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Discounted Payback Period

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Even though payback period does not measure the profitability of proposed capital investments, it is still the favorite method of evaluating them. The author proposes an improved standard —

THE DISCOUNTED PAYBACK PERIOD

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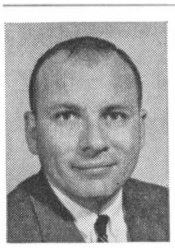
ONE OF THE MOST STRIKING disparities between theory and practice in management today lies in the field of capital budgeting. The literature of capital budgeting abounds with "sound" methods of measuring the economic value of proposed capital expenditures. Almost all of them are methods that give due consideration to the time value of money. Although the use of discounted cash flow techniques is increasing in American industry, it continues to be the exception rather than the rule.



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Payback period remains the most popular method of evaluating capital projects. Despite almost unanimous agreement by the theorists that payback has little value in measuring profitability, it is the only financial measure used in capital expenditure evaluation in many companies.[1] Even the large corporations that employ discounted cash flow analysis often retain payback period as an additional tool.

All this suggests that payback may have some real advantages in capital investment analysis. The purposes of this article are to analyze the reasons for its popularity and, assuming that this popularity will continue, to propose an improved concept of payback period, i.e., the discounted payback period.

Payback shortcomings

The payback period measures the length of time it will take expected cash proceeds generated by an investment to equal the initial cash outlay required to make the investment. For example, if a new machine costs $75,000 and is expected to produce operating savings of $15,000 annually, it has a payback period of five years. If the expected cash flows vary from year to year, then PB is determined by adding the expected proceeds for each year until the sum equals the

initial cash outlay. In any case, the shorter the PB the more desirable the project is assumed to be.

The principal objection to the payback period method is its failure to measure profitability. Simply measuring how long it will take to recover the initial investment outlay contributes little to gauging the earning power of a project. Because payback period analysis ignores differences in the timing of cash flows, it fails to recognize the difference between the present and the future value of money. Because it ignores all proceeds after the payback life, it does not allow for the possible advantages of a project with a longer economic life.

Using payback period as the sole criterion may well lead to an undue emphasis on liquidity at the expense of profitability. By way of illustration, consider two mutually exclusive projects, P_1 and P_2. Each requires an initial investment outlay of $100,000. P_1, with expected annual cash proceeds of $25,000 for the duration of its five-year economic life, has a payback period of four years. P_2 is expected to generate annual cash proceeds of $20,000 for ten years; hence, its payback period is five years. The payback period criterion points to the selection of P_1, but, in fact, whether one applies the unadjusted or the time-adjusted (discounted cash flow) rate of return criterion, P_2 is the more profitable investment. Even if we were to suggest that the economic life of P_1 is four years rather than five years, the payback period criterion would still favor P_1 despite the fact that P_1 would then yield no return or a negative return on a time value basis.

Reasons for popularity

Why, then, does payback period continue to be so widely used as a measure of acceptability for capital projects? The following reasons appear to be the principal ones:

1. *It is easy to calculate.* This reduces the cost of the capital investment evaluation program.

2. *It is relatively easy to understand.* This advantage may be expected to decline in importance as executives gain familiarity with the so-called scientific approaches to decision making.

3. *Under certain conditions the payback reciprocal can serve as a reasonable approximation of a project's time-adjusted rate of return.* However, these conditions are so limited (projects must have relatively long economic lives—at least twice the payback period—and fairly stable earnings[2]) that use of the payback period reciprocal to measure project profitability should be highly selective. Probably its most advantageous application is as a means of quickly eliminating from consideration projects that obviously do not meet predetermined discounted profitability standards.

4. *Some businessmen believe that projecting cash flows more than a few years into the future involves too much uncertainty to incorporate in a useful measure of project acceptability.* As Neil W. Chamberlain explains, "The primary difficulty is that estimation of income receipts beyond a three- to five-year period strikes most managers as too problematical to be meaningful. Whether competing products will have ruled this one off the market, whether technological advances will have stripped this process of its present advantages, whether consumer tastes will sustain the present price structure, whether intensified competition will have shaved profit margins, whether a geographical shift in markets will undermine a present entrenched position — these and other unknowns make the procedure of giving specific values to such considerations not only speculative but a little foolish to many managements."[3]

