equity. A firm's capital budgeting involves making the business decisions on whether or not investment projects are worthwhile, and if they should be funded. It is, therefore, imperative for the firm's management to assess the cost of its funded projects, and this is where the firm's cost of capital comes to play in the firm's investment dynamics. The same assessment is needed for other capital avenues such as mergers or acquisitions, or even in valuing individual securities. Therefore, appreciating the crucial role of cost of capital, and having the knowledge and tools to correctly estimate it became one of the most decisive managerial tasks that a firm can undertake. The basic rationale and objective here is to go back to the classic theoretical reasoning of the topic in order to provide the necessary clarity to treat the cost of capital factor as compared to the generic interest or discount rates traditionally used in the calculations of cash flow under the doctrine of the time value of money.

2. Theoretical Structure:

2.1 The Formal Concept of Cost of Capital

There are two major premises guiding the conceptual setting of cost of capital. By these premises, cost of capital would be a rate of interest which:

1. The firm must earn on its investment in order to maintain a proper market value for its stock.
2. The investors require making their capital attractive and being able to lead their funds to the new investment opportunities.

In this broader sense, cost of capital is considered a shadow opportunity cost of a specific financial venture in comparison to several investment venues. It is expressed by the potentially earned rate of return, given the market dynamics and the state of perceived risk. It is sometimes defined as the "hurdle rate" that a company has to overcome prior to generating any investment value. Since the most common financing sources of capital for the majority of firms in the business market are debt and equity financing, we focus on the estimation of the cost of capital in these sources.

2.2 Cost of Debt Capital

Cost of debt capital is represented by the rate of return that the lending investor would require when they supply their funds to the firm for new investment project. As for the borrowing firm, it would be the minimum rate possible that must be earned on the capital borrowed. Since the interests on debt paid by firms to lenders are tax deductible, this rate on debt capital is measured on after-tax basis. If $\left(k_d^b\right)$ is the nominal interest rate (before taxes) that is paid on debt capital, and (T) is the marginal tax rate that the firm usually pays, then the after-tax rate of debt capital $\left(k_d^a\right)$ is:

$$\boxed{k_d^a = k_d^b(1-T)}$$

Suppose that a firm borrows a certain fund at 9¾% interest, but it pays 39% marginal tax rate on its earnings, the after-tax rate on its debt capital would be:

$$k_d^a = .0975(1-.39)$$
$$k_d^a = 5.95\%$$

This calculated rate of interest would be applied only on the additional capital borrowed by the firm. This would give the cost of capital term the meaning that it is actually measured in terms of the "marginal" cost of capital. If the firm borrows money from the public in terms of issuing corporate bonds, then its before-tax cost of capital $\left(k_{db}^b\right)$ in such a long-term debt would be calculated by:

$$\boxed{k_{db}^b = \frac{I + \left[\frac{M-NP}{n}\right]}{\left[\frac{NP+M}{2}\right]}}$$

where I is the annual interest, M is the face value of bond, NP is the net proceeds (face value adjusted to flotation cost), and n is the number of years to redemption.

Suppose a firm is issuing its 20-year corporate bond of $1,000 at a coupon rate of 9¾%. The bond is sold at 3½% discount and the firm pays a flotation cost of 1½% per bond. The cost of capital for this bond can be calculated as:

I = M(cr)   cr: coupon rate
= (1,000)(.0975) = 97.50
Bond price at discount (B_d) = 1,000 (1-.035) = 965
NP = B_d (1-.015) = 950.52

$$k_{db}^b = \frac{I + \left[\frac{M-NP}{n}\right]}{\left[\frac{NP+M}{2}\right]}$$

$$= \frac{97.50 + \left[\frac{1,000-950.52}{20}\right]}{\left[\frac{950.52+1,000}{2}\right]}$$

= 10.2%

2.3 Cost of Equity Capital (push this down to the top of next page)

Cost of equity capital is represented by the rate of return that the stockholders require when they share the firm ownership through buying its stocks. As for the firm issuing the stocks, it would be the cost of building equity into the firm's financial assets and elevating its performance to achieve the maximum equity possible. Since paying dividends to stockholders is not tax deductible and it is not going to reduce the firm's taxable income in any form, this rate of return is measured by a before-tax basis. The rate of return on equity capital (k_e) incorporates two elements into its estimation.

