CHAPTER 12

Web Extension: The ARR Method, the EAA Approach, and the Marginal WACC

This extension describes the accounting rate of return as a method for evaluating projects. It also describes the equivalent annual annuity approach for comparing projects with unequal lives. Finally, it explains how to incorporate an increasing marginal cost of capital when selecting the optimal capital budget.

Accounting Rate of Return (ARR)

The **accounting rate of return (ARR)**, which focuses on a project's net income rather than its cash flow, is the second-oldest evaluation technique. In its most commonly used form, the ARR is measured as the ratio of the project's average annual expected net income to its average investment. If we assume that Projects S and L, as described in Chapter 12, will both be depreciated by the straight-line method to a book value of zero, then each will have a depreciation expense of $1,000/4 = $250 per year. The average cash flow minus the average depreciation charge is the average annual income. For Project S, average annual income is $75:

$$\text{Average annual income} = \text{Average cash flow} - \text{Average annual depreciation}$$

$$= (\$1,300/4) - \$250 = \$75$$

The average investment is the beginning investment plus the ending investment (the salvage value), divided by 2, or $500:

$$\text{Average investment} = (\text{Cost} + \text{Salvage value})/2$$

$$= (\$1{,}000 + \$0)/2 = \$500$$

This $500 is the book value of the asset halfway through its life. Dividing the average annual income by the average investment, we obtain an ARR for Project S of 15 percent:

$$\text{ARR}_S = \text{Average annual income/Average investment} = \$75/\$500 = 15\%$$

By a similar calculation, we determine ARR_L to be 20 percent. Thus, the ARR method ranks Project L over Project S. If the firm accepts projects with an ARR of 16 percent or more, Project L would be accepted, but Project S would be rejected. Note also that for these two projects the rankings under the ARR method are the opposite of those based on either payback method. We could argue about which method is better, hence which set of rankings should be used. However, this would be a hollow argument, because ARR is badly flawed the same way that payback is flawed; both the regular payback and the ARR ignore the time value of money. Because this procedure does not provide complete information on the project's contribution to the firm's value, it could lead to incorrect capital budgeting decisions.[1]

See ***IFM9 Ch12 Tool Kit.xls*** **for these calculations.**

The Equivalent Annual Annuity (EAA) Approach

Although the example in the textbook illustrates why an extended analysis is necessary if we are comparing mutually exclusive projects with different lives, the arithmetic is generally more complex in practice. For example, one project might have a six-year life versus a ten-year life for the other. This would require a replacement chain analysis over 30 years, the least common multiple of the two lives. In such a situation, it is often simpler to use a second procedure, the equivalent annual annuity (EAA) method, which involves three steps:

1. Find each project's NPV over its initial life. In Figure 12E-1, we find NPV_C = \$7,165 and NPV_F = \$5,391.
2. There is some constant annuity cash flow (the equivalent annual annuity [EAA]) that has the same present value as a project's calculated NPV. For Project F, here is the time line:

Project C:

0	11.5%	1	2
–40,000		8,000	14,000

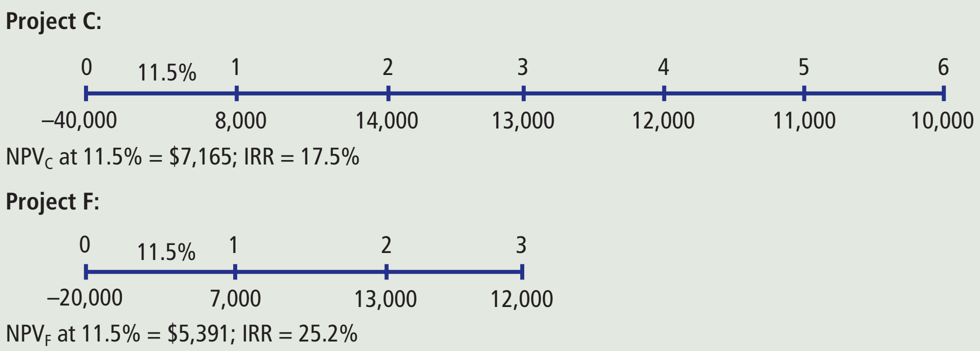
NPV_C at 11.5% = \$7,165; IRR = 17.5%

Project F:

0	11.5%	1	2

[1] Actually, there are many ways to calculate the ARR. Because all of them have major deficiencies, we see no point in extending the discussion. Also, we should note that many firms use the ARR in one form or another to measure divisional performance. Use of the ARR in this way—as opposed to capital budgeting decision making—may make sense.

