PAYBACK SUBSTITUTES FOR DISCOUNTED CASH FLOW

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The logical soundness of discounted-cash-flow (DCF) procedures for analyzing corporate asset investment opportunities has been well established in the financial management literature of the last two decades. The "time value of money" notion of opportunity cost which is embodied in the calculation of project cash flow present values is so eminently consistent with the exigencies of corporate use of shareholders' scarce capital resources as to admit of little serious argument as a matter of principle.

Despite that fact, the adoption of—and enthusiasm for—DCF approaches in actual business operating settings has not been particularly impressive. Periodic survey investigations reveal that only a minority of industrial enterprises use DCF techniques extensively, or they do so except at relatively high levels within the capital expenditure decision-making process [1, 3, 4, 5]. Businessmen seem to feel (1) that the requisite calculations are overly complex, (2) that they imply a degree of precision which is in fact uncharacteristic of many investment opportunities, and (3) that they are difficult to communicate effectively to the lower levels of the organization where a sizeable proportion of the firm's investment decisions are actually made. Instead, rule-of-thumb criteria such as the venerable "payback period" continue in widespread use.

On the one hand, we acknowledge and sympathize with these very legitimate managerial reservations. On the other, however, we would argue that better decisions are likely to be made by a company when an analytical framework in harmony with the tenets of discounted cash flow is employed, even if the ambiguities and uncertainties of real-world circumstances must still be confronted. Accordingly, our objective here is to suggest an investment evaluation strategy which we believe has the potential for effectively balancing the goals of administrative practicality, ease of communication, and theoretical soundness. It involves, in its essence, a simple translation of DCF criteria for project acceptability into a set of equivalent payback-period tests which can then be disseminated to the corporate organization for everyday use. Specifically, it should be possible to develop and communicate a profile of payback criteria which will generally produce in application the same accept-reject and ranking decisions about projects that a DCF approach would produce. If so, as we shall contend, the business firm can to a considerable extent have something of the best of both worlds in its investment selection activities.

Analytical Framework

The methodology for achieving the relevant translations is quite straightforward. The standard formula for the after-tax net present value of an investment proposal is the following:

$$NPV = \frac{C_1(1-t) + tD_1}{1+r} + \frac{C_2(1-t) + tD_2}{(1+r)^2} + \dots$$
$$\dots + \frac{C_n(1-t) + tD_n + S}{(1+r)^n} - I, \tag{1}$$

where C_i refers to the pre-tax operating cash flow benefits anticipated in year i from the project; t denotes the pertinent corporate income tax rate; D_i represents the depreciation charges which can be claimed for tax purposes in year i; n is the number of years of project life; S is the net after-tax salvage value expected in year n; I is the initial capital expenditure required; and r specifies the annual percentage rate of return which the firm requires its investment opportunities to earn in order to be acceptable—i.e., its "cost of capital". By the indicated criterion, projects whose estimated net present values are clearly positive would be undertaken, and those with NPV's equal to zero would be considered marginal—decisions on the latter to be made on other grounds of perceived need and desirability. In the case of such "break-even" proposals, the formula above can be rearranged to read:

$$I = (1-t)\left[\frac{C_1}{1+r} + \frac{C_2}{(1+r)^2} + \dots + \frac{C_n}{(1+r)^n}\right]$$
$$+ (t)\left[\frac{D_1}{1+r} + \frac{D_2}{(1+r)^2} + \dots + \frac{D_n}{(1+r)^n}\right] \tag{2}$$
$$+ \frac{S}{(1+r)^n}.$$

In this form, it expresses the notion that a project which is on the edge of acceptability must promise to generate future operating cash flows, depreciation tax savings, and potential salvage recoveries whose combined discounted worth just matches the initial capital outlays required.

The key elements in that appraisal, obviously, are the stream of $C_1, C_2, \dots, C_n$ values anticipated. The corporate tax rate is a legislative parameter; the hurdle rate, r, is a senior managerial policy decision. Depreciation charges are fixed by IRS stipulation within constrained bounds, and salvage values are an external second-hand-asset market phenomenon. Hence, the primary determinant of project attractiveness is the analyst's forecast of the operating cash flows. A sequence large enough to make the right-hand side of the expression above add up to a number greater than I defines a "good" project in DCF terms.

