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PROFITABILITY METHODS

TCM Framework: 3.3 – Investment Decision Making, 6.1 – Asset Performance Assessment

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INTRODUCTION

Scope

This Recommended Practice (RP) of AACE International defines specific practices for determining the profitability of investments. The methods offered are general, since not all profitability techniques can or should be included in an RP. In its broadest sense, profitability is a measure of value added. Increased profitability thus reflects greater economic good for society. There is no economic progress without profitability.

Purpose

This RP is intended to provide broad guidelines, not standards, for profitability methods that most seasoned practitioners in most industries would consider to be reliable and would generally endorse. Profitability methods with less general applicability, e.g., the revenue requirement technique used by electrical utilities or the benefit-cost ratio used in the public sector, are not included in this RP.

Background

Profitability methods are critical tools for assessing asset performance and making effective investment decisions. These processes are central to portfolio and program management in that selecting the right capital or maintenance projects can be as important to enterprise success as effectively executing any particular project.

This RP is a revision in the spirit of the original RP developed in 1981 by Henry Thorne and Julian Piekarski, past presidents of AACE.

RECOMMENDED PRACTICE

AACE recommends the following practices for determining profitability for investment decision-making:

1. Net present value (NPV). Sometimes denoted as net present worth (NPW). The equivalent annual value practice (EAV), is included.
2. Internal rate-of-return (IRR). The technique is also denoted as discounted cash flow rate-of-return (DCFRR). References including AACE's *Skills and Knowledge of Cost Engineering*, 5th edition, and the tables of contents of popular engineering economics textbooks refer to rate-of-return (ROR). In its most generic sense, however, ROR includes more than IRR or DCFRR and is a less useful term for this RP. Industry and academe show no distinct preference among the terms. The modified IRR method (MIRR), is included.
3. Return-on-investment (ROI).
4. Payback period (PB). Sometimes denoted as payoff period or payout period (PO).

The following practices are recommended for calculating enterprise-level or strategic business unit-level profitability:

5. Economic value added (EVA).
6. Return-on-assets (ROA).

The choice of a particular method will depend on executive preferences, the individual company, and the characteristics of its portfolios, programs, or projects. The 1981 publication of this RP explained that IRR was preferred to NPV by a ratio of three to one, per the results of an earlier survey of some Fortune 500 firms. A 1997 reference confirmed that the techniques maintained that relative popularity decades later. PB followed in popularity after the two leading methods.

PRACTICES DEFINED

The cost engineer should be aware that definitions and resulting calculations of some profitability measures can vary in different organizations and, sometimes, within different offices of the same firm. Whenever applying or discussing the profitability values stated by others, the wise cost engineer makes certain to know how the values have been calculated. Any method chosen must allow reliable comparison among alternatives, so that an investment can be confidently selected. Therefore, although reasonable accuracy is necessary, the cost engineer should not become too engrossed by arcane details of a supposedly “perfect” calculation method.

The returns eventually achieved will almost certainly be somewhat different from those forecasted. It is essential, however, that the method enables choice of an investment that will probably deliver a greater return than any alternative that is discarded as a result of the analysis. Choosing a specific version of calculation of any of these six measures is not as important as uniformly applying the variant to all alternatives, so that their comparison is meaningful. The six recommended measures are defined as follows:

1. **Net present value (NPV)**, equates to the sum of net period cash flows over the periods or life of the analysis, each discounted to an initial point, designated time zero. A net period cash flow is the difference between cash inflows and cash outflows for the time period. An annual period is commonly adopted. Cash inflows comprise revenues and realized salvage values. Cash outflows include capital outlays, all expenses, and taxes. The applied discount rate is commonly the weighted average cost of capital (WACC), for the firm. The NPV may understate the real value of an alternative, since it does not include the “option value,” whereby managers can subsequently leverage the results created by choosing the alternative for later opportunities that would otherwise not be possible.

2. **Internal rate-of-return (IRR)**, equates to the discount rate that yields NPV = 0, given an array of net period cash flows. The IRR offers a straightforward means of comparing the alternative returns so that a venture can be selected.