Figure 12E-1 *Expected Net Cash Flows for Projects C and F*



To find the value of EAA_F with a financial calculator, enter N = 3, r = I = 11.5, PV = −5391, and FV = 0, and solve for PMT. The answer is $2,225. This level annuity cash flow stream, when discounted back three years at 11.5 percent, has a present value equal to Project F's original NPV, $5,391. The $2,225 is called the project's "equivalent annual annuity (EAA)." The EAA for Project C can be found similarly, and it is $1,718. Thus, Project C has an NPV that is equivalent to an annuity of $1,718 per year, while Project F's NPV is equivalent to an annuity of $2,225.

3. The project with the higher EAA will always have the higher NPV when extended out to any common life. Therefore, since F's EAA is larger than C's, we would choose Project F.

The EAA method is often easier to apply than the replacement chain method, but the replacement chain method is easier to explain to decision makers. Still, the two methods lead to the same decision if consistent assumptions are used.

The Marginal Cost of Capital and the Optimal Capital Budget

If the capital budget is so large that a company must issue new equity, then the cost of capital for the company increases. This Extension explains the impact on the optimal capital budget.

Marginal Cost of Capital, MCC The *marginal cost* of any item is the cost of another unit of that item. For example, the marginal cost of labor is the cost of adding one additional worker. The marginal cost of labor may be $25 per person if 10 workers are added but $35 per person if the firm tries to hire 100 new workers, because it will be harder to find 100 people willing and able to do the work. The same concept applies to capital. As the firm tries to attract more new dollars, the cost of each dollar will at some point rise. *Thus, the* marginal cost of capital (MCC) *is defined as the cost of the last dollar of new capital the firm raises, and the marginal cost rises as more and more capital is raised during a given period.*

We can use Axis Goods to illustrate the marginal cost of capital concept. The company's target capital structure and other data follow:

Long-term debt	$ 754,000,000	45%
Preferred stock	40,000,000	2
Common equity	896,000,000	53
Total capital	$1,690,000,000	100%

r_d = 10%.
r_{ps} = 10.3%.
T = 40%.
P_0 = $23.
g = 8%, and it is expected to remain constant.

Here, D_0 = $1.15 = dividends per share in the *last* period. D_0 has already been paid, so someone who purchased this stock today would *not* receive D_0—rather, he or she would receive D_1, the *next* dividend.

$$D_1 = D_0(1 + g) = \$1.15(1.08) = \$1.24$$
$$r_s = D_1/P_0 + g = (\$1.24/\$23) + 0.08 = 0.054 + 0.08 = 0.134 = 13.4\%$$

On the basis of these data, the weighted average cost of capital, WACC, is 10 percent:

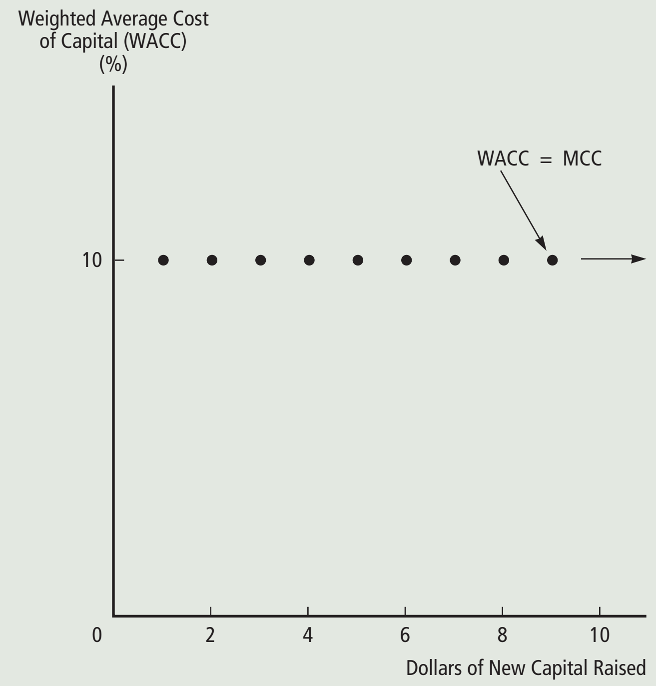
$$\text{WACC} = \begin{pmatrix}\text{Fraction}\\ \text{of}\\ \text{debt}\end{pmatrix}\begin{pmatrix}\text{Interest}\\ \text{rate}\end{pmatrix}(1 - \text{T}) + \begin{pmatrix}\text{Fraction}\\ \text{of}\\ \text{preferred}\\ \text{stock}\end{pmatrix}\begin{pmatrix}\text{Cost}\\ \text{of}\\ \text{preferred}\\ \text{stock}\end{pmatrix} + \begin{pmatrix}\text{Fraction of}\\ \text{common}\\ \text{equity}\end{pmatrix}\begin{pmatrix}\text{Cost}\\ \text{of}\\ \text{equity}\end{pmatrix}$$
$$= (0.45)(10\%)(0.6) + (0.02)(10.3\%) + (0.53)(13.4\%)$$
$$= 2.7\% + 0.2\% + 7.1\%$$
$$= 10.0\%$$

As long as Axis keeps its capital structure on target, and as long as its debt has an after-tax cost of 6 percent, its preferred stock a cost of 10.3 percent, and its common equity a cost of 13.4 percent, then its weighted average cost of capital will be WACC = 10%. Each dollar the firm raises will consist of some long-term debt, some preferred stock, and some common equity, and the cost of the whole dollar will be 10 percent.

A graph that shows how the WACC changes as more and more new capital is raised during a given year is called the marginal cost of capital schedule. The graph shown in Figure 12E-2 is Axis's MCC schedule. Here the dots represent dollars raised. Because each dollar of new capital has a cost of 10 percent, the marginal cost of capital (MCC) for Axis is constant at 10 percent under the assumptions we have used thus far.

The New Equity Break Point Could Axis raise an unlimited amount of new capital at the 10 percent cost? The answer is no. As a practical matter, as a

Figure 12E-2 *Marginal Cost of Capital (MCC) Schedule for Axis Goods Inc.*



company raises larger and larger sums during a given time period, the costs of debt, preferred stock, and common equity begin to rise, and as this occurs, the weighted average cost of each new dollar also rises. Thus, just as corporations cannot hire unlimited numbers of workers at a constant wage, they cannot raise unlimited amounts of capital at a constant cost. At some point, the cost of each new dollar will increase.

Where will this point occur for Axis? As a first step in determining the point at which the MCC begins to rise, recognize that although the company's balance sheet shows total long-term capital of $1,690,000,000, all of this capital was raised in the past, and it has been invested in assets that are being used in operations. New (or marginal) capital presumably will be raised so as to maintain the 45/2/53 debt/preferred/common relationship. Therefore, if Axis wants to raise $1,000,000 in new capital, it should obtain $450,000 of debt, $20,000 of preferred stock, and $530,000 of common equity. The new common equity could come from two sources: (1) retained earnings, defined as the portion of this year's profits that management decides to retain in the business rather than use for dividends (but not earnings retained in the past, for these have already been invested in plant, equipment, inventories, and so on); or (2) proceeds from the sale of new common stock.

