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PITFALLS OF USING INTERNAL RATE OF RETURN TO RANK INVESTMENTS IN FORESTRY

Abstract.—Using the internal rate of return concept to rank the economic desirability of investment opportunities can lead to incorrect investment decisions. Present value provides a correct and unambiguous means of judging such investment alternatives.

Internal rate of return has received widespread acceptance as a means of evaluating and ranking the general economic effectiveness of timber-producing investments. Here we point to instances where rigid use of the internal rate of return concept provides incorrect guidance for investment decisions. The approach using present value provides a correct and unambiguous method for judging the financial merit of such investment alternatives.

The internal rate of return for a timber-management investment is the rate at which the investment grows toward the return it eventually generates. The general formula for computing the rate of return (i) for a single investment (C), yielding a single added value (R), in n years is:

$$C\ (1 + i)^n = R$$

C, n, and R are known; and we solve for i.

The procedure can be readily extended to projects having more than one cost and yielding more than one return during the investment period.

The i's (internal rates of return) generated by various alternative investment projects are customarily used to rank the economic desirability of the projects.

The internal rate of return is considered a valid device for judging whether an investment should be accepted or rejected. If the internal rate of return to a timber-management investment is greater than the investor's cost of borrowing capital (or the rate of return on his best alternative opportunity, whichever is appropriate) then the investment should be accepted.[1]

Consider for example a simple hypothetical project (A), with schedule of investments and net returns as follows:

Year	*Operation*	*Cost*	*Return*
1970	Precommercial thinning	$25/acre	——
1980	Commercial thinning	——	$29/acre
1990	Commercial thinning	——	$58/acre
2000	Harvest cut	——	$88/acre

The formula for computing internal rate of return for this project is:

$$25\ (1 + i)^{30} = 29\ (1 + i)^{20} + 58\ (1 + i)^{10} + 88$$

Solving for i yields a rate of about 10 percent. If our investor can borrow investment funds at a rate of 4 percent, this project is worth undertaking. He would accept it.

Now consider two similar investment alternatives (B) and (C) represented by the following income flows:

Investment	*1970*	*1980*	*1990*	*2000*
B	−$25	0	0	$250
C	−$25	$42	$42	$ 42

The internal rate of return to B is about 8 percent and to C about 10 percent. At a 4 percent borrowing rate, these investments would be worth undertaking too.

However, when the question asked is "Which of the projects is the better one?"; and not "Are the projects worth undertaking?"; the use of internal rate of return as a selection criterion can lead to an incorrect choice. If our investor ranks A, B, and C strictly in terms of internal rate of return values he will see no difference between investments A and C since both yield rates of 10 percent. And he will prefer either of these investments to B, because it yields a return of only 8 percent.

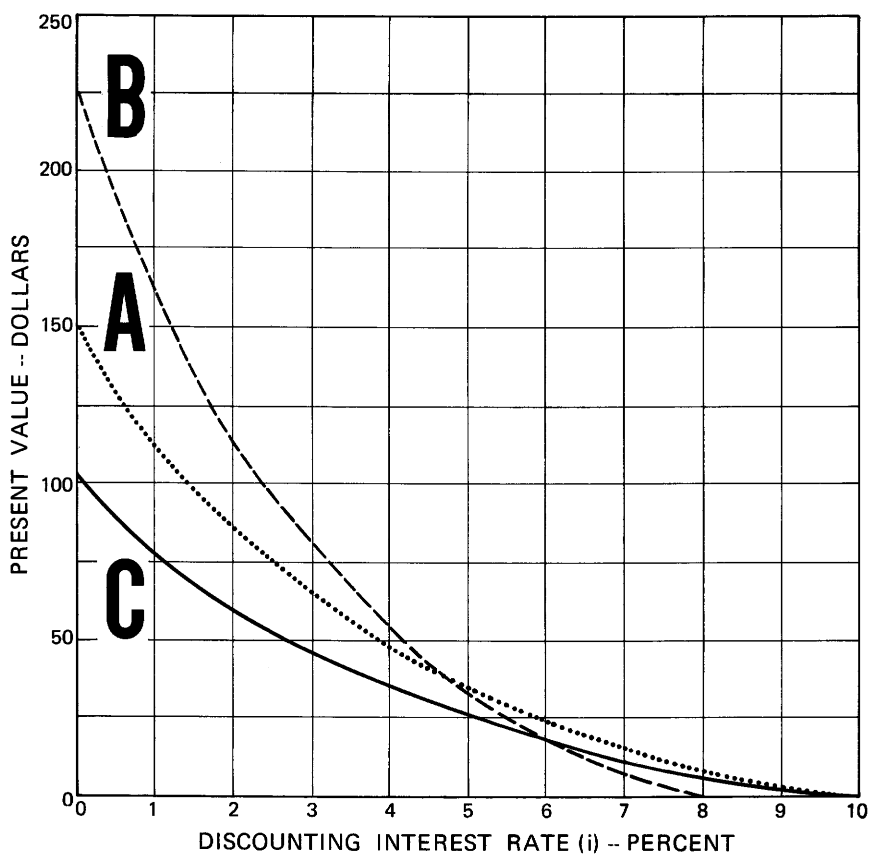
But the best financial alternative is the one yielding the greatest present value at the investors cost of capital. Discounting A, B and C at 4 percent yields present values of $48, $52, and $35, respectively. Clearly, investment B is the best alternative.