3. **Return-on-investment (ROI)**, is the ratio of net investment gain to investment cost. In its simplest form, which is most common, no provision is made for the time-value of money. A more accurate ROI calculation incorporates the time-value of money of cash inflows, the return, and cash outflows, the investment. Complex ROI, the engineer’s or the DuPont method, is the ratio of the average annual gain to the initial investment, expressed as a percentage.

4. **Payback period (PB)**, is the period of time that an investment requires to recoup the amount invested or to break even. As with ROI, it is most commonly calculated without considering the time-value of money, but a more accurate version adjusts for time-value.

5. **Economic value added (EVA)**, is economic profit. EVA can be applied to project and program profitability determinations, but it is typically applied to business unit or enterprise-level analysis. The measure considers the total capital employed by the enterprise. The enterprise is expected to generate income that covers both capital and operational costs.

6. **Return-on-assets (ROA)**, is normally calculated as the percentage ratio of net income, after interest and taxes, to total asset book value. Other formulas instead use operating income, earnings before interest and taxes (EBIT), or earnings before interest and after taxes (EBIAT). Whether strictly formulated or modified, ROA generally measures the efficiency of enterprise asset application for financial gain—a useful metric for asset managers.

PRACTICES DISCUSSION

1a. Net present value (NPV), and rate-of-return (IRR), methods have been applied for many years. NPV is favored by some managers, but business executives preferred IRR to NPV by three to one, at least until 1997. The recommended methods have different purposes, except that the four investment decision-making techniques all enable the cost engineer to choose the most profitable venture from alternatives competing for selection at a point in time. The two strategic business unit or enterprise-level profitability methods enable the cost engineer to compare profitability longitudinally, from period-to-period, either against previous performance or against industry benchmarks.

The advantage of NPV is that various discount rates can be used for component investments of a particular venture. But if a single discount rate is used, the NPVs of the ventures are additive. Once the discount rate or set of discount rates is fixed, the results are consistent and no multiple or false solutions are possible. However, individual companies may use different discount rates, in which case the resulting NPVs will not be equal, and the economic conclusions may differ.

NPV is expressed as an absolute currency number, rather than as a percentage rate. This allows direct comparison of mutually exclusive alternatives. If the alternatives are of substantially different magnitudes, then a much larger project with a poor rate of return might be inappropriately selected over a more attractive but smaller venture. Thus the magnitudes of respective investments must also be considered when comparing the NPVs that they generate. An efficiency ratio metric such as (NPV ÷ investment) can be applied to better weigh the alternatives.

A business venture's NPV determined with the WACC equates to the value that is added to the enterprise's market value, if the venture is selected and the estimated cash flows are correct. Say that a proposed project's NPV = $1,000,000 and the firm has authorized a total of 5,000,000 shares of stock; the project would presumably add $1,000,000 ÷ 5,000,000 = $0.20 per share, if the project were authorized.

Management may designate a project discount rate other than the WACC. A minimum attractive rate-of-return (MARR), sometimes called a hurdle rate, might be greater than the WACC for especially risky business ventures. On the other hand, management might accept a lower MARR, a rate less than the WACC and nearer the firm's cost of debt, for purely internal cost-reduction projects, since internal activities are usually more controllable and involve less risk. The higher the risk inherent to the anticipated cash flow, the greater should be the value of the applied discount rate. The enterprise's WACC normally offers the best single rate by which to discount anticipated cash flows of all types that are associated with the enterprise.

1b. Equivalent annual value (EAV), enables the cost engineer to compare alternatives of different lifetimes. An appropriate formula allows variable period cash flows to be converted to a single value or annuity, which occurs each period throughout the lifetime of the investment. One can repeat cash flows of alternatives until their study durations are equal. For example, if the lifetime of one alternative is seven years, and that of the possible investment to which it is compared is eight years, then the period of study between the alternatives would need to be 7 x 8 = 56 years to make their NPVs comparable. That approach would be burdensome. The cost engineer would almost certainly find it more efficient to calculate the EAV of both alternatives and recommend selection of that which has the greater EAV.