5. *Risk-conscious businessmen probably have stronger liquidity preferences than economists generally acknowledge.* Strong liquidity preferences, like reluctance to engage in longer-term projections, find their basis in the uncertain nature of future outcomes. Uncertainty thus influences businessmen to sacrifice some profitability in favor of projects that offer prospects of an early return of investment outlay. Payback period does emphasize the liquidity aspect of the investment decision. According to an executive of a major oil company, "With the passage of time, there are increasing possibilities of obsolescence in product design or equipment, of deviations from the original estimates of income and operating costs, and of changes in competitive conditions. Payout figures are useful measures of risk, because they show the length of time for which the original capital investment is exposed to these hazards."[4]

These last two reasons for payback period's popularity carry considerable weight. The businessman's necessary preoccupation with time risks and liquidity as well as with profitability indicates that some refinement of the payback period criterion may in fact serve a useful role in capital investment decision making. However, even as an index of liquidity and time risk, the conventional calculation of the payback period has serious shortcomings. As a means of overcoming these limitations, an alternative concept of payback period is proposed, namely, the discounted payback period.

Opportunity investment rate

The conventional payback period measures the length of time it will take to recover the absolute investment outlay. While such a measurement may have great intuitive significance to the capital investment decision maker, it neither considers the costs a company must incur to obtain and sustain capital nor the existence of alternative investment opportunities. In the language of capital budgeting, the conventional payback ignores the company's "cost of capital."

In the context of capital budgeting, the cost of capital is generally regarded as the minimum rate of

Calculation of Discounted Payback Period and "Profitability Index"*

Period (year)	(1) Investment Outlay	(2) Incremental Cash Flow	(3) Present Value of $1 Discounted at 15%	(4) Present Value of Incremental Cash Flow = (2) x (3)	(5) Cumulative Present Value of Incremental Cash Flow	(6) Percent Investment Recovery = (5) ÷ (1)	
t_0	$100,000						
t_1		$20,000	$ .8696	$17,392	$ 17,392	17.39	
t_2		30,000	.7561	22,683	40,075	40.08	
t_3		50,000	.6575	32,875	72,950	72.95	
t_4		30,000	.5718	17,154	90,104	90.10	
t_5		20,000	.4972	9,944	100,048	100.05	Discounted Payback Date
t_6		10,000	.4323	4,323	104,371	104.37	
t_7		10,000	.3759	3,759	108,130	108.13	Profitability Index

*cash flows received at end of period

EXHIBIT I

return for accepting projects. Let us consider two distinct cost-of-capital rates — the borrowing rate and the lending rate. Horngren distinguishes between the two as follows: ". . . the 'borrowing' rate — the weighted-average rate that a company must pay for long-run capital. This is an indicator of the overall minimum return that the company must earn if the stockholder's rate of return is going to be maintained. It is stockholder-oriented inasmuch as it is determined by market prices, which in turn are influenced by the investor's opportunities. The lending rate is basically an opportunity-cost concept; it is the rate that can be earned on alternative investments having a like degree of risk. It is the investment rate, which varies with risk, that should be used for purposes of discounting future cash flow to the present. . . ."[5]

While these two rates are often used interchangeably in the literature, each serves a distinct purpose. The borrowing rate is properly employed in measuring the expected cost of new capital. The lending rate, on the other hand, is the appropriate rate for discounting future cash flows to the present. This is particularly true when the lending rate exceeds the borrowing rate. From a purely economic standpoint, a management would be hard pressed to justify the authorization of projects within the company when greater returns on "like-risk" equity investments outside the company are available. A company using the borrowing rate as the minimum return when the lending rate is significantly higher probably will find its shareholders shifting to the same higher-yielding equity investments whose rates of return the company should be using as a minimum standard for its own capital projects. The lending rate or, as it will be referred to hereafter, the "opportunity investment rate" is the appropriate rate for discounting cash flows.[6]

Discounted payback period

Let us now relate the "opportunity investment rate" notion to payback period measurement. The conventional payback period calculation clearly fails to consider a company's cost of capital. To contend that the conventionally measured payback date is the breakeven date for a given project is tantamount to suggesting that capital is obtainable without cost. A more reasonable approach is suggested by the discounted payback period criterion.

The discounted payback period is the length of time it takes a project's incremental cash flows discounted at the "opportunity investment rate" to accumulate to investment outlay. Only at the end of this period is the breakeven claim one with economic substance, for this is the length of time it takes project proceeds (reinvested at the "opportunity investment rate") to accumulate to a sum equal to the investment outlay compounded at the "opportunity investment rate" over the same period. Then, and only then, has the project broken even with respect to alternative investment opportunities of like degree of risk. The technique of calculating discounted payback period and its significance as a measure of time risk and liquidity can be best demonstrated by means of an illustration.