The debt will have an interest rate of 10 percent and an after-tax cost of 6 percent, and the preferred stock will have a cost of 10.3 percent. *The cost of common equity will be* $r_s = 13.4\%$ *as long as the equity is obtained as retained earnings, but it will jump to* $r_e = 14\%$ *once the company uses up all of its retained earnings and is thus forced to sell new common stock.*

Table 12E-1 *Axis's WACC Using New Retained Earnings and New Common Stock*

	Weight ×	Component Cost =	Product
I. WACC When Equity Is from New Retained Earnings			
Debt	0.45	6.0%	2.7%
Preferred stock	0.02	10.3	0.2
Common equity (Retained earnings)	0.53	13.4	7.1
	1.00		$WACC_1$ = 10.0%
II. WACC When Equity Is from Sale of New Common Stock			
Debt	0.45	6.0%	2.7%
Preferred stock	0.02	10.3	0.2
Common equity (New common stock)	0.53	14.0	7.4
	1.00		$WACC_2$ = 10.3%

Axis's weighted average cost of capital, when it uses new retained earnings (earnings retained this year, not in the past) and also when it uses new common stock, is shown in Table 12E-1. We see that the weighted average cost of each dollar is 10 percent as long as retained earnings are used, but the WACC jumps to 10.3 percent as soon as the firm exhausts its retained earnings and is forced to sell new common stock.

How much new capital can Axis raise before it exhausts its retained earnings and is forced to sell new common stock; that is, where will an increase in the MCC schedule occur? We find this point as follows:[2]

1. Assume that the company expects to have total earnings of $137.8 million. Further, it has a target payout ratio of 45 percent, so it plans to pay out 45 percent of its earnings as dividends. Thus, the retained earnings for the year are projected to be $137.8(1.0 − 0.45) = $75.8 million.
2. We know that Axis expects to have $75.8 million of retained earnings for the year. We also know that if the company is to remain at its optimal capital structure, it must raise each dollar as 45 cents of debt, 2 cents of preferred, and 53 cents of common equity. Therefore, each 53 cents of retained earnings will support $1 of capital, and the $75.8 million of retained earnings will not be exhausted, hence the WACC will not rise, until $75.8 million of retained earnings, plus some additional amount of debt and preferred stock, have been used up.
3. We now want to know how much *total new capital*—debt, preferred stock, and retained earnings—can be raised before the $75.8 million of retained earnings is exhausted and Axis is forced to sell new common stock. In effect, we are seeking some amount of capital, X, which is called a break point (BP) and which represents the total financing that can be done before Axis is forced to sell new common stock.

[2]The numbers in this set of calculations are rounded. Since the inputs are estimates, it makes little sense to carry estimates out to very many decimal places—this is "spurious accuracy."

4. We know that 53 percent, or 0.53, of X, the total capital raised, will be retained earnings, whereas 47 percent will be debt plus preferred. We also know that retained earnings will amount to $75.8 million. Therefore,

$$\text{Retained earnings} = 0.53X = \$75{,}800{,}000$$

5. Solving for X, which is the retained earnings break point, we obtain BP_{RE} = $143 million:

$$X = BP_{RE} = \frac{\text{Retained earnings}}{\text{Equity fraction}} = \frac{\$75{,}800{,}000}{0.53}$$

$$= \$143{,}018{,}868 \approx 143 \text{ million}$$

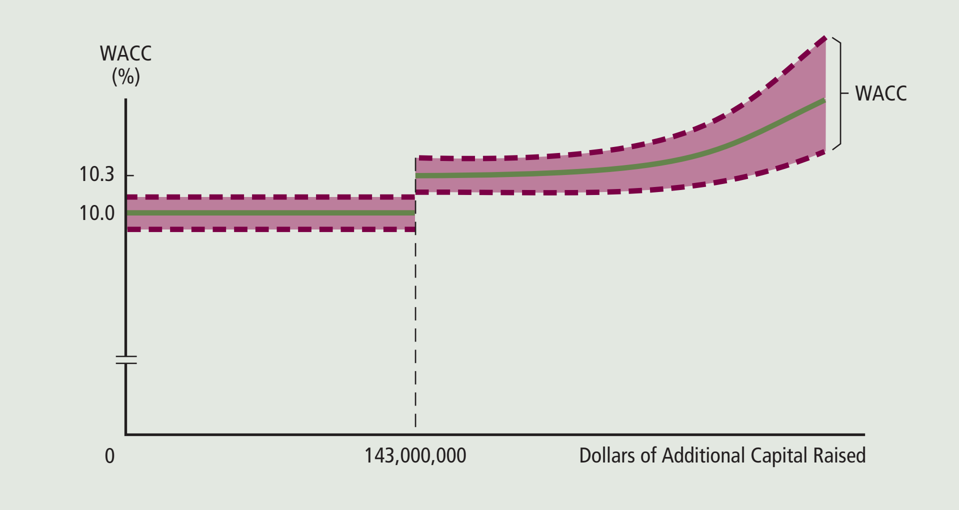
6. Thus, given $75.8 million of retained earnings, Axis can raise a total of $143 million, consisting of 0.53 ($143 million) = $75.8 million of retained earnings plus 0.02($143 million) = $2.9 million of preferred stock plus 0.45($143 million) = $64.3 million of new debt supported by these new retained earnings, without altering its capital structure (dollars in millions):