2a. The IRR is a general profitability indicator that allows comparison of ventures of various magnitudes and in different areas of business and technology by expressing results on the same scale, i.e., as an interest rate percentage. Compared to an established MARR, the IRR allows an investment to be readily accepted or declined. If profitability of mutually exclusive alternatives is considered, and if capital funds are practically unlimited, the IRR should be calculated on an incremental basis. Normally, however, the funds would be considered for other needed projects.

The IRR has the rare disadvantage of occasionally leading to multiple or false solutions, if successive periods of cash flow alternate between inflows and outflows.[1] Also, IRR does not consider the possibility of more than one discount rate to reflect variations in interest rate. Unlike NPVs, IRR values of investment components are not additive. The IRR from the selection of multiple components is not equal to the sum of their individual IRRs: $IRR_A + IRR_B \neq IRR_{A+B}$. The IRR is potentially inaccurate when its calculated value is uncommonly high and much greater than the firm's WACC.

2b. Much that is said of the usefulness of the IRR is true also of the MIRR, which merits mention for limited application, when an IRR solution yields multiple rates or a very high rate. For MIRR, $PV_{costs} = PV_{\text{terminal value}}$. Net cash outflows are discounted at the WACC to time period zero, and net cash inflows are compounded at the WACC to the terminal time period. MIRR is the rate of return that equates the PV of the discounted time zero cost to the PV of the compounded terminal value. The usefulness of this technique derives from the application of the WACC as the discount rate. WACC is a more likely, historically demonstrated reinvestment rate than an uncommonly high IRR, which would probably not be achieved, or at least, not maintained very long. Also, the MIRR technique eliminates the possibility of multiple IRRs. If compared ventures have equal lives and are of the same investment magnitude, then NPV and MIRR will result in the same investment selection decision. As with IRR, MIRR offers cost engineers and managers that quick profitability “sound bite” of a venture for ready comparison to other possible returns. For most investment comparisons, the IRR and MIRR yield the same selection.

3. Return-on-Investment (ROI), is a common technique. The magnitude and timing of estimated gains for the investment cost determine the return. It is not always simple for a business to segregate specific project gains and investment amounts by which to calculate a reliable ROI. Speeding and increasing cash inflows or delaying and reducing cash outflows will increase an ROI that incorporates the time-value of money.

4. Payback period (PB), is normally the least accurate method by which to compare investments for selection. Only in some circumstances will the speed of investment recovery lead to the greatest economic gain for an enterprise. As the risk of investment cash flows increases, PB becomes more appropriate as an investment selection method. On the other hand, as an example of PB being inappropriate, one alternative might be slow to recover the initial investment but offer large returns after break-even. In that case PB would be delayed, but IRR and NPV would be high. Another alternative might rapidly recover the investment, providing quick PB, but offer lackluster returns with low IRR and NPV after the investment is recouped. The first of those two alternatives would probably be preferred despite the longer PB period.

5. An underlying concept for economic value added (EVA), is that accounting profit does not reflect economic value created, unless that profit–specifically the net operating profit after taxes (NOPAT)–exceeds the cost of the capital applied to generate the profit. NOPAT is normally determined at the strategic business unit or divisional level. If other factors remain equal, EVA theoretically approaches zero over time, due to competition. New factors or changes in existing factors may enable multi-year, long-term EVA. Monopolistic influences, say, from a patent, will permit an enterprise to add economic value over the long run.

6. Return on assets (ROA), can also be determined from income before interest and taxes are deducted. This provides a better measure of the operational efficiency of the assets, before the effects of capital structure and tax efficiency are considered. Yet another variation deducts interest but not taxes, to better gauge the performance of company management. The rationale for allowing interest but not taxes to impact the return is that taxes are a universal burden with prescribed rates unaffected by management. On the other hand, interest charges derive from the debt-equity ratio of the enterprise's capital structure, which management controls. In any event, managers who use ROA pick a calculation method and stay with it over time, to ensure meaningful period-to-period comparisons.