Example

Consider a contemplated project with a required initial outlay of $100,000 and forecasted incremental cash flows during its estimated seven years of economic life as fol-

Comparison of Compounded Values of $100,000 Invested at "Opportunity Investment Rate" vs. Project's Incremental Cash Flows Reinvested at "Opportunity Investment Rate"*

Period	(1) Investment outlay	(2) Incremental Cash Flow	(3) $100,000 Invested in Project yielding 15%	(4) Incremental Cash Flows Reinvested at 15%
t_0	$100,000		$100,000	———
t_1		$20,000	115,000	$ 20,000
t_2		30,000	132,250	53,000
t_3		50,000	152,087	110,950
t_4		30,000	174,900	157,592
t_5		20,000	201,135 Discounted Payback Date	201,230
t_6		10,000	231,305	241,415
t_7		10,000	266,000	287,627

*cash flows received at end of period

EXHIBIT 2

lows: $20,000; $30,000; $50,000; $30,000; $20,000; $10,000; and $10,000, respectively. Within the framework of the conventional payback period calculation, the decision maker may well conclude that the initial investment will be recovered in three years and that at that point the firm has achieved a breakeven position. This is, of course, a grossly misleading notion, since it is based on the false premise that there are no alternative, productive uses for the invested capital.

Calculation

Assume that the company considering this project perceives its "opportunity investment rate" to be 15 per cent. Thus, for the project under consideration 15 per cent is the minimum acceptable rate of return and the relevant rate for discounting incremental cash flows. The discounted payback period calculation is presented in Exhibit 1 on page 32. Note that the discounted payback period for the project under consideration is five years, as contrasted with three years under the conventionally calculated payback period. Note also that at the end of three years the company will have recovered only 73 per cent of its original investment, not 100 per cent as suggested by the conventional payback calculation.

The discounted payback period may be viewed alternatively as the length of time it takes for a project's incremental cash flows reinvested at the "opportunity interest rate" to accumulate to a sum equal to the investment outlay compounded at the same rate and over the same period. This approach to the discounted payback period calculation[7] is illustrated in Exhibit 2 above. Note that the compounded project cash flows (Column 4) do not begin to exceed the compounded initial investment (Column 3) until the end of the fifth year. At that point they are $201,230 and $201,135, respectively. Thus, we see that identical answers are gained from these two methods of calculating discounted payback period.

Advantages

The advantages of replacing the conventional payback measurement with the discounted payback period criterion are compelling. The principal ones are as follows:

1. Discounted payback period represents a significantly improved criterion for the measurement of project time risk, i.e., the length of time for which the original capital investment is exposed to economic hazards, because it recognizes the productivity of capital and consequently the time value of money.

It is important to emphasize, however, that the discounted payback period is not a substitute for profitability measurements. Clearly, organizations that now employ only the conventional payback for evaluating investment acceptability can only stand to improve the basis for their decisions. Nevertheless, the proper role for the discounted payback period analysis is as a supplement to profitability measurements. In this case it might be used as a measure of relative time risk.

2. The discounted payback measurement allows management to compare the rate of a project's discounted (at "opportunity investment rate") cash flows with its own subjective time preferences for "accept or reject" decisions.

Assume, for example, that for a given class of investments management establishes 15 per cent as the minimum acceptable rate of return, i.e., 15 per cent is the "opportunity

