Profitability

Book : ***Plant Design and Economics for Chemical Engineers*****, M.S. Peters and K. D. Timmerhaus**
Chapter 10 (4th Edition)

- A new project, such as constructing and operating a new chemical plant requires a commitment of capital funds
- The resources required to undertake a project are always limited. Therefore, the resources should be used in an appropriate and efficient manner. A wise investor selects investments that are expected to maximise the return from the capital that is available
- A proposed investment must be evaluated for its *economic feasibility*
- Before capital is invested in a project or enterprise, it is necessary to know how much profit can be obtained from an investment and whether or not it might be more advantageous to invest the capital in another form of investment.

The term ***'profitability'*** is used as the general term for **the measure of the amount of profit that can be obtained from a given situation**

- The basic aim of the ***profitability analysis*** is to give a measure of the attractiveness of a project for comparison with other possible project options
- Thus, the determination and analysis of profits obtainable from the investment among alternatives are the major goals of economic analysis

Profitability Standard

- In the process of making an investment decision, the profits anticipated from the 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
- Though profit is usually the ultimate goal of an investment, just maximising profit is an inadequate profitability standard. The profit must be judged relative to the investment.

For eg., if there are two investment opportunities,

	Option 1	Option 2
Capital Investment	$ 100000	$1000000
Profit per year	$10000	$25000
Annual rate of return on investment	(10000/100000) x 100 = 10%	(25000/1000000) x 100 = 2.5%

1st option is more attractive as it has a higher rate of return.

Return on investment is a more relevant profitability standard than total profit

If an investor has $1,000,000, he can put $100,000 in Option 1 and invest the rest in other options such as bonds, stocks etc which will earn a higher rate of return than 2.5%

Minimum acceptable rate of return

- A commonly used profitability standard is *minimum acceptable rate of return (m_{ar})*
- This rate of return is the rate of earning that must be achieved by an investment in order for it to be acceptable to the investor

Cost of capital

- The cost of capital can also be used as a profitability standard
- Cost of capital is the amount paid for the use of capital from such sources as loans, bonds and stocks
- The argument for using the cost of capital as a basis of profitability standard is that any project must earn at least that rate so as to just repay the external capital sources

Methods for calculating profitability

The calculation of profitability is generally performed with one of the methods listed below:

(1) Rate of return on investment
(2) Payback period (or payout period)
(3) Discounted cash flow
(4) Net present worth
(5) Capitalized costs

The first two methods do not consider the time value of money while the last three methods consider the time value of money

For methods that do not consider the time value of money, it is not important which depreciation schedule is used in the evaluation. Therefore, straight line method is usually used for calculating depreciation for convenience.

Methods that do not consider the time value of money

(1) Rate of return on investment (ROI)

This profitability measure is defined as the ratio of profit to investment.

The most common estimation is a percentage of annual net profit upon the total capital investment

$$ROI = \frac{Net\ annual\ profit}{Total\ initial\ capital\ investment} \times 100$$

In some cases, gross profit (before taxes) may be used to calculate ROI, but it should be mentioned

$$Gross\ profit\ =\ Total\ sales\ revenue\ -\ Total\ product\ cost\ =\ Income\ -\ Expense$$
$$Net\ Profit\ =\ Gross\ profit\ (1\ -\ income\ tax\ rate)$$

Net profit is usually not constant from year to year in a project

This can be considered by using average value of net profit per year over the evaluation period

$$ROI = \frac{\left(\frac{1}{N}\right)\sum_{j=1}^{N}\left(N_{p,j}\right)}{TCI} = \frac{Average\ net\ profit\ per\ year}{Total\ capital\ investment}$$

Rate of return on investment (ROI) (contd…)

If the ROI equals or exceeds the minimum acceptable rate of return, 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

Another method which is sometimes used for reporting rate of return is based on the assumption that it must be possible to obtain a certain minimum profit or return from an investment before the necessary capital spending will be desirable.

The minimum profit is included as an expense (fictitious). The return on investment calculated this way represents a return over and above that necessary to make the capital attractive.

If the return is zero (0) or larger (positive), the investment is considered attractive.

This is **return based on capital recovery with minimum profit**

Example 1 Determination of rate of return on investment-consideration of income-tax effects. A proposed manufacturing plant requires an initial fixed-capital investment of $900,000 and $100,000 of working capital. It is estimated that the annual income will be $800,000 and the annual expenses including depreciation will be $520,000 before income taxes. A minimum annual return of 15 percent before income taxes is required before the investment will be worthwhile. Income taxes amount to 34 percent of all pre-tax profits.

Determine the following:

(a) The annual percent return on the total initial investment before income taxes.
(*b*) The annual percent return on the total initial investment after income taxes.
(*c*) The annual percent return on the total initial investment before income taxes based on capital recovery with minimum profit.

Solution

(a) Annual profit before income taxes = $800,000 − $520,000 = $280,000.
Annual percent return on the total initial investment before income taxes = [280,000/(900,000 + 100,000)](100) = 28 percent.