The significance of that observation for our purposes here, of course, is that precisely the *same* sequence is used to measure the payback period for the project. Accordingly, there is necessarily a one-to-one translation of the underlying test of DCF acceptability into a counterpart payback test within a given situation of project economic life and general cash flow pattern. Our suggestion, therefore, is that a firm can make convenient use of this correspondence merely by establishing the payback criteria it conveys to lower-level management, in a way which ensures that projects which meet or exceed those payback hurdles automatically satisfy DCF conditions for desirability as well. In this manner, the simplicity of payback can readily be exploited to yield decisions in a decentralized organization commensurate with the inherent logic of present value appraisals as they would be applied by senior management.

The Computational Process

As an illustration, consider the case of a category of investment proposals within an enterprise for which five-year productive lives are foreseen, for which terminal net salvage values commonly amount to 25% of the initial outlays made, and which embody a start-up period such that the first year of operations typically produces cash flows only half as large as those which ensue during each of the remaining years of activity. Assume the firm at issue uses the sum-of-years-digits depreciation schedule, confronts a 48% corporate tax rate, and insists upon a 10% after-tax rate of return on all new capital investments.

A project in the indicated category which promises, say, a \$500 first-year operating cash benefit, therefore, will be expected to have associated with it the stream of cash flows portrayed in Exhibit 1. The inflows created by depreciation tax savings and salvage are direct functions of the initial cost of the project, I, as shown. Since I is the only "unknown" in the tabulation, we can determine that value for it which would render the proposal *just* marginally acceptable in the DCF sense of having a zero net present value. In this instance, the requisite figure is $3788, which is to say that the corporation should insist that the proposal in question cost no more than $3788 if it is to be undertaken. If, however, it is any less expensive, it *is* a desirable project by the established standards.

There are two important corollaries to this observation. The first is that the break-even value for I turns out always to be precisely the same *multiple* of the operating cash flow benefits anticipated from investments of the designated sort, regardless of how large in *absolute* dollar terms we posit those benefits to be. Thus, if we had instead projected C_1 to be $2500 and C_2 through C_5 to be $5000, the implied zero-NPV maximum initial outlay would have come out to $18,940, or again, exactly 7.58 times C_1. Within a specified investment-life and operating-earnings profile, therefore, the proportionate DCF test for acceptability is completely independent of project size. Obviously, it could also be expressed as a fixed multiple of the annual operating cash flows expected for years two through five as well.

The second and complementary point is that the corresponding payback period test is similarly size-independent. A project in the stipulated category will inevitably appear desirable *in DCF terms* as long as its prospective payback interval does not exceed 4.29 years. By that time, the expected cumulative pre-tax operating earnings of $500 in year one, plus $1000 each in years two through four, plus 290/1000 of the $1000 in year five, will provide a "recovery" of the project's initial cost, by the usual payback definition. For our alternative example proposal five times as large but having the same earnings time shape, the first-year, $2500, second-year, $5000, and so on, also offer a 4.29-year payback potential.

If, then, any investment in this category promises a more rapid income recovery—i.e., if its likely operating earnings are larger relative to the required initial outlay than the payback standards indicated—its associated net present value must necessarily *also* be positive. Acceptability by one test within a given class of investments automatically implies acceptability by the other. A firm's top management can, therefore, prescribe *either* criterion for use by the organization and achieve the same correct set of project selection outcomes. It need only be able to specify a sufficient range of investment earnings-time-shape classifications that most proposals can be classed in standard groupings. In this fashion, the firm can have substantial confidence that it is get-

Exhibit 1. Breakeven Discounted-Cash-Flow Analysis of a Hypothetical Investment Proposal

Year, i	PV factor at 10%	Operating cash flows $C_i\,(1-t)$	PV	Depreciation tax savings* tD_i	PV	Net salvage value** S	PV
1	0.909	$ 500 (.52)	236	$ (.48)(5/15)(I)	.145I	–	–
2	0.826	1000 (.52)	430	(.48)(4/15)(I)	.106I	–	–
3	0.751	1000 (.52)	391	(.48)(3/15)(I)	.072I	–	–
4	0.683	1000 (.52)	355	(.48)(2/15)(I)	.044I	–	–
5	0.621	1000 (.52)	323	(.48)(1/15)(I)	.020I	$(.25)(I)	.155I
Project totals			$1735		.387I		.155I

Thus, for a *zero* net present value, the condition is:

$$I = 1735 + .387I + .155I, \text{ or } I = \$3788$$

*According to an SYD depreciation schedule, for an initial investment of size I.

