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THE INCOMPATIBILITY OF THE AVERAGE INVESTMENT METHOD FOR CALCULATING INTEREST COSTS WITH THE PRINCIPLE OF ALTERNATIVE OPPORTUNITIES

Arthur J. Walrath

"The rate of interest charged should be . . . the amount the money could earn in an alternative investment. Interest is commonly charged at 6 percent on the average value of the machinery . . . ." This is a quotation taken from a bulletin published in 1965. Similar statements can be found in many publications. That bulletin has recently been revised. In the revision, the first part of that statement is still recognized, but the average investment method is not used to calculate interest costs.

In the first sentence, the principle of alternative opportunities is accepted, i.e., the minimum acceptable rate of return is that which the investor can obtain in an alternative investment that he would be willing to make. In general, economists agree that this is the rate that should be used in analyzing investment opportunities.

The second sentence in that quotation refers to a method that, as the authors correctly stated, is commonly used. In a review of literature of agricultural experiment stations and state extension services, 99 publications were found which included some analysis of investment costs or costs of owning. In 90 of these publications, the average investment method, was used in the analysis. In spite of this wide acceptance, this method is incompatible with the principle of alternative opportunities. Whenever interest costs are based upon the average investment for a depreciable asset, the actual rate of return on the unrecovered part of the investment during the early years is always less than the rate indicated. If there is no salvage value, the rate of return the first year is only one-half of what is stated as being the MINIMUM ACCEPTABLE RATE OF RETURN. Furthermore, the flow of income as interest during the life of the investment will be at a rate less than that recognized as being the minimum acceptable rate of return.

In the early texts on farm management, a primary emphasis was on farm records or farm accounts. Interest charge on machinery and buildings for a given year was calculated on the average value of the asset at the beginning of the year and at the end of the year. This is the "average investment method." Eventually, agricultural economists started to use this method, which is a reasonable way to estimate the interest cost for any given year, for analyzing investments and estimating interest costs over the life of an investment.

To a large extent, agricultural economists in analyzing investments or costs of ownership have blindly fallen into step with their predecessors without realizing the incompatibility of the method used with the data as given.

Nowhere in our literature has it been possible to find an analysis of the average investment method. The purpose of this paper is to show the incompatibility of this method with the principle of alternative opportunities by analyzing the results that occur when this method is used. An understanding of what this method involves should provide basis for discontinuing its further use in our profession.

FACTORS INVOLVED IN THE ANALYSIS OF DEPRECIABLE INVESTMENTS

Two basic factors are involved in the analysis of investments. Both relate directly to the amount of the investment. The investor is concerned with the eventual recovery of the money that he will invest. Second, he desires to obtain a return on any investment that is at least equal to the return that

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could be obtained from some alternative use. The flow of funds that will be available for interest on the investment and for recovery of capital will be of primary concern.

Depreciation is not of primary importance in the analysis, although many agricultural economists give major consideration to depreciation and none to capital recovery. Depreciation is merely an accounting device, an attempt to define the loss in value of an asset over the period of its useful life.

However, depreciation can enter the analysis in two ways. First, the investor wants to recover the amount that he will invest before the asset is worn out. Normally, he will attempt to select a period for capital recovery that is less than the life of the asset. Second, the effects of depreciation on taxes will be a point that will likely be considered. Here the method used for claiming depreciation as A COST FOR INCOME TAX PURPOSES is important. Much material on the different methods for using this accounting device and the effects of the methods is readily available.

THE AVERAGE INVESTMENT METHOD

With C as the original cost of investment, L as the estimated salvage value, i as opportunity costs, and n as the period of time over which the capital is to be recovered, the annual flow required to recover an investment, with data as given, would be:

$$(1)\quad R = \frac{C + L}{2} i + \frac{C - L}{n}.$$

The first term represents the amount claimed as interest. The second term should be called capital recovery although it is normally referred to as depreciation. This method provides for an equal amount to be recovered each year. It will be shown later that, with the acceptance of a given minimum rate of return, it is impossible to recover capital each year in an amount equal to $\frac{C - L}{n}$.