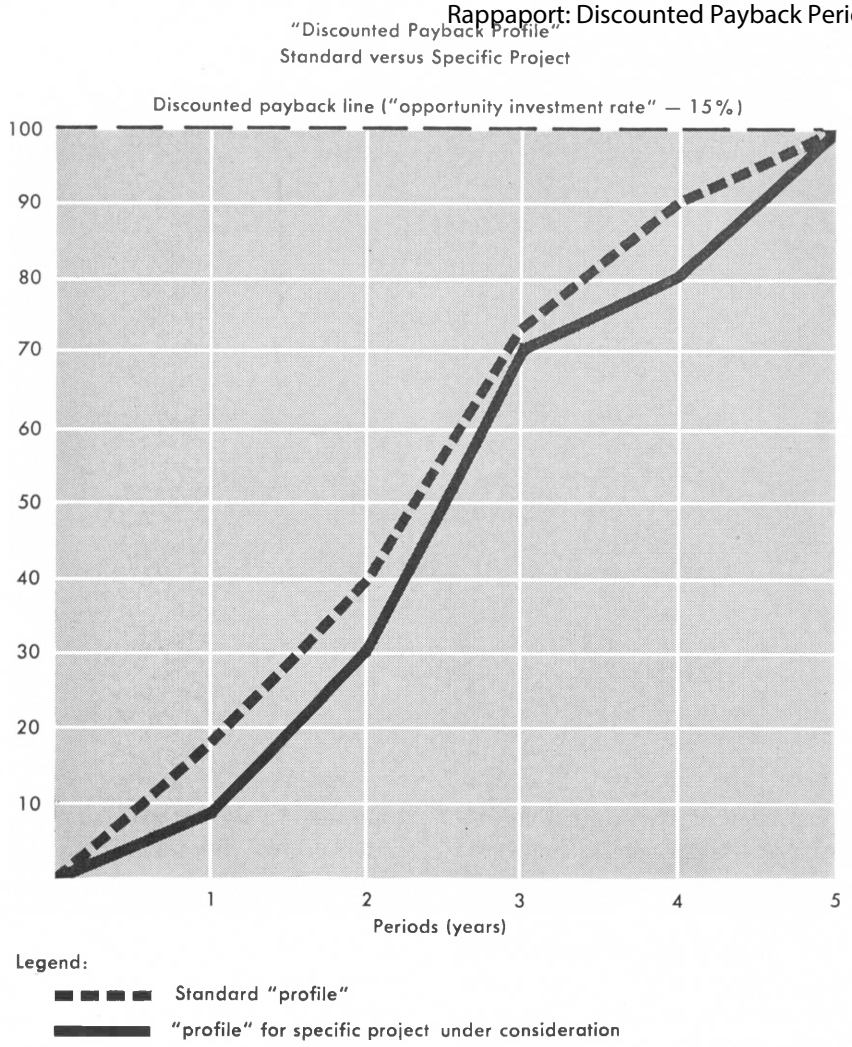

EXHIBIT 3

investment rate." In addition, management requires a discounted payback period not exceeding five years. Consider a given project that exceeds the minimum rate of return by only a marginal rate and has a discounted payback period of just under the maximum acceptable of five years. Management remains undecided regarding the desirability of investing in this project. The discounted payback data provide management with yet another criterion that may be useful in influencing the ultimate decision — "the discounted payback profile." Managerial time preferences may be represented by a minimum acceptable "discounted payback profile" illustrated in Exhibit 3 above. Note that in this example cumulative discounted cash flows are required to be at least 10%, 30%, 70%, 80%, and 100% of investment outlay at the end of each year, respectively. Note also in Exhibit 3 that the project illustrated in this paper has an acceptable 17%, 40%, 73%, 90%, and 100% "profile" (see Exhibit 1, Column 6, for the source of these percentages). It is acceptable because at the end of each year its cumulative capital recovery rate exceeds management's standard.

The "discounted payback profile" may also be a useful supplemental criterion for deciding between two or more mutually exclusive proposals. Consider, for example, two projects under consideration, only one of which can be undertaken. Each project is expected to attain the 15 per cent minimum acceptable rate of return and maximum five-year discounted payback standards. In fact, according to the best available forecasts, each project will better the minimum standards by comfortable but identical margins. Which project should be selected? The "discounted payback profile" criterion may be instrumental in resolving this question. The "profiles" for the hypothetical projects under consideration are as follows: Project A—20%, 50%, 75%, 90%, 100%; Project B—0%, 0%, 10%, 30%, 100%. While both projects have identical net present values and discounted payback periods, Project A can be expected to promote greater liquidity while reducing the magnitude of the time risk. Nonfinancial factors excluded, the selection of Project A in preference to Project B is indisputable.