1. The opportunity cost to investors of forgoing current consumption when diverting some of their income to buy stocks. This element is represented by the interest rate on short term U.S. treasury bills. It is a risk-free rate of return on investment (R_f).
2. The cost of risk that the investors take when they choose to invest into stocks as opposed to investing into other safer investment opportunities. This element is represented by the risk premium (R_p).

The rate of return on equity capital (k_e) can, therefore, be:

$$\boxed{k_e = R_f + R_p}$$

There are two common methods to estimate k_e. The CAPM and the dividend evaluation methods. The risk premium (R_p) for any stock in the market can be estimated using the financial index beta (β), and the risk-free interest rate.

2.4 The CAPM Estimation

The capital asset pricing model (CAPM) can estimate the value of risk premium (R_p) for any stock in the market using the financial index beta (β) which compares the risk associated with any stock to the overall risk of securities in the market. The cost of equity capital (k_e) can, therefore, be estimated as:

$$k_e = R_f + R_p$$

$$k_e = R_f + \beta_i[k_m - R_f]$$

where the risk premium (R_p) is obtained by multiplying the financial index β by the market risk premium, which is the difference between the market expected rate of return (k_m) and the risk-free rate (R_f).

Generally speaking, CAPM is a technical tool to analyze the relationship between the financial asset's expected return and the non-diversifiable market. We can write the central equation of the capital asset pricing model where Beta is an essential factor to calculate the required rate of return on any asset (k_i) given the asset Beta (β_i), the market's required rate of return (k_m), and the riskless rate of return, which is traditionally the rate of return on the U.S. Treasury bond (R_f):

$$\boxed{k_i = R_f + \beta_i[k_m - R_f]}$$

This model means that the required rate of return for any asset would be obtained by adding the risk-free rate of return to the market risk premium, given that

1) It is the difference between the market required rate of return and the risk-free rate of return, $[k_m - R_f]$
2) It is adjusted to that asset's index of risk by being multiplied by beta: $\beta_i\,[k_m - R_f]$

Let's consider the required rate of return for Y-corporation that has a beta of 1.85, given that the return on the market portfolio of assets is 12% and the risk-free rate is 6.5%?

$$\begin{aligned} k_i &= R_f + \beta_i\,[k_m - R_f] \\ &= .065 + 1.85\,[.12 - .065] \\ &= 16.67\% \end{aligned}$$

So, the market risk premium is 5.5% (.12 - .065), and it went to a little more than 10% when it was adjusted to the asset's index of risk, beta of 1.85. When the result of the adjustment was added to the risk-free rate of 6.5%, we got the corp required rate of 16.67%.Algebraically, we can obtain any of β_i, R_f, and k_m if the other variables in the equation are available.

Therefore, we can find Beta out of the $k_i$equation:

$$k_i = R_f + \beta_i\,[k_m - R_f]$$

$$k_i - R_f = \beta_i\,[k_m - R_f]$$

$$\boxed{\beta_i = \frac{k_i - R_f}{k_m - R_f}}$$

$$\beta_i = \frac{.1667 - .065}{.12 - .065} = \boxed{1.85}$$

and the risk -free return (R_f) would be:

$$k_i = R_f + \beta_i\,[k_m - R_f]$$

$$k_i = R_f - \beta_i R_f + \beta_i\,k_m$$

$$k_i - \beta_i\,k_m = R_f\,(1 - \beta_i)$$

$$\boxed{R_f = \frac{k_i - \beta_i k_m}{1 - \beta_i}}$$

$$R_f = \frac{.1667 - (1.85)(.12)}{1 - 1.85}$$

$$R_f = \frac{-.0553}{-.85} = \boxed{.065}$$

and the Market Rate of Return (k_m) would be:

$$k_i = R_f + \beta_i\,[k_m - R_f]$$

$$k_i = R_f + \beta_i\,k_m - \beta_i R_f$$

Tap to line up

$$k_i + R_f\,(\beta_i - 1) = \beta_i\,k_m$$

$$\boxed{k_m = \frac{k_i + R_f\,(\beta_i - 1)}{\beta_i}}$$

$$k_m = \frac{.1667 + .065(1.85 - 1)}{1.85}$$

$$k_m = \boxed{.12}$$

Back to the cost of capital estimation, and for a quick illustration, consider a somehow riskier than average stock with a beta of 1.3, an expected market return of 8½%, and a risk-free rate of 5%. The rate of return on equity capital for this particular stock would be:

$$\begin{aligned} k_e &= R_f + \beta_i[k_m - R_f] \\ &= .05 + 1.3\,[.085 - .05] \\ &= 9.5\% \end{aligned}$$

Now consider a safer stock than the average stock in the market with beta equal to .4, and if we assume that the risk-free rate and the expected market rate stay the same, then the rate of return on equity capital would be:

$$\begin{aligned} k_e &= .05 + .45[.085 - .05] \\ &= 6.6\% \end{aligned}$$

which makes perfect sense that riskier stock would cost more than the safer stock.

2.5 The Dividend Valuation Estimation

Since the firm issues and sells common stocks and pays dividends to the stockholders, we can view the value of a common stock share (V_0) as the present value of all dividends (D_t) paid in the future for period t, as they discounted at the firm's cost of equity capital (k_e).

$$V_0 = \sum_{t=1}^{\infty}\left[\frac{D_t}{(1 + k_e)^t}\right]$$

$$= \frac{D_1}{(1+k_e)^1} + \frac{D_2}{(1+k_e)^2} + ... + \frac{D_t}{(1+k_e)^t}$$

under the assumption that those dividends will continue to be paid for an indefinite period of time, V_0 can be viewed as a perpetuity, and can therefore be expressed by:

$$V_0 = \frac{D}{k_e}$$

where the dividend D remains constant throughout the future. But if the dividend increases by a certain annual rate of growth such as (g), then

$$V_0 = \frac{D}{k_e - g}$$

V_0 is the value of a common stock share and D is the dividend paid to stockholders. We can logically replace V_0 by the market price per share (MPS) and D by the dividend per share (DPS):

$$MPS = \frac{DPS}{k_e - g}$$

and therefore we can express this equation in terms of k_e

$$MPS.k_e - MPS.g = DPS$$

$$MPS.k_e = DPS + MPS.g$$

$$k_e = \frac{DPS}{MPS} + g$$

and if we want to use the net market price of a share, we can factor in the percentage of the flotation cost (F) so that the net price per share becomes MPS(1-F) and, therefore, the cost of equity capital k_e becomes:

$$\boxed{k_e = \frac{DPS}{MPS(1-F)} + g}$$

since the ratio of dividend per share (DPS) to the market price per share (MPS) is the dividend yield (DY), then the cost of equity capital (k_e) would be equal to the dividend yield plus the dividend growth rate (g).

$$\boxed{k_e = DY + g}$$

which is the rate of return used to calculate equity cost in selling new stock or even inusing the firm's own retained earnings.