RECOVERY OF CAPITAL AND RETURN ON INVESTMENT

In the analysis of investments, certain postulates are normally accepted. An investment will not be made unless the expectations indicate that it is possible to recover the amount of the original investment and a return, in the form of interest, on the investment over its life. Economists recognize that a reasonable return is that return which could be obtained from alternative opportunities.

One relationship that is frequently ignored is that the present value of future income that is expected to flow from an investment should equal (or exceed) the cost of the investment. What is the present value of the flow of income as estimated by the average investment method?

If the amount invested is fully recovered with interest, the following relationship should exist:

$$(2)\left[\frac{C + L}{2} i + \frac{C - L}{n}\right]\left[\frac{1 - (1 + i)^{-n}}{i}\right] + L(1 + i)^{-n} = C.$$

In solving this equation, we find that this equality exists only for one special situation -- when the cost of the investment is equal to its salvage value. This is an impossibility. Since $C > L$, we can prove that equation (2) must be restated:

$$(3)\left[\frac{C + L}{2} i + \frac{C - L}{n}\right]\left[\frac{1 - (1 + i)^{-n}}{i}\right] + L(1 + i)^{-n} < C.$$

If the annual flow equals the interest on the average value plus an amount equal to straight line depreciation, the present value of this flow plus the present value of the estimated salvage will be less than the amount of the original investment. If a person makes an investment based upon an analysis using the average investment method, the return on the investment, under the conditions as given, will be less than his minimum acceptable rate of return.

It makes no difference whether one looks at an investment at the beginning of its life or at the end of its life. However, an examination of the status of the investment at the end of its assumed life can be revealing.

If capital recovery and return on the investment have been based upon principles of compounding, all capital will have been recovered during the life of the investment. The following relationship exists at the end of the n^{th} year:

$$(4)\quad C(1 + i)^n - \left\{L + \left\{[C - L]\left[\frac{i}{1 - (1 + i)^{-n}}\right] + Li\right\}\left[\frac{(1 + i)^n - 1}{i}\right]\right\} = C.$$

In other words all capital has been recovered with the minimum acceptable rate of return on that capital.

However, when the average investment method is used, some of the investment will not have been recovered. It can be proven that

$$(5)\quad C(1 + i)^n - \left\{L + \left[\frac{C + L}{2} i + \frac{C - L}{n}\right]\left[\frac{(1 + i)^n - 1}{i}\right]\right\} > 0.$$

Whenever the analysis involves the average investment method, a return less than the minimum acceptable rate will be received under the conditions as given. This can be shown when interest is calculated at the minimum acceptable rate. Some of the investment will remain unrecovered at the end of the life of the asset.

The amount of the investment unrecovered is dependent upon three factors: (1) ratio of salvage value to original cost, (2) the minimum acceptable rate of return, and (3) the length of life of the investment. The percentage of the investment not recovered increases as the estimated salvage value approaches zero. Likewise, the higher the interest rate or longer the anticipated life, the greater the amount of investment unrecovered at the end of the anticipated life.

In one study with a given rate of return of 7 percent, there was a 7 percent loss for one asset with a life of 8 years, 10 percent loss for another with a 10 year life, and a 38 percent loss for an asset with a 20 year life. The longer the life, the greater the loss when estimated returns required are based on the average investment.

If a 10 percent rate of return had been used, these losses would have been 14 percent, 20 percent, and 100 percent, respectively. The higher the rate used, the greater the loss.

For an asset with a life of 10 years, 7 percent return, and salvage value of 25 percent of the original cost, 7.6 percent of the original cost will be unrecovered at the end of life. This loss would increase to 10.2 percent if there is no salvage value. The amount of capital unrecovered increases with a reduction in the estimated salvage value.