The "discounted payback profile" is a simple yet effective means of dealing with the liquidity or time preference problem. The need for such a tool is clearly indicated in Chamberlain's succinct statement regarding the role of management time preferences in capital investment analysis, "A project which gives rise to small returns in the near future, building up very substantially in the more distant future, is discounted at the same objective rate as one which may return larger sums in the near term and virtually nothing later. If their present value is the same, or if their flows discount to the same rate, they are viewed as equally preferable. From the point of view of most businessmen, however, there would in fact be a clear-cut preference for the second investment, which yielded its cash returns more quickly. This is not because they fail out of ignorance to give adequate consideration to the future, but because their own subjective time preference—based on the uncertainty and riskiness of the future — leads them to that result. The economist may question their judgment, but only in the same way he might question consumer tastes. He would be on sounder ground in accepting their time preference and building it into his formulations.[8]

3. The discounted payback criterion is consistent with discounted

cash flow profitability measurements, whereas the conventional payback is not. The two principal variations of the discounted cash flow method, discounted rate of return and present value, reflect the time value of money, as does the discounted payback period. Use of the conventional payback in conjunction with one of the discounted cash flow variations results in inconsistent criteria. The integration of these two criteria in a single investment decision is tantamount to denying while simultaneously upholding the time value of money.

4. Discounted payback can easily be integrated with discounted cash flow profitability measurements, particularly the present value approach. In brief, the present value method involves selecting a minimum acceptable rate of return, i.e., the "opportunity investment rate," and discounting both investment outlays and incremental cash flows to the present. If the present value of incremental cash flows exceeds the present value of investment outlays, then the project is rated as potentially acceptable. Under the present value approach some companies compute the "profitability index" for each project as a measure of relative profitability among competing projects. The "profitability index" is simply the ratio of the present value of incremental cash flows to the present value of the required investment outlay.[9]

The hypothetical project presented in Exhibit 1 makes the relationship between discounted payback and the present value approach very evident. In fact, the reader will now note that Exhibit 1 is actually an illustration of the present value approach and its logical by-product, the discounted payback period measurement. The first six figures in Column 6 represent intermediate measures of capital recovery and the final figure, 108.13, the project's "profitability index." The intermediate measurement at the end of the fifth year, 100.05, indicates that at that point the project has broken even in the opportunity sense or that the discounted payback period for this project is just under five years. Companies currently employing the present value approach can calculate the discounted payback period as well as the "profile" with little or no extra effort, and consequently, can use all three criteria to produce a financial plan that balances profitability, liquidity, and time risk.

Organizations wishing to integrate their investment planning and cash forecasting activities may prefer the second method of calculating discounted payback as illustrated in Exhibit 2. In this case, the "profitability index" can be easily calculated from the data present. If Column 3 exceeds Column 4, the project yields less than the "opportunity investment rate" and is therefore unacceptable. If the project is acceptable, the excess of Column 4 terminal value ($287,627) over Column 3 terminal value ($266,000), discounted to the present at the "opportunity investment rate," will yield an amount equal to the excess of the present value of project cash flow over required investment outlay. This calculation is summarized in Exhibit 4 below. [For those readers who are interested, a demonstration of the mathematical derivation of this approach to calculating excess present value is available from the author.]

Summary

Despite the fact that the conventional payback criterion is not a measure of profitability, it remains the most commonly employed financial measure of project acceptability. Its popularity is mainly attributable to its simplicity, to the belief among some businessmen that it is futile to project cash flows beyond three or four years, and, finally, to the strong liquidity preferences of many businessmen.

Liquidity and time risk, as well as profitability, are important factors to be incorporated into investment decisions. The conventional payback, however, does not yield a meaningful, reliable measurement of time risk. Its failure can be traced to the fact that it ignores alternative investment opportunities of the firm and, consequently, the time value of money. This results in an underestimate of a project's time risk, i.e., the length of time for which the original capital investment is exposed to economic hazards.

The discounted payback criterion overcomes this basic failure and is

EXHIBIT 4

Profitability Index Calculation
(Alternative Method)

Terminal value of incremental cash flows reinvested at "opportunity investment rate" (15%)	$287,627
Terminal value of required investment amount ($100,000) invested at "opportunity investment rate" (15%)	266,000
	$ 21,627
Present value of $1 to be received at the end of 7 years and discounted at 15%	.3759
Excess present value	$ 8,130

$$\text{"Profitability index"} = \frac{\text{Required investment} + \text{Excess present value}}{\text{Required investment}}$$

$$= \frac{100{,}000 + 8130}{100{,}000}$$

$$= 108.13$$

a greatly improved measurement of project time risk. The calculation of the discounted payback period also yields a "profile" from which management can incorporate its subjective time preferences into investment decisions. Beyond its measurement virtues, the discounted payback period can be gained at bargain prices for it is an informational by-product of discounted cash flow profitability measurement. Because it is so demonstrably superior to the conventional payback criterion, I believe it should become a widely – and profitably – applied tool in capital investment analysis.

