Al-Mustaqbal University College
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Chemical Engineering Economics

4th Stage

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Lecture 11

ECONOMIC EVALUATION OF PROJECTS

A proposed investment must be evaluated for its economic feasibility. When a new technical project is proposed, a design study must be carried out. The design study produces specifications from which cost estimates can be made. These cost estimates, in turn, become the data for evaluating the economic consequences of the project. Principles and methods for carrying out economic evaluations are introduced. Such economic evaluations provide information that is essential, although not necessarily sufficient, for making decisions about how to use these limited resources.

PROFITABILITY STANDARDS

In the process of making an investment decision, the profit anticipated from an investment must be judged relative to some profitability standard. A profitability standard is a quantitative measure of profit with respect to the investment required to generate that profit.

Profit is the goal of any investment, but maximizing profit is an inadequate profitability standard. The profit must be judged relative to the investment.

For example,
suppose two equally sound investment opportunities are available. One of these requires a $ 100,000 capital investment and will yield a profit of $ 10,000 per year, while the second requires $1 million of capital investment and will yield a profit of $25,000 per year. While the second investment provides a greater yearly profit than the first, the annual rate of return on that investment is only ($25,000/$l, 000,000) (100), or 2.5 percent, while it is 10 percent for the first investment. If one had $1 million to invest and there were no alternative uses for these funds, then one might select the second investment.
However, because there are numerous reliable alternatives, such as bonds, that will yield annual returns greater than 2.5 percent, the second investment is not attractive. In this case, it would be advisable to invest $100,000 in the first alternative, assuming that it is not significantly more risky than the second alternative, and invest the remaining $900,000 in other reliable alternatives that provide higher annual returns.

Cost of Capital

The cost of capital based upon corporate experience is often used as a basic profitability standard. Cost of capital is the amount paid for the use of capital from such sources as bonds common and preferred stock, and loans.

The cost of capital after income taxes is found by weighting the cost of each of these outside sources according to its fraction of the total capital from these sources.

METHODS FOR CALCULATING PROFITABILITY

1. Methods that Do Not Consider the Time Value of Money

- Rate of return on investment,
- Payback period
- Net return

2. Methods that Consider the Time Value of Money

- The discounted cash flow rate of return
- Net present worth

Table 8-2 Use of profitability measures†

Evaluation method	Percentage use	
	Small companies	Large companies
Payback period	43	52
Return on investment	22	34
Net present worth	16	80
Discounted cash flw rate of return	11	78

†E. J. Farragher, R. T. Kleiman, and A. P. Sahu, *Eng. Econ.*, **44**(2): 137 (1999).

Return on Investment (ROI) This profitability measure is defined as the ratio of profit to investment. Although any of several measures of profit and investment can be used, the most common are net profit and total capital investment. This can be expressed as

$$\text{ROI} = \frac{N_p}{\mathcal{F}} \qquad (8\text{-}1a)$$

where ROI is the annual return on investment expressed as a fraction or percentage per year, N_p the annual net profit, and $\mathcal{F}$ the total capital investment. This definition agrees with the way in which the m_{ar} values in Table 8-1 are defined. Gross profit, before income taxes, or cash flw is sometimes used in place of net profit. Fixed-capital investment can be used rather than total investment. Corporate policy or the preference of the resource analyst determines the choice.

The symbol mar will be used for the minimum acceptable annual rate of return, and it is used as a fraction per year but often expressed as a percentage per year.