In general, these losses, which are automatically built in, have not been recognized by agricultural economists. In many studies, a high degree of accuracy is implied with data on costs and returns frequently presented with 7 and even 9 significant figures. If our work in this field is to become more meaningful, we will need to use a reliable method in the analysis of investment opportunities. The high degree of accuracy that is so often implied is incompatible with the errors created by using the average investment method.

METHODS INVOLVING THE USE OF COMPOUND INTEREST

Grant states that "it is necessary to understand the principles of compound interest in order to make economy studies in which time is an element." Any method used to analyze investment opportunities must be based upon principles of compounding or discounting. Various methods are available. The method used should be determined largely by how the investor visualizes the flow of revenue that will be available for interest and capital recovery.

If the flow is not an annually recurring constant, then each item in that flow must be considered individually. The present value of each item needs to be determined. If the present value of the anticipated flow is less than the cost of the investment, the potential investor will recognize that with the given rate of return, he will not recover all his investment.

Calculations are simplified if one anticipates a flow for interest and capital recovery that is a constant amount each year. In this case, the annuity method can be used and the analysis can be tackled from either of two ways. The investor can determine the present value of the anticipated flow. This can be expressed as

$$(6)\quad PV = R\left[\frac{1 - (1 + i)^{-n}}{i}\right] + L(1 + i)^{-n}.$$

The present value can be compared with the cost required to make the investment.

Or the investor can determine what annual flow would be required to recover the investment. This would be:

$$(7)\quad R = (C - L)\left[\frac{i}{1 - (1 + i)^{-n}}\right] + Li.$$

This can be compared with the annual flow that one estimates will be available for interest and recovery of capital.

The annuity method is probably the easiest method to work with. It actually involves fewer calculations than the average investment method. However, the annuity method does have the disadvantage of providing relatively little capital recovery during the early years of the investment.

For much of our analysis, the annuity method is highly suitable. This method involves the use of annuity tables that are readily available.

COMPARISON OF METHODS

If we accept the principle that the minimum acceptable rate of return is determined by alternative investment opportunities, then it is logical to use an INTEREST RATE on the INVESTMENT that is consistent with this principle. Calculating interest on the average investment is the same as using, during the first year, a rate equal to only ONE-HALF THE MINIMUM ACCEPTABLE RATE when there is no salvage value. This makes the average investment method incompatible with the data as given.

The incompatibility has been shown in the previous section. It might be easier to recognize if an example is taken. This example involves a depreciable asset involving an investment of $10,000 with a life of 10 years and with no salvage value. Alternative investment opportunities require a minimum return of 8 percent.

According to the average investment method, an annual flow of $1,400 would be required, with $1,000 of this allotted for capital recovery and $400

for interest. If a schedule for interest payments and capital recovery is prepared, one would find that the amount of investment outstanding could not be reduced by $1,000 each year. With only $400 being credited as interest the first year, there is a deficit of $400. The deficit continues for the first seven years and totals $1,646.32. During the last three years, interest is in excess of the amount required to return 8 percent on the balance. The excess interest in these three years totals only $338.25. The excess interest during the last three years can never offset the deficit created during the first seven years. During the 10-year life, the amount of interest deferred beyond the life of the investment totals $1,308.07 (Table 1).

Table 1.

AMOUNT OF INVESTMENT OUTSTANDING AT BEGINNING OF YEAR AND SCHEDULE FOR INTEREST AND CAPITAL RECOVERY FOR AN INVESTMENT OF $10,000, AT 8 PERCENT, WITH LIFE OF 10 YEARS, AND WITH NO SALVAGE VALUE, WITH ANNUAL CHARGE OF $1,400 DETERMINED BY THE AVERAGE INVESTMENT METHOD

