Interim Period Asset Valuation: A Method for Making Investment Decisions

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A COMMON METHOD of estimating an asset's potential contribution to the value of the firm has been based upon the discounted value of the stream of income expected to be generated by the asset. Variations of this have been proposed by several authors.¹ Most of these methods consider the investment from a net standpoint: initial investment minus the salvage value. Implicit in this type of calculation is either of two assumptions: (1) that the asset will be worth its stated salvage value at the end of the planning period or (2) that the asset will be used as long as implied in the calculations.

In certain situations and for some types of assets neither of these assumptions is valid. In these cases the rate of return cannot be meaningfully calculated. The objective of this paper is to provide a method for determining the economic feasibility of proposed investments and evaluating their economic consequences when the salvage value and the interval of use for the asset are unknown.

For many types of assets in most manufacturing processes both the salvage value and the use interval are known and the decision-makers have little difficulty in using net investment data to calculate the rate of return needed for proposed investments. For other types of business, particularly single proprietorships, the use interval is uncertain because of the operator's incomplete knowledge of his future willingness or ability to operate the firm for as long as implied by the specified planning period. In such instances, he needs to form estimates on the value of the asset at interim time intervals because of the possibility that he may cease to operate the firm and that the value of the asset may at that time be subject to test on the market.

The operator also needs to know at the time of his purchase decision what the future loss or profit to him will be if he ceases to operate the firm. In addition, if he has little or no control of product or factor prices, the annual return from the asset is subject to variation. It may then be more useful for him to know the required annual increment he must earn in order to recapture the investment, given the internal rate of interest for discounting. The opportunity rate of return is the rate of earnings expected from the best alternative investment. The method for valuing assets illustrated in this paper is relatively easy to employ. The method provides information for determining the annual increment which must be earned and the minimum expectation required on the value of the asset at successive time intervals following purchase. Data required for using the method are (1) the investment cost, (2) the opportunity rate of return, and (3) the expected earnings. The theoretical rationale for the method is well known and needs no explanation here.²

One assumption is critical in the use of the method. It is that the decision-maker has some rate which can be used to discount the time-flow units of income. Usually this rate is the opportunity rate of return and will approximate the opportunity cost of capital. An annual expected income flow is presumed to be available from previous budgetary or other economic analysis.

The relevant relationships are:

\[ I = V_0 = \frac{t}{k} \sum_{i=1}^{k} \frac{E_0(Y_t)}{(1 + r)^t} + \frac{E_0(M_k)}{(1 + r)^k} \]


\[ E_0(Y) = \left[ I - \frac{E_0(M_k)}{1 - (1 + r)^k} \right] \frac{r}{1 - (1 + r)^k} \]

\[ E_0'(M_k) = \left[ I - \frac{\sum_{t = 1}^{t = k} E_0(Y_t)}{(l + r)^k} \right] (l + r)^k \]

where:

- \( V_o \) = the value of the investment to the farm operator at \( t_0 \) (the present);
- \( I \) = the investment cost, used here as a substitute for the value \( V_o \) since \( V_o \) is unknown in some instances;
- \( E_0(Y_t) \) = the expectation held at \( t_0 \) on the annual increment the asset will earn in year \( t \);
- \( E_0(M_k) \) = the expectation held at \( t_0 \) of the market value at \( t_k \);
- \( E_0'(Y) \) = the minimum expectation held at \( t_0 \) on the annual increment required to be earned between \( t_1 \) and \( t_k \) if \( I = V_o \);
- \( E_0'(M_k) \) = the minimum expectation held at \( t_0 \) on the value remaining in the asset at \( t_k \) which represents the value the decision-maker would have to receive for the asset at \( t_k \) to completely recover the investment cost;
- \( r \) = the rate used to discount the annual increment;
- \( t \) = unit of time; and
- \( k \) = the number of years the asset is expected to be used.

Equation (1) says the value of the investment to the decision-maker at \( t_0 \) (the present) is equal to the sum of the discounted expected annual earnings between \( t_1 \) and \( t_k \) (i.e., during the period the asset is expected to be used) plus the expected value remaining in the asset at \( t_k \), again discounted back to the present. In practice, the expected value remaining in the asset \( E_0(M_k) \) will be one of several values, depending upon the type of asset in question. It could be the salvage value at \( t_k \) if the asset were used up to the end of its economic life. It could also be the value the decision-maker expects the market to generate for the asset at \( t_k \). For some types of assets such a value is either readily available or can be estimated easily. This would be the case for frequently traded machinery. For assets attached to real estate, such as drainage ditches, buildings, etc., \( E_0(M_k) \) will be the expected addition to the value of the real estate to which it is attached.