[1] Descarte's Rule of Signs states that the number of sign changes in coefficients equals the maximum number of positive real roots of any polynomial. (Gönen, 1990)

FORMULAS AND SOME SAMPLE CALCULATIONS

The cost engineer remembers that the ultimate purpose of any profitability method is to choose the best investment alternative. One considers rigorous technical details when selecting a method and tries to ensure the calculation is an accurate forecast of returns to come. Devoting excessive time to make a calculation "just right" and supposedly ideal in all ways might not be efficient. Often, different methods lead to the same selection. This is certainly not to say that any method and values can be applied to obtain the same selection outcome for any circumstances. However, the cost engineer should apply good judgment and devote enough time to the selection of the method and values to obtain a good decision from among the alternatives, and nothing more.

1a. Net Present Value (NPV).

Apply a discount rate, i = WACC, which is assumed to be 12.0%.
The discount factor = $(1 + \text{WACC})^j$

$\text{NPV} = \Sigma_{(i = 1 \text{ to } n)} [\text{Cash Flow}_{(\text{Out or In})} \div (1 + \text{WACC})^j]$

Period, j	0	1	2	3	4	5
Cash Flow	($1,117)	($675)	$833	$1,294	$1,812	$2,076
Discount Factor, for WACC = 12%	1.000	0.8929	0.7972	0.7118	0.6355	0.5674
Present Value	($1,117)	($602.7)	$664.1	$921.0	$1,152	$1,178

Adding the period PVs yields NPV = $2,195. The cash flows of this imaginary venture would increase the value of the firm, whose WACC = 12%, by $2,195.

1b. Equivalent Annual Value (EAV).

This method is applied to alternative investments of different lifetimes. Apply a discount rate, i = WACC, which is again assumed to be 12.0%.

$\text{EAV} = \text{NPV} \times \text{Capital Recovery Factor} = \text{NPV} \times \{[i\ (1+i)^n] \div [(1 + i)^n - 1]\}$

$\text{EAV}_1 = \$2{,}195 \times \{[.12\ (1 + .12)^5] \div [(1 + .12)^5 - 1]\}$
$\text{EAV}_1 = \$2{,}195 \times 0.27741 = \$608.9$

Period, j	0	1	2	3	4	n = 5
Cash Flow	($1,117)	($675)	$833	$1,294	$1,812	$2,076
Discount Factor, for WACC = 12%	1.000	0.8929	0.7972	0.7118	0.6355	0.5674
Present Value	($1,117)	($602.7)	$664.1	$921.0	$1,152	$1,178
NPV	$2,195					
Equivalent Annual Value	0	$608.9	$608.9	$608.9	$608.9	$608.9

For the alternative investment, $\text{EAV}_2 = \$1{,}713 \times \{[.12\ (1 + .12)^4] \div [(1 + .12)^4 - 1]\}$

EAV_2 = $1,713 x 0.32923 = $564.0

Period, j	0	1	2	3	n = 4
Cash Flow	($847)	($585)	$926	$1,582	$1,917
Discount Factor, for WACC = 12%	1.000	0.8929	0.7972	0.7118	0.6355
Present Value	($847)	($522.3)	$738.2	$1,126	$1,218
NPV	$1,713				
Equivalent Annual Value	0	$564.0	$564.0	$564.0	$564.0

Since $608.9 = EAV_1 > EAV_2 = $564.0, the first alternative is chosen.

2a. Internal Rate of Return (IRR).

ROR = i, and NPV = 0 = $\Sigma_{(i = 1 \text{ to } n)}$ [Cash $\text{Flow}_{(\text{Out or In})}$ ÷ $(1 + i)^j$]

The IRR is easiest determined with a financial calculator, but it can be calculated by trial-and-error. Given the cash flow and applying the prescribed routine for the HP-12C calculator yields IRR = 44.2%. Without knowing this, one would note that the IRR must be greater than the WACC = 12%, if the NPV = 0. The process to find the IRR is successful, if NPVs greater and less than zero are calculated. The discount rates, the assumed IRRs that correspond to the NPVs that “bracket” zero, permit interpolation by which to find a reasonably close IRR. One can then perform additional iterations to obtain a more precise IRR, depending on specific needs. Two or three significant figures are all that are normally required for the IRR to enable accurate comparison of investment alternatives. In this case, one can assume IRR = 2 x 12% = 24%:

Period, j	0	1	2	3	4	5
Cash Flow	($1,117)	($675)	$833	$1,294	$1,812	$2,076
Discount Factor, for i = 24%	1.000	0.8065	0.6504	0.5245	0.4230	0.3411
Present Value	($1,117)	($544.4)	$541.8	$678.7	$766.4	$708.1
NPV	$1,034					

One still seeks an NPV < 0, so again doubling the assumed IRR to reduce the NPV seems to be appropriate:

Period, j	0	1	2	3	4	5
Cash Flow	($1,117)	($675)	$833	$1,294	$1,812	$2,076
Discount Factor, for i = 48%	1.000	0.6757	0.4565	0.3085	0.2084	0.1408
Present Value	($1,117)	($456.1)	$380.3	$399.2	$377.7	$292.4
NPV	($123.6)					

Restating: for i = 24%, NPV = $1,034; for i = 48%, NPV = -$123.6. Interpolating to find the i = ROR, which corresponds to NPV = 0:

ROR = 48% - (48% - 24%) {$123.6 ÷ [$1,034 – (-$123.6)]} = 45.4%

Discounting the cash flow, as repeatedly done before, but for i = 45.4%, the NPV = -$41.4. One thus sees that the IRR must be a bit less than 45.4%, as indeed the calculator routine revealed.

No matter if the IRR = 45.4% or, more accurately, 44.2%, the rate far exceeds the firm's WACC. Managers would probably re-examine very closely any assumptions forecasted into the cash flows, when a project is forecasted to be uncommonly profitable. The WACC embodies the returns of the firm's previous business ventures, so unless there is something very special about the circumstances for the abnormally high-return project, expecting that it will garner almost 3.7 times (44.2% ÷ 12%) the composite of those earlier returns seems unrealistic. The IRR assumption is that the projected cash flows are reinvested and obtain the same return as in previous periods. A more realistic assumption would be that cash inflows will be able to be reinvested at the firm's cost of capital, which is based on rates of return that have actually been achieved. That is where MIRR can sometimes offer more realism than IRR.

2b. Modified Internal Rate of Return (MIRR).

MIRR = i, where $PV_{costs} = PV_{Terminal\ Value}$ = Terminal Value ÷ $(1 + i)^n$

$PV_{costs} = \Sigma_{(i=1\ to\ n)}$ [(Cash Outflow)$_i$ ÷ (1 + WACC)^j]

Terminal Value = $\Sigma_{(i=1\ to\ n)}$ [(Cash Inflow)$_i$ (1 + WACC)$^{(n-j)}$]

Period, j	0	1	2	3	4	5
Cash Flow	($1,117)	($675)	$833	$1,294	$1,812	$2,076
Discount Factor, for WACC = 12%	1.000	0.8929				
Present Value	($1,117)	($602.7)				
NPV Cash Outflows	($1,720)					
Compound Factor, for WACC = 12%			1.405	1.254	1.120	1.000
Terminal Value			$1,170	$1,623	$2,029	$2,076
Net Terminal Value Cash Inflows						$6,899

For MIRR = i, $PV_{costs} = PV_{Terminal\ Value}$ = Terminal Value ÷ $(1 + i)^n$

$1,720 = $6,899 ÷ $(1 + i)^5$

$(1 + i)^5$ = $6,899 ÷ $1,720 = 4.011

$1 + i = (4.011)^{0.2} = 1.320$

i = 0.320 = 32.0%

Although this remains a handsome rate of return compared to WACC = 12%, the 32.0% MIRR is more achievable and realistic than the IRR of 44.2% from the same cash flows. Further, if there were multiple changes, say, from net cash outflow in early years, to net cash inflow and, finally, to net outflow again, then MIRR would often be preferable to the IRR calculation with the multiple solutions IRR would generate.

3. Return on Investment (ROI).

ROI = Net Gain ÷ Investment = (Gains – Investment) ÷ Investment

Period, j	0	1	2	3	4	5
Cash Flow	($1,117)	($675)	$833	$1,294	$1,812	$2,076

Gains = ($675) + $833 + $1,294 + $1,812 + $2,076 = $5,340
Investment = $1,117
ROI = ($5,340 - $1,117) ÷ $1,117 = 3.781 = 378.1%

ROI can also include the time value of money by discounting cash flows to a given time period, usually the present, and then calculating the ratio of net gain to investment. Such a practice becomes more appropriate with increasing numbers of pay periods.