Table 8-1 Suggested values for risk and minimum acceptable return on investment

Investment description	Level of risk	Minimum acceptable return m_{ar} (after income taxes), percent/year
Basis: Safe corporate investment opportunities or cost of capital	Safe	4–8
New capacity with established corporate market position	Low	8–16
New product entering into established market, or new process technology	Medium	16–24
New product or process in a new application	High	24–32
Everything new, high R&D and marketing effort	Very high	32–48+

where N is the evaluation period, $N_{p,j}$ the net profit in year j, $-b$ the year in which the first investment is made in the project with respect to zero as the startup time, and $\mathcal{F}_j$ the total capital investment in year j. Note that for $j > 0$, that is, anytime after the original investment, $\mathcal{F}_j$ may often be zero or at most small compared to the original investment, and the denominator can be replaced by the initial total capital investment to simplify Eq. (8-1b) to

$$\text{ROI} = \frac{(1/N)\sum_{j=1}^{N}(N_{p,j})}{\mathcal{F}} = \frac{N_{p,\text{ave}}}{\mathcal{F}} \tag{8-1c}$$

where $N_{p,\text{ave}}$ is the average value of net profit per year over the evaluation period.

An ROI calculated from any of these three prior equations can be compared directly with a m_{ar} value supplied or selected from Table 8-1. If the ROI equals or exceeds the minimum acceptable rate of return m_{ar}, then the project offers an acceptable rate of return. If it does not, then the conclusion is that the project is not desirable for the investment of either borrowed or corporate funds.

Calculation of Profitability Measures Not Considering Time Value of Money

EXAMPLE 8-1

The research department of a large specialty monomer and polymer company has developed and formulated a new product. Early tests have been encouraging regarding the use of this product as a high-performance adhesive and sealant for cracks and joints in new and old cured concrete. The company foresees a substantial, virtually competition-free market in construction and repair if detailed product development and marketing studies are successful and the company enters the market early.

A preliminary design study has just been completed. The estimated economic parameters relevant to the project include the following items:

Production at 100 percent of capacity = 2×10^6 kg/yr
Batch process, total capital investment = $28 million
Fixed-capital investment = $24 million
Working capital = $4 million
Sum of the variable product costs at full capacity = $5 million/yr
Sum of the fixed costs (except for depreciation) = $1 million/yr

Because of the high risk factor, a minimum acceptable return of 30 percent per year is the profitability standard for this preliminary economic evaluation.

Calculate the product sales price that is required to achieve the m_{ar} obtained by using the methods of return on investment, payback period, and net return.

■ Solution

First calculate the quantities to be used in the calculation of the evaluation criteria.

Summary of economic data used in the profitability analysis

	Year										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Sum**
A. Percent of operating time	50	90	100	100	100	100	100	100	100	100	—
B. Product rate, $\$10^6$ kg/yr	1	1.8	2	2	2	2	2	2	2	2	18.8
C. All variable costs, $\$10^6$/yr	2.5	4.5	5	5	5	5	5	5	5	5	47
D. All fixed costs (except depreciation), $\$10^6$/yr	1	1	1	1	1	1	1	1	1	1	10
E. Depreciation,† $\$10^6$/yr	4.8	7.7	4.6	2.8	2.7	1.4	0	0	0	0	24
F. Total product cost (C + D + E), $\$10^6$/yr	8.3	13.2	10.6	8.8	8.7	7.4	6	6	6	6	81

Return on Investment

For this method Eq. (8-1*c*) is used; so first calculate the average net profit

$$N_{p,ave} = \frac{1}{10}[p(18.8) - 81](1 - 0.35)(10^6) = (1.222p - 5.265)(10^6)$$

where p is the unit price of the product in \$/kg. Since $\mathcal{F} = \$28 \times 10^6$,

$$\text{ROI} = 0.30 = \frac{(1.222p - 5.265)(10^6)}{28 \times 10^6}$$

Solving for p gives

$$p = \frac{0.30(28) + 5.265}{1.222} = \$11.18/\text{kg}$$

Selecting a Profitability Method

The net present worth method, combined with the discounted cash flw rate of return method, is strongly recommended for making economic decisions. These methods not only include all the pertinent information of the other methods, but also take into account the time value of money. In that way they give a more realistic picture of the value of the earnings in relationship to the investment than do those methods that do not include the time value of money.