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The weighted average cost of capital is not quite right

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Abstract

A firm's cost of capital used in discounted cash flow analysis is commonly calculated as a weighted average of the after tax costs of the firm's various sources of financing (equity, debt, preferred stock). Its use implies that for investment projects earning precisely the WACC the cash (in)flow is exactly sufficient to reward all the suppliers of finance with their respective costs of capital. However, the necessary cash flow (normal profit) implied by the WACC is inadequate to provide the cash flows to the individual sources of financing when they are considered separately. This note discusses the problem (WACC is a linear approximation of a nonlinear relationship) and presents a modification of the WACC which is conceptually superior to the WACC as commonly calculated.
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Investment decisions by business firms require estimates of the investment costs, the economic life of the investment, the cash flows from production and sale of goods and services over that life, and salvage or removal costs. Accepting (or rejecting) investment decisions should be based on net present value calculations, the discounting of the cash flows to the present using the firm's discount rate or cost of capital. If NPV > 0, accept the project; reject if NPV < 0. If NPV = 0, the discounted cash inflows are exactly sufficient to cover the investment cost, i.e. over the life of the investment the firm is expected to earn the economic financial cost, in economics termed "normal profit," with neither positive or negative economic profit. In consultants Stern Stewart's terms, economic value

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added is zero when NPV = 0.[1] NPV = 0, where normal profit is precisely earned, is the dividing line between accept and reject decisions. If the cost of capital is improperly calculated, then calculations of NPV, normal profit, supranormal profit, and EVA are also improperly calculated.

What is a firm's cost of capital, the interest rate used to discount the cash flows in the NPV calculation?[2] Standard treatment (e.g. Baker & Powell, 2005, p. 358; Brealey & Myers, 1996, pp. 517, 521; Koller, Goedhart, & Wessels, 2005, p. 292; Ross, Westerfield, & Jaffe, 2005, pp. 331, 424, 480–481), when the firm uses more than one source of financial capital, involves the computation of the weighted average cost of capital, where the after tax costs of capital for the separate sources of funding are averaged using as weights the proportions of those separate sources. For a firm using common stock (equity) and bond (debt) financing, with r_e and r_d as the cost of equity capital and the cost of debt capital, the WACC is expressed in Eq. (1):

$$\text{WACC} = r = w_d r_d (1 - t) + w_e r_e \tag{1}$$

where w_d (weight (proportion) of debt) = (value of debt/value of debt and value of equity), w_e (weight (proportion) of equity) = (value of equity/value of debt and value of equity), $w_d + w_e = 1$, and t = tax rate on corporate income.The component costs, r_e and r_d, as well as the weights are based on market values: r_e is frequently calculated as the risk free rate plus a risk premium, based on the capital asset pricing model, and r_d reflects the market rates on the firm's outstanding debt and on the r_d of similar firms. The standard treatment includes $(1 - t)$ in the WACC calculation to reflect the deductibility of interest payments in the calculation of the corporate tax on the firm's income statement: the interest cost of debt, by this procedure, is reduced. Also, to avoid double counting the tax "advantage" of debt, the interest payments are not calculated in the prospective cash flows. This is the textbook treatment in calculating a firm's cost of capital.

An important question arises: if the firm earns in cash flow exactly the cost of capital (as figured by the WACC), is that cash flow, when divided between the bondholders (as suppliers of debt) and the stockholders (as suppliers of equity), sufficient to pay each group its individual necessary cash flow? In general, the answer is no. The objective here is to present an alternative (nonlinear) method of calculating the firm's cost of capital, a method which is conceptually superior to the WACC as currently practiced.

1. Cash flow and normal profit, with and without tax: the standard treatment

Consider the following example: investment cost of $200,000, with a life expectancy of 8 years, depreciated by the straight-line method. What is the necessary annual cash flow (assumed equal for each year for 8 years for ease of calculation) which will exactly justify this investment expenditure? That is, what is this opportunity's "normal profit"? (All cash flow figures are annual and occur at the end of each year.) This (annual) normal profit depends on the interest rate used

[1] EVA = net operating profit after taxes (NOPAT)—[capital × the cost of capital]. "EVA is net operating profit minus an appropriate charge for the opportunity cost of all capital invested in an enterprise. As such, EVA is an estimate of true 'economic' profit, or the amount by which earnings exceed or fall short of the required minimum rate of return that shareholders and lenders could get by investing in other securities of comparable risk." (http://www.sternstewart.com/evaabout/whatis.phb). EVA is thus economic profit, or the supernormal profit in excess of the cost of capital called "normal profit."

[2] Alternatively the internal rate of return, as the interest or discount rate which makes the NPV of the cash flows zero, could be compared to the firm's cost of capital.

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