[1] Actually, investment is not an end in itself, but is a process of distributing consumption over time. The investment decision must take in to account the income preferences of investors over time. It must also consider problems of uncertainty, opportunities for reinvesting incremental cash flows, and choices of discounting rates. Such difficulties are beyond the scope of this paper and are not discussed.

We can use graphics to fully clarify this point. The chart in figure 1 plots the present values of options A, B and C as a function of discounting interest rates (fig. 1).

Internal rate of return for any multiperiod investment is that discounting rate of interest which makes the present value of the cash-flow stream equal to zero. The internal rates of return to A, B, and C are 10 percent, 8 percent, and 10 percent, respectively. Ranking in terms of internal rate of return would leave the investor indifferent between investments A and C, and he would prefer either A or C to B. However, the chart clearly shows that the choice between A, B, and C will depend on the rate of discount used. At discount rates of less than 4.6 percent, investment B is the best alternative. At rates greater than 4.6 percent, A is preferred.

Figure 1.—Present values of investments A, B, and C at varying discount rates.



C would never be preferred at any discount rate that yielded this investment a positive present value.

Thus, when we are deciding between mutually exclusive investment alternatives, the choice of the one with the highest internal rate of return is not, in general, correct. In fact, a decision between the alternatives cannot be made without knowing the appropriate discounting rate.

Another fundamental difficulty of using internal rate of return to evaluate investment alternatives is that some options may not yield a unique rate of return. Take for example a hypothetical project (D) having the following income flows:

1970	*1980*	*1990*	*2000*
−$25	$112.25	−$165.96	$80.78

Calculation of internal rate of return to this investment yields multiple values. The present value is zero at discounting rates of 2, 4, and 6 percent [2] (fig. 2).

[2] This is in accord with Descartes' rule of signs: The number of positive solutions for which present value equals zero is at most equal to the number of reversals of sign in the terms of the income flow sequence.

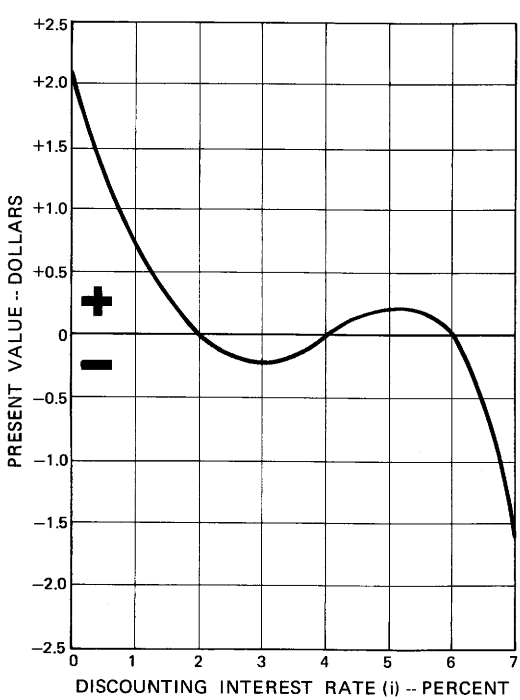


Figure 2.—Present value of investment D at varying discount rates.

Once again, the decision to invest will depend on the rate of discounting used. The present value of investment D is positive at discounting rates of 0 to 2 percent and 4 to 6 percent; and negative at rates of 2 to 4 percent and greater than 6 percent. Using the appropriate discounting rate the investor can calculate a correct and unambiguous present value which can be used to judge the financial merit of this investment.

Forest economists and others who use internal rate of return to rank the financial desirability of alternative investments in timber production must use this economic tool with care. If a particular investment yields a unique internal rate of return, the internal rate of return value is a sound index for determining whether or not the investment is worth undertaking.

But when the problem is to choose between mutually exclusive productive investment alternatives, the internal rates of return to these options will not rank them consistently with their present values. A choice cannot be made without knowning the appropriate discounting rate. Given this discounting rate, the options should be ranked in terms of their present values. This approach insures that the investment yielding the highest level of present worth will be chosen.

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