Suppose that the dividend per share for a firm is $16 and this particular stock sells at $104 in the market and is expected to be increasing by 4% every year. The cost of equity capital in this firm can be estimated after obtaining the dividend yield as:

$$DY = \frac{16}{104} = 16.6\%$$

$$k_e = .166 + .04$$

$$k_e = 20.6\%$$

It is noteworthy here to say that (g) represents a constant annual rate of growth in the dividend per share. In reality, the growth fluctuates up and down over the years and within the same year. The following formula presents an example of the value of share (V_0) for which the growth is variable, going between non-constant and constant periods. It is from such specific formulas; a more realistic cost of equity capital can be obtained if we solve for the value of k_e:

$$\boxed{V_0 = \sum_{t=1}^{n}\left[\frac{DPS_t}{(1+k_e)^t}\right] + \left(\frac{DPS_{n+1}}{k_e - g}\right)\left[\frac{1}{(1+k_e)}\right]^n}$$

where:

DPS_t is the dividend per share for a period t in which the growth rate is constant.

DPS_{n+1} is the first dividend per share obtained for a period in which the growth rate is

Pull here variable.

k_e is the cost of equity capital

g is the constant rate of growth in DPS

2.6 The Weighted Marginal Cost of Capital

Firms use different types of capital to finance their new investment projects. Since each type has its own cost of capital and may pose a different level of risk on the firm as a whole, most firms try to maintain an optimal capital structure where they adopt a certain combination of debt and equity capital that would minimize the overall firm's cost of capital and maximize the market stock price. In this case, the marginal cost of capital becomes a composite rate weighted by the proportion of each type of capital in the firm's capital structure. Let's assume that a firm is using four types of capital, each has its own proportion (weight) in the firm's capital structure (w_1 through w_4) and each has its own cost of capital rate (k_1 through k_4). The marginal cost of capital for the firm would be a composite measure represented by the weighted average cost of capital (k_w):

$$k_w = w_1k_1 + w_2k_2 + w_3k_3 + w_4k_4$$

$$k_w = \sum_{i=1}^{n} w_i k_i$$

Suppose that a firm's capital structure is made up of the following components:

1. common stock 52%
2. preferred stock 11%
3. long-termstock 37%

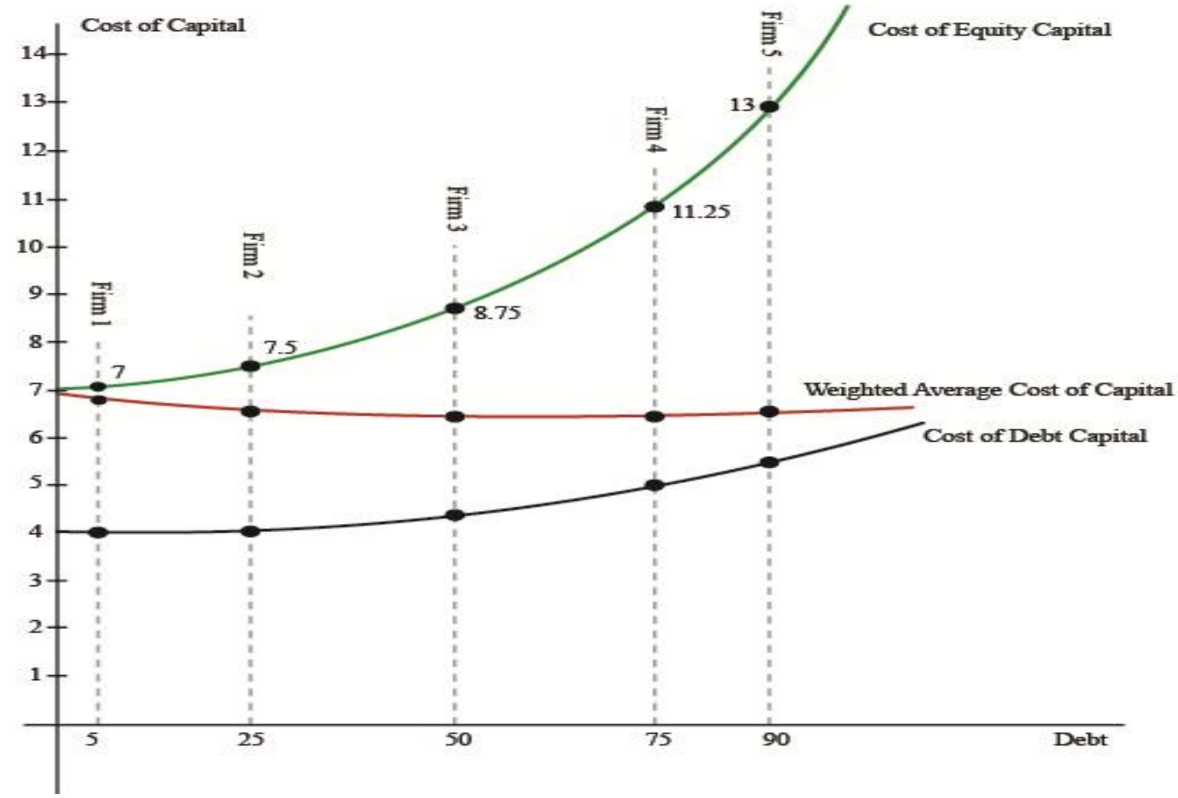
and if the cost of capital for common stock is 13.5%, preferred stock is 9.25%, and debt is 7¾%, then the weighted average cost of capital for the firm is 10.9% as calculated according to the following table of the firm's capital structure:

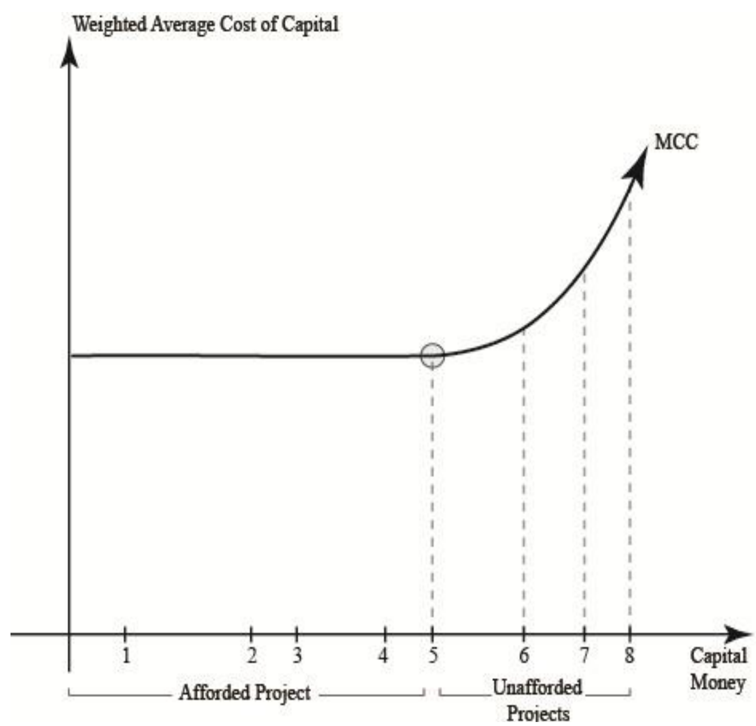
Type of Capital	Proportion (w_i)	Cost ofCapital (k_i)	w_ik_i
Common stock	52%	13.5%	.0702
Preferred stock	11%	9.25%	.010175
Long-term debt	37%	7.75%	.028675
	100%	$\sum w_ik_i$ =	.10905

Weighted average cost of capital can also be calculated for the industry. The following table and graph show five firms with their capital structures of debt and equity capitals and their own individual weighted average costs of capital which together form the industry's weighted average cost of capital.