Period, j	0	1	2	3	4	5
Cash Flow	($1,117)	($675)	$833	$1,294	$1,812	$2,076
Discount Factor, for WACC = 12%	1.000	0.8929	0.7972	0.7118	0.6355	0.5674
Present Value	($1,117)	($602.7)	$664.1	$921.0	$1,152	$1,178

Gains = ($602.7) + $664.1 + $921.0 + $1,152 + $1,178 = $3,312.4
Investment = $1,117
ROI = ($3,312.4 – $1,117) ÷ $1,117 = 1.965 = 196.5%

Complex ROI can also be calculated:
Average annual gain = [($602.7) + $664.1 + $921.0 + $1,152 + $1,178] ÷ 5 = $662.4
Complex ROI = Average annual gain ÷ Investment = $662.4 ÷ $1,117 = 59.3%

4. Payback period (PB).

PB occurs at the point in time when positive cash flow equals the cost of the investment.

Period, j	0	1	2	3	4	5
Cash Flow	($1,117)	($675)	$833	$1,294	$1,812	$2,076

Original investment, plus negative cash flow, period #1 = ($1,117) + ($675) = ($1,792)
By the end of period #2, ($1,792) + $833 = ($959)
By the end of period #3, ($959) + $1,294 = $335
PB is obtained during period #3. The point in time when it occurs is calculated:
$959 ÷ $1,294 = 0.74. The payback occurs 0.74 into period #3, or 2.74 periods after initial investment – at the end of the ninth month of the third year, if the above periods are annual. If uniform payments and receipts occur throughout the year, one would say that the payback period is 2.74 years. But since the example depicts end-of-year cash flows, PB is simply said to occur within three years. An integral value for PB is most common.

For the example EVA and ROA calculations that follow, assume that at 20XX year-end the Total Assets = $3,545,700. The WACC is assumed to be 11.0 %. Also accept the following as the corresponding Income Statement:

ACME Construction Company 20XX Year-End Income Statement		
Sales		$9,645,600
Cost of Sales		$3,934,500
Gross Profit		$5,711,100
Operating Expenses		$3,750,200
Utilities	$278,000	
Rent	$919,000	
Transportation	$323,000	
Salaries	$953,200	
Wages	$1,079,300	
Advertising	$19,900	
Bank Charges	$12,600	
Legal Fees	$18,900	
Accountant Fees	$33,100	
Insurance	$34,900	
Depreciation and Amortization	$78,300	
Operating Income		$1,960,900
Interest Expense	$83,800	
Income Before Taxes		$1,887,100
Income Taxes @ 40%	$750,840	
Net Income		$1,126,260

5. Economic Value Added (EVA).

EVA = (Net Sales – Operating Expenses – Taxes) – …
… – (Capital Employed * Weighted Average Cost of Capital Employed)
= Net Operating Profit after Taxes (NOPAT) - (K * WACC)
= ($5,711,100 - $3,750,200 - $750,840) – ($3,545,700 * 11.0 %)
= $820,033

In this case all of the enterprise's capital has been invested in the business effort, so capital employed, K, equates to Total Assets.

6. Return on Assets (ROA).

ROA = Net Income ÷ Total Assets

But is sometimes modified to

ROA = Earnings before Interest and Taxes (EBIT) ÷ Total Assets

or

ROA = Earnings before Interest, after Taxes (EBIAT) ÷ Total Assets

From a Balance Sheet,

Total Assets = Current Assets + Fixed Assets + Other Assets.

Net Income is drawn from “the bottom line” of the Income Statement.

ROA = Net Income ÷ Total Assets = $1,126,260 ÷ $3,545,700 = 31.8%.

or

ROA = EBIT ÷ Total Assets = $1,960,900 ÷ $3,545,700 = 55.3%.

or

ROA = EBIAT ÷ Total Assets = ($1,960,900 - $750,840) ÷ $3,545,700 = 34.1%.

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