However \( E_0'(M_k) \) is determined, it must be discounted to the present in order to be valid in determining the value of the investment \( [V_o] \) for comparison with the investment cost \( [I] \). The reason for discounting is to give the proper weight to this value in the decision process. To do otherwise would understate the required annual increment in equation (2) or undervalue the expected annual increment in equation (3).

In words, equation (2) states that the minimum annual increment required to retire the investment in \( k \) years \( E_0'(Y) \) is equal to the quantity, investment cost \( I \) minus the discounted expected value remaining, \( \frac{E_0'(M_k)}{(l + r)^k} \) times the capital recovery factor. If this value, \( E_0'(Y) \), is earned each year between \( t_1 \) and \( t_k \), the investment cost would be exactly recovered provided the expectation \( E_0'(M_k) \) held at \( t_0 \) was realized at \( t_k \). This is an important point.

It should be noted here that \( E_0'(Y) \) includes both the return to capital and depreciation. Proof of this is offered in Smith's article and will not be detailed here. Since depreciation and return to capital are both included, the decision-maker is assured that \( E_0'(Y) \) is the current cost of using the capital item. Once \( E_0'(Y) \) is calculated it can be compared to the expectation held at \( t_0 \) on the annual increment expected to be earned \( [E_0(Y)] \), to determine whether the expected earnings suffice to make the investment economically feasible, given \( k \) and the discount rate.

Comparing \( E_0'(Y) \) to \( E_0(Y) \) is then an alternative method of deciding whether the investment is feasible within the decision-maker's constraints. One advantage in using this method to determine investment feasibility is that the decision-maker need not search for the rate of return. If the firm requires the asset to earn at a rate of 15 percent on investment, this could be used as the rate for discounting. Equation (2) would provide information for determining investment requirements in terms of earnings when the opportunity rate of return is constrained to a minimum level.

Equation (3) states that the minimum expected value remaining in the asset at \( t_k \) \( [E_0'(M_k)] \) as seen by the decision-maker at \( t_0 \) is equal to the investment cost \( I \) minus the sum of the discounted annual returns between \( t_1 \) and \( t_k \) multiplied by the compound interest factor for year \( k \). While equations (1) and (2) provide information and are of interest to the decision-maker, equation (3) is the equation which allows the decision-maker to see the

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3 Smith, op. cit., p. 65.
consequences of making the investment in terms of possible loss. At any time after $t_1$ there will be an asset value remaining which must be recovered if the investment cost is to be recovered. In this equation $E_o(Y_t)$, the expectation held at $t_0$ on the annual increment the asset will generate, performs the function that $E_o(Y)$, the required annual increment, does in equation (2). That is, it allows both depreciation and return to investment to be taken into consideration in determining the minimum expected value remaining at $t_k$. Because the time value of the earnings is explicitly taken into consideration in calculating $E_o(M_k)$, the higher the rate used to discount $E_o(Y_t)$ the greater is the value remaining to be recovered. This is particularly important if $t_k$ is greater than 4.

The value calculated for $E'_o(M_k)$ with equation (3) should not be confused with the value for $E_o(M_k)$, the expectation held at $t_0$ of the market value at $t_k$, used in equations (1) and (2). All three values can be the same, though they need not be. As explained above, $E_o(M_k)$ may be known for some types of assets. Then equations (1) and (2) can be solved. In others, $E_o(M_k)$ may not be known and must be solved for in terms of minimum value remaining at $t_k$ as seen by the decision-maker at $t_0$.

Illustration of the Decision Model

The method of valuing assets outlined above was used in a study concerning durable assets specialized in use for beef feeding. Equations (2) and (3) were used in valuing the beef feeding assets.\(^4\) In equation (2), $E_o(M_k)$ was assumed to have a value of zero. An owner-operator is assumed already to be feeding cattle with a minimum of equipment. He wants to expand feeding capacity without increasing the use of labor. The proposed expansion is to come through an innovation requiring a large capital outlay. Farming is uncertain, but the farm operator needs to know prior to purchase of the capital assets what the assets must earn each year in order to recover the required investment. He must also know what the addition to the feeding enterprise will add to the value of the whole farm. However, market values are not readily available for the fixed assets he anticipates adding. As an alternative value he can calculate the minimum addition to whole farm value if the investment cost is to be completely recovered at any

of a succession of future dates. This will be $E_o'(M_k)$ as defined by equation (3) above.