New debt supported by retained earnings	$ 64.3	45%
Preferred stock supported by retained earnings	2.9	2
Retained earnings	75.8	53
Total capital supported by retained earnings, or break point for retained earnings	$143.0	100%

7. The value of X, or BP_{RE} = $143 million, is defined as the retained earnings break point, and it is the amount of total capital at which a break, or jump, occurs in the MCC schedule.

Figure 12E-3 graphs Axis's marginal cost of capital schedule with the retained earnings break point. Each dollar has a weighted average cost of 10 percent until the company has raised a total of $143 million. This $143 million will consist of

Figure 12E-3 *Marginal Cost of Capital Schedule beyond the Break Point for Axis Goods Inc.*



$64.3 million of new debt with an after-tax cost of 6 percent, $2.9 million of preferred stock with a cost of 10.3 percent, and $75.8 million of retained earnings with a cost of 13.4 percent. However, if Axis raises more than $143 million, each new dollar will contain 53 cents of equity *obtained by selling new common equity at a cost of 14 percent*; therefore, WACC jumps from 10 percent to 10.3 percent, as calculated back in Table 12E-1.

Note that we don't really think the MCC jumps by precisely 0.3 percent for the first $1 over $143 million. Thus, Figure 12E-3 should be regarded as an approximation rather than as a precise representation of reality.

The MCC Schedule beyond the Break Point There is a jump, or break, in Axis's MCC schedule at $143 million of new capital. Could there be other breaks in the schedule? Yes, there could. The cost of capital could also rise due to increases in the cost of debt or the cost of preferred stock, or as a result of further increases in flotation costs as the firm issues more and more common stock. Some people have asserted that the costs of capital components other than common stock should not rise. Their argument is that as long as the capital structure does not change, and presuming that the firm uses new capital to invest in projects with the same expected return and degree of risk as its existing projects, investors should be willing to invest unlimited amounts of additional capital at the same rate. However, this argument is not borne out in empirical studies. In practice, the demand curve for securities is downward sloping, so the more securities issued during a given period, (1) the lower the price received for the securities and (2) the higher the required rate of return. Therefore, the more new financing required, the higher the firm's WACC.

As a result of all this, firms face increasing MCC schedules, such as the one shown in Figure 12E-3. Here we have identified a specific retained earnings break point, but because of estimation difficulties, we have not attempted to identify precisely any additional break points. Moreover, we have (1) shown the MCC schedule to be upward sloping, reflecting a positive relationship between capital raised and capital costs, and (2) we indicate our inability to measure these costs precisely by using a band of costs rather than a single line. Note that this band exists over the whole range of capital raised—our component costs are only estimates; these estimates become more uncertain as the firm requires more and more capital, and thus the band widens as the amount of new capital raised increases.