Firm	Debt Capital w_d	Cost of Debt Capital k_d	Equity Capital w_e	Cost of Equity Capital k_e	Firm's Weighted Cost of Capital k_w	Weight of Firm in Industry v_i	k_w v_i
1	5%	4%	95%	7%	6.85%	33%	2.3%
2	25%	4.25%	75%	7.5%	6.7%	25%	1.7%
3	50%	4.5%	50%	8.75%	6.6%	18%	1.2%
4	75%	4.75%	25%	10.75%	6.25%	15%	.9%
5	90%	5.5%	10%	13%	6.25%	9%	.5%
Industry's weighted average cost of capital =							6.6%

Generally speaking, if any firm tries to expand beyond the limit of its affordability to fund new investment projects, the marginal list of capital (MCC) would start to increase right at that point. As we have seen before and as the following graph shows, the MCC curve would turn up to a positively sloped curve at and beyond the point of maximum affordability of funding (the fifth project as shown below).





2.7 Capitalization and Capitalized Cost

Relevant to capital budgeting, the capitalized cost calculations are often used within the firm's decision-making process, especially on selecting the most economic alternatives of assets and their uses.Capitalization of a fund (asset or liability) refers to the present value or cash equivalent of its unlimited number of periodic payments. For example, if a certain fund is invested now at a certain interest rate, we can assume that we would continue to collect periodic interests on that fund forever.

Therefore, if we put this logic in reverse, we can realize that the current fund is, in fact, the present value for all of its periodic payments that are held in perpetuity. Capitalization is used to evaluate the cash equivalent of assets and liabilities that have periodic payments.From a successful business management perspective, a firm should not only allocate funds to buy capital assets, but also allocate additional funds to maintain them throughout their useful lives, and allocate investment to replace them after they give their due services. The capitalized cost of an asset is, therefore, a sum of its original cost, the present value of unlimited maintenance cost, and the present value of unlimited number of replacements.

$$K = C + \frac{C - S}{(1+r)^n - 1} + \frac{M}{r}$$

where:

K: capitalized cost of an asset

C: the original cost of the asset

S: the scrap value of the asset after its useful life

M: the annual maintenance cost of the asset

Let's suppose that a construction company is contemplating the purchase of heavy equipment. The decision maker narrowed down the alternatives to two of the best machines:

	Machine I	Machine II
Initial cost ($)	35,000	39,000
Useful life (years)	10	15
Annual maintenance ($)	3,000	2,500
Scrap value ($)	5,000	4,000

Which of the two machines should be purchased if the interest rate is 9½%?

We calculate the capitalized cost for both machines individually and will choose the least costly as the better alternative.

$$K_1 = C_1 + \frac{C_1 - S_1}{(1+r)^n - 1} + \frac{M_1}{r}$$

$$= \$35{,}000 + \frac{\$35{,}000 = \$5{,}000}{(1+.095)^{10} - 1} + \frac{\$3{,}000}{.095}$$

$$= \$86{,}873.52$$

$$K_2 = C_2 + \frac{C_2 - S_2}{(1+r)^n - 1} + \frac{M_2}{r}$$

$$= \$39{,}000 + \frac{\$39{,}000 = \$4{,}000}{(1+.095)^{15} - 1} + \frac{\$2{,}500}{.095}$$

$$= \$77{,}379.25$$

Machine II should be purchased for having less capitalized cost.

For another example, let's suppose that a town board was asked to estimate an endowment to build a children's playground. If the construction costs $50,000 and needs to be replaced every 10 years at an estimated cost of $40,000, and the maintenance cost is $15,000, how much would the endowment be if the interest rate is 12%?

The endowment total would be considered a capitalized cost and the replacement cost would be the (C-S).

$$K = \$50{,}000 + \frac{\$40{,}000}{(1+.12)^{10} - 1} + \frac{\$1{,}500}{.12}$$

$$K = \$193{,}994.72$$

The board will ask the donor to allocate $194,000.

Another application for the capitalized cost is to figure out the extent of improvement that can be made on asset performance or equipment productivity. Let's assume we have a printing machine, the original cost of which was $65,000 and its scrap value is estimated at $5,000 after 12 years. The machine productivity is 20,000 books a year and its maintenance cost $3,000.