Figure 1 illustrates the effect at the end of successive years of use, of using a high rate \([r]\) to discount expected annual earnings on the minimum value remaining (i.e., the minimum required addition to whole farm value, \(E_o(M_k)\)). The investment cost for this illustration was determined to be \(\$112,264\), which equips the feedlot for 1,151 head of steer calves 330 days each year. The expected annual increment \([E_o(Y)]\) was determined to be \(\$23,064\). The investment cost in this case is the cost of additional equipment. The estimate of \(\$112,264\) was arrived at by determining the new cost for the equipment required to feed 1,151 steer calves per year. Budgets were constructed to determine the expected annual increment of \(\$23,064\). From figure 1 it is possible to see that the minimum required value remaining (or more appropriately in this case, minimum addition to farm value) does not vary extremely for short time periods (\(k\) is relatively small) and for relatively small values of \(r\). However, for large values of either \(k\) or \(r\), the variation in the required value to be recovered from the market becomes increasingly larger.

For example, if \(k = 6\), given \(E_o(Y) = \$23,064\), the minimum required value remaining is zero for all values of \(r\) up to \(r = 6\). This means the investment cost will be completely recovered provided the expectations with respect to expected annual income \(E_o(Y)\) are realized. For values of \(r\) greater than \(r = 6\), the minimum required value remaining, \([E_o'(M_k)]\) takes on a positive value, the magnitude of which increases as the discount rate gets larger. Therefore, when \(r = 15\), \(E_o'(M_k) = \$58,000\) and with \(r = 17\), \(E_o'(M_k)\) increases to approximately \(\$75,000\). Since \(E_o'(M_k)\) is the minimum value that must be added to the value of the whole farm to recover the investment, the owner-operator must be concerned about the magnitude of this addition. As was demonstrated above, the addition increases as \(r\) becomes larger. Knowing this and the magnitude provides a basis for evaluating the investment by using a rate for discounting that reflects the opportunity cost of the investment.

We mentioned earlier that the single-proprietor type of business organization was particularly susceptible to uncertainty with respect to investments since when the owner leaves the firm it is likely to be transferred to other ownership. In cases of transfer the expected asset value or addition to the value of the whole farm based on the expectation \(E_o(M_k)\) will be subject to test on the market. Using high rates for discounting expected annual earnings could overestimate the additional value the market is willing to generate for the asset. The result would be a loss to the owner-operator. Conversely, using a low rate could underestimate the value the market is willing to generate, resulting in a gain to the owner-operator. The principal advantage of using equation (3) would be to see the required addition to the whole farm value at any point in time, thereby providing an additional piece of information at the time the investment is contemplated.

Application of equation (2) is straightforward. Given the investment cost \((I)\), the years the investment is expected to be used \((k)\), the discount rate \((r)\), and the assumption concerning \([E_o(M_k)], E_o(Y)\), the required annual increment, is found by using the capital recovery factor. As would be expected, the closer \(t_k\) is to \(t_o\), at any \(r\), the larger is \(E_o'(Y)\). Figure 2 illustrates the effect of both \(k\) and \(r\) on the required annual increment \([E_o(Y)]\). At a discount rate such as 6 percent the decision-maker would be required to use the asset for at least 6 years in order to completely recover the investment cost if he assumed \(E_o(M_k)\) were zero. If a value is known or can be assumed for \(E_o(M_k)\) all of the curves in figure 2 would be moved downward, indicating a smaller required value to be earned.

Comparing the calculated required annual earnings \([E_o'(Y)]\) with the budgeted annual earnings \([E_o(Y)]\) enables the owner-operator to determine the amount of the addition he has in the amount the investment must earn each year. For example, if \(E_o(Y) = \$23,064\) (as shown by the horizontal dash line in figure 2) and \(k = 6\) with \(r = 6\), \(E_o'(Y)\) is determined to be \(\$22,500\). On this basis the assumptions underlying the expected income \([E_o(Y)]\) must be very sound if a loss is to be avoided at \(t_k\) (at the end of the 6-year period). On the other hand, if \(k = 10\), \(r = 6\) with \(E_o(Y) = \$23,064\), \(E_o'(Y)\) need only be \(\$15,000\) which allows income to decline 35 percent without jeopardizing the expectation held for the addition to whole firm value (in this case \(E_o(M_k) = 0\)) at \(t_o\).

Using equation (2) and \(E_o(Y)\) together with equation (3) will improve the decision-making process and enable the owner-operator to better judge whether the investment is economically feasible, given the uncertainty of his situation. Not only will he be able to determine the size of the minimum required annual increment to be earned, but he can also make a comparison to determine latitude between the expectation held on annual earnings and the required annual earnings.
ANNUAL EARNINGS REQUIRED AT SELECTED RATES OF DISCOUNT \( r \) TO RECOVER INVESTMENT OF $112,264 IN FEEDLOT EQUIPMENT FOR A STEER FEEDING ENTERPRISE ASSUMING A ZERO RESALE VALUE FOR EQUIPMENT AT ANY YEAR \( k \).

Figure 2