Year	Investment outstanding at beginning of year	Interest on balance[a]	Interest credited[b]	Interest deferred[c]	Excess interest[d]	Amount credited for capital recovery[b]
	dollars					
1	10,000.00	800.00	400.00	400.00	--	1,000.00
2	9,400.00	752.00	400.00	352.00	--	1,000.00
3	8,752.00	700.16	400.00	300.16	--	1,000.00
4	8,052.16	644.17	400.00	244.17	--	1,000.00
5	7,296.33	583.71	400.00	183.71	--	1,000.00
6	6,480.04	518.40	400.00	118.40	--	1,000.00
7	5,598.44	447.88	400.00	47.88	--	1,000.00
8	4,646.32	371.71	400.00	--	28.29	1,000.00
9	3,618.03	289.44	400.00	--	110.56	1,000.00
10	2,507.47	200.60	400.00	--	199.40	1,000.00
11	1,308.07					

[a]Based on data as given; i.e., interest calculated at 8 percent on balance.

[b]Based on average investment method.

[c]Any interest deferred must be considered as an additional investment.

[d]Excess interest credited in later years is considered as additional capital recovery.

If one had anticipated a flow of $1,400 from this investment, he could have calculated the present value of this flow by using formula (6). The present value of $1,400 annually for 10 years at 8 percent is $9,394. Not many persons would exchange $10,000 for something that is worth only $9,394. This is the type of exchange that is encouraged when the average investment method is used.

Using the annuity method, one finds that the annual payment required is $1,490.30 if an investment of $10,000 is to be recovered with an 8 percent return over 10 years (Table 2).

IN CONCLUSION

Analysis of investment opportunities is one step in the decision process. The evaluation that takes place should be made prior to making the commitment, although at times the owner of an investment will be concerned with liquidation

because of changing conditions relating to the investment or to alternative opportunities. In the evaluation, the investor is concerned with the flow of income that will be available for a return in the form of interest, that is equal to his alternative opportunities, and for capital recovery. A sound analysis involves not only the use of reasonable estimates as to the flow; it also involves the use of a method that provides a reasonably accurate estimate of either the present value of that flow or an estimate of the annual flow required to recover the investment WITH INTEREST AT THE RATE ASSUMED. The average investment method definitely is NOT that method. It does not provide a reliable estimate of the annual flow required. The average investment method is inaccurate, with the inaccuracy increasing with higher interest rates, with a lengthening of the period of life of the asset, or with a reduction in the proportion of the investment recovered as salvage. The average investment method does not involve the principles of compounding; the time concept of money is ignored.

Any evaluation of investment opportunities must be based upon the principles of compounding or discounting. The only errors that will arise when principles of compounding are used will be ones of judgment. These will be due to errors in estimating the flow of income available for capital recovery and interest. When principles of compounding are used, the analysis will be as correct and as reasonable as the data. Analysis must be based upon these principles.

Table 2.

AMOUNT OF INVESTMENT OUTSTANDING AT BEGINNING OF YEAR AND SCHEDULE FOR INTEREST AND CAPITAL RECOVERY FOR AN INVESTMENT OF $10,000, AT 8 PERCENT, WITH LIFE OF 10 YEARS, AND WITH NO SALVAGE VALUE, WITH ANNUAL PAYMENTS DETERMINED BY THE ANNUITY METHOD

Year	Investment outstanding at beginning of year	Annual charge required[a]	Interest charge on balance[b]	Amount available for capital recovery[c]
	dollars			
1	10,000.00	1,490.30	800.00	690.30
2	9,309.70	1,490.30	744.78	745.52
3	8,564.18	1,490.30	685.13	805.17
4	7,759.01	1,490.30	620.72	869.58
5	6,889.43	1,490.30	551.15	939.15
6	5,950.28	1,490.30	476.02	1,014.28
7	4,936.00	1,490.30	394.88	1,095.42
8	3,840.58	1,490.30	307.25	1,183.05
9	2,657.53	1,490.30	212.60	1,277.70
10	1,379.83	1,490.22[d]	110.39	1,379.84
11	0			

[a]As determined by equation 7.

[b]Calculated at 8 percent on balance at beginning of year.

[c]This is the annual charge required less interest charge.

[d]The rounding-off process makes the final payment slightly smaller.