The firm's engineer figured that installing an additional part can raise the machine productivity to 30,000 books a year without affecting its maintenance or its useful age. How much can the firm spend economically to achieve the boost in productivity if the investment rate is 8%?Here we can set an equation of ratios. The ratios of the capitalized costs of the machine to its productivity before and after the technological improvement. If K_b and K_a are the capitalized cost of the machine before and after the technological improvement, and P_b and P_a are the productivity of the machine before and after the technological improvement, then

$$\frac{K_b}{P_b} = \frac{K_a}{P_a}$$

We set up the capitalized costs where the subject of the question (how much can we spend) would be an addition (x) to the original cost in the calculation of the capitalized cost after the technological improvement. Then we would algebraically solve for x.

$$K_b = C_b + \frac{C_b - S_b}{(1+r)^n - 1} + \frac{M_b}{r}$$

$$K_b = \$65,000 + \frac{\$65,000 - \$5,000}{(1+.08)^{12} - 1} + \frac{\$3,000}{.08}$$

$$K_b = \$142,021$$

$$K_a = C_a + \frac{C_a - S_a}{(1+r)^n - 1} + \frac{M_a}{r}$$

Since $C_a = C_b + x$ where x is what should be spent on the technological improvement of the machine.

and $S_a = S_b$

$M_a = M_b$ no change in the life of the machine and its residual value.

Then:

$$K_a = (C_b + x) + \frac{C_b + x - S_b}{(1+r)^n - 1} + \frac{M_b}{r}$$

$$K_a = (\$65,000 + x) + \frac{\$65,000 + x - \$5,000}{(1+.08)^{12} - 1} + \frac{\$3,000}{.08}$$

$$K_a = \frac{\$227,271 + 3x}{1.5}$$

$$\frac{K_b}{P_b} = \frac{K_a}{P_a}$$

$$\frac{\$142,021}{20,000} = \frac{\frac{\$227,271 + 3x}{1.5}}{30,000}$$

$$x = \$30,758$$

The firm can spend $30,758 to improve the machine and raise its productivity to 30,000 books a year.

3. Conclusion and Limitation

Understanding and correctly estimating the cost of capital is a crucial matter, not only for assessing the worth of potential investment projects for corporations and small businesses, but also vital for mergers, acquisitions, and even for valuing individual securities. It is therefore important to distinguish between cost of debt capital and cost of equity capital. This would lead to the task of knowing and estimating the rate of return on equity capital. We explained the most two reliable methods for the estimation: the capital asset pricing model (CAPM) and the dividend evaluation. In case of using different types of capital, we had the weighted marginal cost of capital method, and the capitalized cost calculations are for the firm's decision-making process, especially on selecting the most economic alternatives of assets and their uses. Throughout the previous discussion of the cost of capital, it was assumed that only the flotation cost would make the difference between the new common stock and the retained earnings when it comes to the cost of capital for both.

In reality, there could be other reasons for the differential. Among those reasons is the plausible investor's preference for capital gain (as represented by g) over the dividend yield $\left(\frac{DPS}{MPS}\right)$. This preference can most likely be due to the fact that capital gains are taxed by a lower tax rate than the dividend income when it comes to the personal income tax for investors. The typical cost of capital in our explanation did not include the firm's depreciation as a source of capital, which may be found significant for some firms. Neither did the typical cost of capital include the firm's deferred taxes, which sometimes forms a source of capital, nor it can, in reality, be collectively considered a source equal to an interest-free loan from the IRS. The discussion focused on the publicly owned corporations but the same principles of the cost of capital should apply to the private, non-publicly trading firms, as well as to small businesses. Finally, Just like with many theoretical concepts, cost of capital calculations may prove to be not easy to perfect in practice, especially on estimating the risk premium for different securities, as well as for correctly assessing risks and growth rates.

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