(*b*) Annual profit after income taxes = ($280,000)(0.66) = $184,800.
Annual percent return on the total initial investment after income taxes = [184,800/(900,000 + 100,000)](100) = 18.5 percent.

(*c*) Minimum profit required per year before income taxes = ($900,000 + $100,000)(0.15) = $150,000.
Fictitious expenses based on capital recovery with minimum profit = $520,000 + $150,000 = **$670,000/year.** Annual percent return on the total investment based on capital recovery with minimum annual rate of return of 15 percent before income taxes = [(800,000 − 670,000)/(900,000 + 100,000)](100) = 13 percent.

(2) Payout Period (Payback period)

Payout period is defined as the minimum length of time necessary to recover the original capital investment in the form of cash flow to the project based on total income minus all costs except depreciation

The original capital investment is the depreciable fixed capital investment and the cash flow to the project is the average profit per year + average depreciation per year

Depreciation can be calculated using the straight line method

$$Payout\ Period\ in\ Years = \frac{Depreciable\ fixed\ capital\ investment}{Average\ profit\ per\ year + Average\ depreciation\ per\ year} \quad \text{..... (1)}$$

This is the Payout period calculated with no interest charged.

Lower the Payout period, more attractive is the project

Payout Period (Payback period) (contd….)

In some cases, the Payout period is calculated after including interest

$$Payout\ Period\ in\ Years = \frac{Depreciable\ fixed\ capital\ investment + Interest\ on\ TCI\ during\ estimated\ service\ life}{(Average\ profit\ per\ year + Average\ depreciation\ per\ year)_{at\ constant\ annuity}}$$

…… (2)

The Payout period using equation (1) is compared to the Payout period calculated from the minimum acceptable rate of return

$$PBP = \frac{(0.85\ \times TCI)}{Minimim\ acceptable\ rate\ of\ return\ \times TCI + \frac{(0.85\ \times TCI)}{N}}$$

The actual Payout period from eqn (1) should be less than the value (PBP) calculated above

- Another method of determining profitability without considering the time value of money is **Net Return**.
- Net return is the cash flow over and above that required to meet the minimum acceptable rate of return and recover the total capital investment.
- This is calculated by subtracting the total amount earned at the minimum acceptable rate of return, as well as total capital investment from the total cash flow

$$R_n = \sum_{j=1}^{N} \left(N_{p,j} + d_j + rec_j\right) - \sum_{j=-b}^{N} F_j - m_{ar}\, N \sum_{j=-b}^{N} F_j$$

d_j = depreciable fixed capital

rec_j = amount recovered from working capital and the sale of assets in year j

Now sum of $d_j + rec_j$ = total capital investment = $\sum F_j$

Therefore,

$$R_n = \sum_{j=1}^{N} N_{p,j} - m_{ar}\, N \sum_{j=-b}^{N} F_j$$

- Any positive value for R_n indicates that the cash flow to the project is actually greater then the amount necessary to repay the investment and obtain a return that meets the minimum acceptable rate
- If $R_n = 0$, the project is repaying the investment and matching the required m_{ar}
- Either result shows a favourable rating for the project. A negative value is, however, unacceptable. This method is not a widely used method though.

Example

A company invests $10,000 to produce and sell a product. The company generates $15,000 in revenue from selling the product, but incurs $5,000 in costs associated with production and sales, such as raw materials, labor, marketing, and shipping.

- To calculate the net return, we need to subtract the total costs from the total revenue:

- Net return = Total revenue - Total costs
- Net return = $15,000 - $5,000
- Net return = $10,000

In this example, the net return of $10,000 indicates that the investment or business activity was profitable, as the revenue generated was greater than the costs incurred.

Problem:

In a chemical plant, the fixed capital investment is Rs. 4×10^9 and the working capital is 20% of total capital investment. The annual total product cost and annual depreciation costs are Rs. 2×10^9 and Rs. 2×10^8, respectively. If the total annual sales are Rs. 3×10^9 and income tax rate is 40% then determine,

(i) the percentage of total capital investment returned annually as net profit (return on investment)

(ii) payout time

(i) $$ROI = \frac{Net\ annual\ profit}{Total\ initial\ capital\ investment} \times 100$$

FCI = Rs. 4×10^9 , TCI = x, WC = 20% of TCI = 0.2x

Therefore, $4 \times 10^9 + 0.2x = x$ and this gives,

x = Rs. 5×10^9

Annual gross profit = Rs. 3×10^9 - Rs. 2×10^9 = Rs. 1×10^9

[Depreciation is not subtracted as the total product cost already has depreciation component]

Net profit = Rs. 1×10^9 (1-0.4) = Rs. 6×10^8

ROI = $(6 \times 10^8 / 5 \times 10^9) \times 100 = 12\%$

(ii) $$Payout\ Period\ in\ Years = \frac{Depreciable\ fixed\ capital\ investment}{Average\ profit\ per\ year + Average\ depreciation\ per\ year}$$

Payout period = $4 \times 10^9 / (6 \times 10^8 + 2 \times 10^8) = 5$ years