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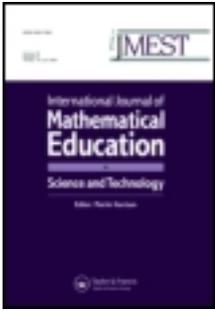
A note on equivalence in ranking investments

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A note on equivalence in ranking investments

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Present net worth, benefit/cost, and internal rate of return are considered for ranking investments. In some cases, rankings can be contradictory, and the investment criterion can influence inter-project allocations. There are situations, however, when ranking equivalence is assured. In this article, conditions for equivalence in ranking investments are presented using simple graphics and algebra. The conditions are restrictive, and can be effective in demonstrating the need for discretion in selecting an economic criterion for evaluating investments.

1. Introduction

Many curricula in science and engineering include instruction in evaluating capital investments. Three of the most common economic criteria are present net worth (PNW), benefit/cost (B/C), and internal rate of return (IRR). The time value of capital is an important characteristic of most investments, and is reflected by each criterion: PNW is the present value of benefits minus the present value of costs, B/C is a ratio of the present value of benefits to the present value of costs, and IRR is the interest rate at which the present value of benefits equals the present value of costs. Although they involve the future, projects are evaluated and decisions are made in the present, requiring that performance be measured in present value terms.

Investment criteria may be used for descriptive or for ranking purposes. Using PNW, B/C or IRR to answer the question, 'Given the alternative rate of return (ARR), is this investment profitable?' is a descriptive use. The answer is 'yes', of course, if PNW is positive, B/C is greater than one or IRR is greater than ARR. In accepting or rejecting investments, PNW, B/C and IRR produce equivalent results [2]. That is

$$B - C \gtreqqless 0, \quad B/C \gtreqqless 1 \quad \text{and} \quad IRR \gtreqqless ARR \quad \text{are non-contradictory.}$$

In cases where more than one project is profitable, however, these criteria may be used to order or rank competing projects. Ranking is necessary if alternatives are mutually exclusive, or if funds are insufficient for all potential investments. In either case, the most profitable set of alternatives can be selected by PNW, B/C or IRR. Equivalence is when rankings are identical for all criteria.

2. Equivalence in ranking

Although equivalent for descriptive purposes, PNW, B/C and IRR do not always rank investments identically. The following brief discussion of conditions for equivalence has been effective in classroom presentations of this concept, since the conditions are simple yet very restrictive. IRR and PNW are considered first, followed by a discussion of PNW and B/C.

IRR is not often recommended as an investment ranking criterion (see [3] or [4]), yet is sometimes equivalent to ranking by PNW and B/C. A sufficient condition for investment ranking by IRR *to* be equivalent to ranking by PNW is that the PNW relations for competing projects be non-intersecting within the range of positive values. For discount rates greater than the lowest IRR, PNWs are negative and ranking is not a concern. Simple PNW relations for two projects are presented in figures (*a*) and (*b*). In figure (*a*), knowing that $IRR_1 > IRR_2$, and that the PNW relations do not cross, implies that $PNW_1 > PNW_2$ for all relevant discount rates. In figure (*b*), however, $IRR_1 > IRR_2$ does not imply that $PNW_1 > PNW_2$.
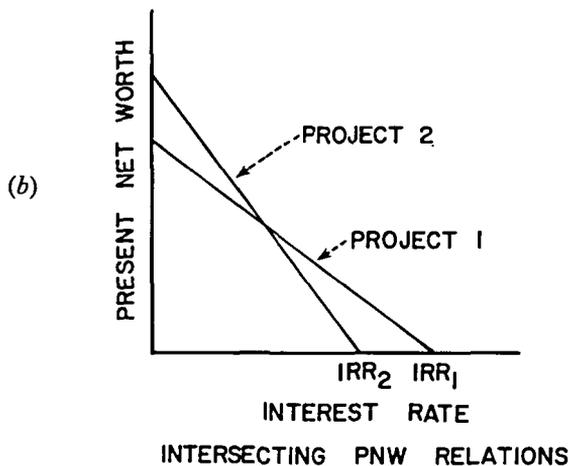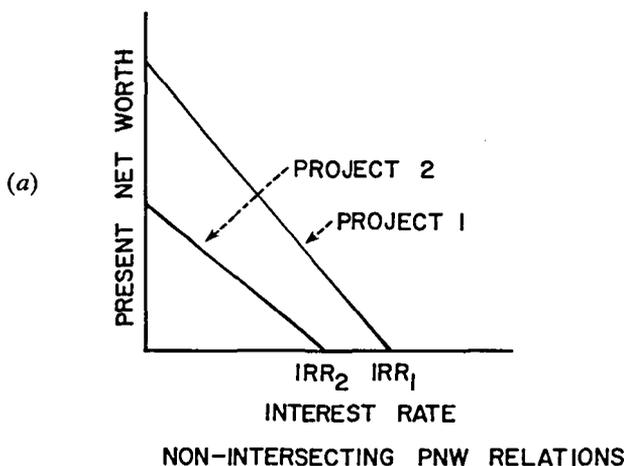
Non-intersecting (*a*) and intersecting (*b*) present net worth relations for two projects. Only positive values are considered since ranking is unnecessary if potential investments are not profitable.

The next comparison involves PNW and B/C. When does ranking projects by PNW imply a similar ranking by B/C and vice versa? Only one general statement is possible:

$$PNW_1 > PNW_2 \Rightarrow B_1/C_1 > B_2/C_2 \text{ if } C_1 \leqslant C_2$$

This results because $PNW_1 > PNW_2$ and $C_1 \leqslant C_2$ implies that

$$\frac{PNW_1}{C_1} > \frac{PNW_2}{C_2} \Rightarrow \frac{B_1 - C_1}{C_1} > \frac{B_2 - C_2}{C_2}$$

$$\Rightarrow \frac{B_1}{C_1} - 1 > \frac{B_2}{C_2} - 1$$

$$\Rightarrow \frac{B_1}{C_1} > \frac{B_2}{C_2}$$

Therefore, if $C_1 \leqslant C_2$ and $PNW_1 > PNW_2$, it follows that $B_1/C_1 > B_2/C_2$. The reverse (B/C to PNW) does not necessarily hold, however, regardless of the relationship between C_1 and C_2, as can be demonstrated with simple counter-examples [1].

3. Conclusions

PNW, B/C and IRR are very useful in deciding if investments should be accepted or rejected. Answers are similar since $PNW > 0$, $B/C > 1$ and $IRR > ARR$ are non-contradictory. The most appropriate descriptive measure therefore depends on factors such as user familiarity and computational effort. IRR, for example, requires more computation, yet is more meaningful to many users than PNW or B/C.

In selecting profitable investments, however, contradictory rankings can occur. Descending order by PNW implies a similar rank by B/C if costs of the first ranked project are less than or equal to costs of the second ranked project. The result does not apply if $C_1 > C_2$, however, and generalizations are not possible for PNW ranking when B/C ordering is known. Ranking by IRR is equivalent to PNW if the PNW curves do not intersect with positive values, and is therefore equivalent to B/C ranking under the added condition that $C_1 \leqslant C_2$. The conditions discussed are not necessary for investment rankings to agree, but point out the caution needed when using different criteria. Only under restrictive circumstances can equivalence be assured. For any other conditions, the criterion selected and used can influence the final allocation of investment resources among competing projects.

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