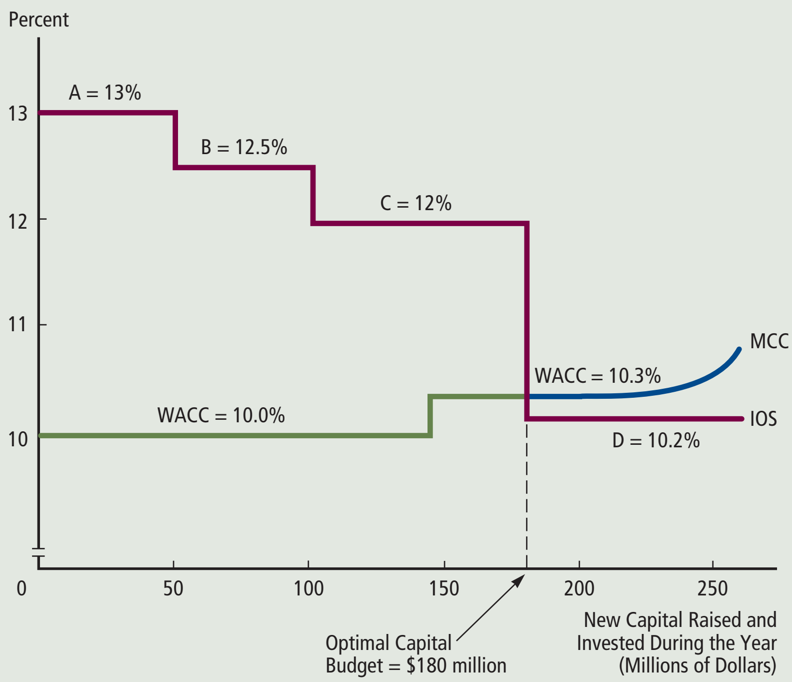
The Optimal Capital Budget The cost of capital is a key element in the capital budgeting process. In essence, capital budgeting consists of these steps:

1. Identify the set of available investment opportunities.
2. Estimate the future cash flows associated with each project.
3. Find the present value of each future cash flow, discounted at the cost of the capital used to finance the project, and sum these PVs to obtain the total PV of each project.
4. Compare each project's PV with its cost, and accept a project if the PV of its future cash inflows exceeds the cost of the project.

An issue that arises is picking the appropriate point on the marginal cost of capital schedule for use in capital budgeting. As we have seen, every dollar raised by Axis Goods Inc. is a weighted average that consists of 45 cents of debt, 2 cents of preferred stock, and 53 cents of common equity (with the equity coming from retained earnings until they have been used up, and then from the issuance of new common stock). Further, we saw that the WACC is constant for a while, but after the firm has exhausted its least expensive sources of capital, the WACC begins to rise. Thus, the firm has an MCC schedule that shows its WACC at different amounts of capital raised; Figure 12E-3 gave Axis's MCC schedule.

Since its cost of capital depends on how much capital the firm raises, just which cost should we use in capital budgeting? Put another way, which of the WACC numbers shown in Figure 12E-3 should be used to evaluate an average-risk project? We could use 10.0 percent, 10.3 percent, or some higher number, but which one *should* we use? The answer is based on the concept of marginal analysis as developed in economics. In economics, you learned that firms should expand output to the point where marginal revenue is equal to marginal cost. At that point, the last unit of output exactly covers its cost—further expansion would reduce profits, while the firm would forgo profits at any lower production rate. Therefore, the firm should expand to the point where its marginal revenue equals its marginal cost.

Figure 12E-4 *Combining the MCC and IOS Schedules to Determine the Optimal Capital Budget*



Project	Cost (in Millions)	Rate of Return
A	$50	13.0%
B	50	12.5
C	80	12.0
D	80	10.2

This same type of analysis is applied in capital budgeting. We have already developed the marginal cost curve—it is the MCC schedule. Now we need to develop a schedule that is analogous to the marginal revenue schedule. This is the Investment Opportunity Schedule (IOS), which shows the rate of return, or IRR, expected on each potential investment opportunity. We can plot those returns on the same graph that shows our marginal cost of capital. Figure 12E-4 gives such a graph for Axis. Projects A, B, and C all have expected rates of return that exceed the cost of the capital that will be used to finance them, but the expected return on Project D is less than its cost of capital. Therefore, Projects A, B, and C should be accepted, and Project D should be rejected.

The WACC at the point where the Investment Opportunity Schedule intersects the MCC curve is defined as the corporate cost of capital—this point reflects the marginal cost of capital to the corporation. In our Figure 12E-4 example, Axis's corporate cost of capital is WACC = 10.3%.