Footnotes

[1] A number of recent studies show that payback period continues to be a widely used measure of acceptability for capital projects. A National Industrial Conference Board study of 346 manufacturing companies found payback period to be the most commonly employed financial measure for evaluating capital projects (Norman E. Pflomm, *Managing Capital Expenditures,* Business Policy Study No. 107, National Industrial Conference Board, Inc., New York, 1963, p. 42). Donald F. Istvan, in a study designed to ascertain how "big business" decides to invest in capital projects, found that only 7 of 48 companies recognized the time value of money in their analyses. These 48 companies expended more than $8 billion for plant and equipment in 1959, almost 25 per cent of the aggregate $33 billion recorded by the Department of Commerce for that year (Donald F. Istvan, "The Economic Evaluation of Capital Expenditures," *The Journal of Business,* January, 1961, p. 45). Similar results were reported in James H. Miller's survey of 127 replying companies selected from the American Institute of Management's *Manual of Excellently Managed Companies* and *Fortune's* list of the 500 largest industrial companies. Only 38 of the 127 companies employed evaluation methods recognizing that a dollar received or disbursed in the future is not the value equivalent of a dollar received or disbursed today (James H. Miller, "A Glimpse at Practice in Calculating and Using Return on Investment," *N.A.A. Bulletin,* June, 1960, pp. 72-73).

[2] Myron J. Gordon, "The Payoff Period and the Rate of Profit," *Journal of Business,* October, 1955, pp. 253-260.

[3] Neil W. Chamberlain, *The Firm: Micro-Economic Planning and Action,* McGraw-Hill Book Company, New York, 1962, p. 270.

[4] John G. McLean, "Measuring the Return on Capital–Relating Calculations to Uses," *N.A.A. Bulletin,* Sec. 3, September, 1960, p. 35.

[5] Charles T. Horngren, *Cost Accounting –A Managerial Emphasis,* Prentice-Hall, Inc., Englewood Cliffs, N.J., 1962, p. 615. A more detailed discussion of the "borrowing rate" versus the "lending rate" may be found in Harry V. Roberts' "Current Problems in the Economics of Capital Budgeting" in Ezra Solomon's *The Management of Corporate Capital,* The Free Press of Glencoe, Illinois, 1959, pp. 198-202. For consideration of these rates under varying degrees of capital rationing see Harold Bierman, Jr., and Seymour Smidt, *The Capital Budgeting Decision,* The Macmillan Company, New York, 1960, pp. 162-170.

[6] A company may well employ several "opportunity investment rates" with increasing rates as the risks involved in investment projects increase. Multiple cutoff rates represent but one method of coping with risk and uncertainty. The application of probability concepts to capital budgeting calculations is surely one of the most significant developments of recent years. It is not feasible to discuss probability applications in this article. However, the discounted payback principle is susceptible to such applications. Indeed, as probability statements enhance the basis for projecting cash flows, discounted payback period calculations improve correspondingly. Those interested in the applicability of probability concepts to capital budgeting are referred to Edward G. Bennion, "Capital Budgeting and Game Theory," *Harvard Business Review,* November-December, 1956, pp. 115-123; Bierman and Smidt, *op. cit.,* Chapter 9; and David B. Hertz, "Risk Analysis in Capital Investment," *Harvard Business Review,* January-February, 1964, pp. 95-106.

[7] I am endebted to my colleague, Professor James T. Murphy of Tulane University, for suggesting this alternative approach to the discounted payback period calculation.

[8] Chamberlain, *op. cit.,* pp. 274-275.

[9] The discounted rate of return and present value approaches may rank projects with unequal lives differently. This is explained by their differing assumptions regarding the rate of return on cash proceeds reinvested at the end of the shorter project's life. The present value approach assumes that cash proceeds can be reinvested at the discount rate. The discounted rate of return approach makes the implicit assumption that the reinvestment rate is equal to the rate indicated by the project itself. Solomon, *op. cit.,* p. 127, demonstrates that there will always be a consistent ranking of projects if explicit assumptions with respect to reinvestment rates for funds are made up to the terminal date of the longer-lived project. The "profitability index" must be used with great care since under certain circumstances it will yield project rankings that contradict rankings based on the excess present value approach. For an exposition of this problem see William Beranek, "A Note on the Equivalence of Certain Capital Budgeting Criteria," *The Accounting Review,* October, 1964, pp. 914-916.