**Estimated equal to 25% of the initial investment outlay.

ting the DCF results it would like without the need for an extensive re-education program to get everyone tooled up actually to do the DCF calculations.

Clearly, there will remain some slippage. Not all possible projects can be fit neatly into predetermined categories, nor will the cash flow profile of those categories be met precisely in every detail, even when the broad pattern seems a good match. It would be unrealistic to expect as much. Nonetheless, some very significant moves in the direction of rationalizing the capital expenditure selection function, while maintaining a high degree of computational simplicity, do seem possible with only a modest initial staff effort. Decentralized decision-makers can be given quite compact tabulations of appropriate payback tests which they can readily apply. Indeed, the imposed need for them in such a context to make explicit estimates of the three key individual-project profitability elements—economic life, salvage value, and probable earnings pattern—should itself lead to benefits in systematizing the organization's approach to investment opportunities. Any procedure which demands a higher standard of care in the underlying estimating process can only improve the decisions which emerge.

Tabulating the Criteria

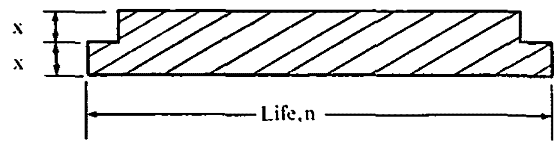
In order to create the relevant set of transformations, of course, the firm in question must establish some ground rules. Of prime importance is the choice of such computational parameters as the DCF hurdle rate (cost of capital) that defines the company's minimum requirement for investment return. Also of great importance is the depreciation schedule it plans to employ for tax—not necessarily reporting—purposes. Both of these, however, are senior management issues about which little need be said here, and in connection with which complete freedom of specification is available. Similarly, the exact variant of payback period which the investment analyst might be asked to calculate is also a discretionary policy decision. The most common form in use is the one adopted above—i.e., the number of years until *pre-tax* operating earnings, ignoring depreciation, recover the project's initial outlay. But regardless of the format preferred, a one-to-one conversion of zero-net-present value conditions into counterpart payback maxima can be achieved.

The sorts of benchmark decision criteria which might thereby be generated for lower-level management are illustrated in Exhibit 2. These standards pertain to an operating-benefit pattern of the form indicated at the top of the exhibit. Thus, investments to be judged against the payback tests listed are any which are thought to promise a two-year initial buildup to a steady long-run level of earnings, followed by a two-year decline to zero at the end of their useful lives. In the case at hand, the stipulation is that the steady-state flows involved be *twice* the first and last-year values. Tabulations are offered for after-tax DCF hurdle rates of both 6 and 10%, in order to provide a feel for the impact of different such rates on the resulting payback standards. In practice, however, a single cost of capital would very likely be selected by top management for communication down the line. Given that choice, the payback period which implies an NPV equal to zero for a project is dependent entirely on the project's economic life and net salvage value—the latter expressed most conveniently as a percentage of the initial capital outlay incurred (salvage "values", of course, could on occasion be negative if the project in question required clean-up expenditures at its termination). To make use of the exhibits, therefore, the decision-maker need only estimate these two features of the proposal and then compare his computation of its payback period to the corresponding "critical value" obtained from the exhibit. A project in the category under consideration which had a ten-year forecast life but no probable salvage recoupment would, for example, have to show a prospective payback period of less than 4.81 years in order to be acceptable to an enterprise which perceived its opportunity cost of capital to be 10%. Failure to meet that test inevitably means failure to meet the underlying—and precisely equivalent—DCF test of at least a zero net present value.

The pattern which the tabulated payback maxima display has strong intuitive support. Cash flows have to be larger relative to project capital expenditures (i.e., the payback period must be shorter), the higher the DCF return on investment required by the firm. Thus, each of the surrogate payback hurdles for the 10% cost-of-capital case is more exacting than its 6% counterpart, due to the corresponding greater severity of the DCF test on which it is based. Conversely, the longer the anticipated economic life of a proposal, the more *relaxed* can be the associated payback standard of acceptability. A project which will produce earnings for 15 years obviously need not have such large early returns as a competing proposal of similar size and earnings time-shape having only a 5-year forecast life. Finally, and equally logically, if a longer pay-

Exhibit 2. Minimum Payback Period Criteria Consistent With Zero Net Project Present Values

Time Pattern of Project Operating Earnings:



Parameters: 48% corporate tax rate
SYD tax depreciation schedule

A. Minimum payback standard (years) to match 6% cost of capital

Project life, n (years)	For project salvage value of: 0%	10%	25%	50%
5	3.52	3.97	5.00	5.00
10	6.08	6.64	7.71	10.00
15	7.75	8.25	9.15	11.20
25	9.57	9.88	10.39	11.38

B. Minimum payback standard (years) to match 10% cost of capital

Project life, n (years)	For project salvage value of: 0%	10%	25%	50%
5	3.07	3.36	3.94	5.00
10	4.81	5.07	5.54	6.57
15	5.69	5.88	6.17	6.76
25	6.33	6.40	6.51	6.71

Note: Salvage values expressed as a percentage of project initial cost.

back period can be countenanced, the greater is the probable terminal salvage worth of the investment.

While all these phenomena make eminent sense, they also are precisely the elements of a project's character which ordinary payback tests *ignore*. It is the nature of those tests to render irrelevant both the time value of money and all flows beyond the payback interval, whether the latter be operating earnings or salvage amounts. A compelling virtue of the framework we propose, therefore, *is* its explicit recognition of these important investment components, without an attendant sacrifice of computational convenience.

Variations on the Theme

An additional virtue, of course, is a high degree of flexibility. The payback definition employed in setting up the tabulations for the operating manager could, as was suggested earlier, take on any alternative form—e.g., the number of years until reported earnings, net of taxes and depreciation, provide a recovery of initial costs, or perhaps the number of years until actual cash flows provide such recovery, to name but two. There is no particular magic in any of these definitions, nor in the one we used above; all can be accommodated. Moreover, the analysis and the tabulations could be cast in terms of some *ad hoc* index other than payback period. A transformation of DCF standards into "accounting rate of return" equivalents, for instance, would be equally feasible.

Potential variations on the other constituents of the process abound. For purposes of Exhibit 2, the initial capital outlay for each project was depreciated to zero over its indicated expected economic life, even if some salvage value was anticipated. Clearly, the analysis could be modified to prescribe depreciation down only to salvage value rather than to zero—or to permit depreciation lives based on standard IRS guidelines instead of on probable economic lives.

Certain items of cash flow which were omitted from the calculations portrayed above could be introduced as well. We did not, for example, include an allowance for any changes in working capital requirements which might have been associated with the projects considered. Such changes in inventory, cash balance, or accounts receivable needs are elements in a proper DCF evaluation and would, therefore, affect the resulting payback-equivalent hurdles. Again, standard assumptions about the amounts involved or additional tabulations permitting the specification of those amounts as extra input parameters in the individual project case can be made a part of the analysis. Likely expenditures on periodic mechanical overhauls or uneven maintenance costs are further candidates for separate inclusion. The firm, in short, need only define the dimensions of its ongoing investment-opportunity circumstances, and that scenario, however peculiar it might be, can be reflected accurately in a set of calculations which still resolve the whole problem into a simple array of maximum payback criteria for dissemination to the organization.

Capital Rationing

Those criteria, moreover, need not necessarily be constructed around DCF tests of *zero* project net present values. In particular, if a corporation felt itself to be short of the financial resources which permit all available profitable investment opportunities to be exploited (apparently not an uncommon situation), it could establish a rule that no proposals be accepted unless they promise a cash inflow present value, say, 25% *in excess* of initial capital outlay requirements. In this manner, the notion of a "marginal" individual project could be made more stringent to recognize the impact of the firm's over-all budget constraints (albeit we acknowledge that such a procedure is only an imperfect substitute for the explicit comprehension of budget limitations in a rationing situation [2]). More importantly in the current context, however, there remains a one-to-one correspondence between payback-period and DCF acceptance standards even when a positive present value is demanded. The proposal whose operating-earnings potential was identified in Exhibit 1, for example, would be justified for inclusion in the capital budget of a company which insisted on a 25% excess net present value payoff only if the investment met the condition that

$$1.25I = 1735 + .387I + .155I, \tag{3}$$

which would imply a maximum acceptable initial capital outlay of $2451 and a matching payback period of no more than 2.95 years. The DCF-into-payback translation, therefore, is no less unique—and no less independent of project absolute size—for underlying present value standards other than zero.

Risk Analysis

A final aspect of the suggested strategy deserves mention. One of the key problems surrounding capital expenditure decisions in practice is, of course, the uncertainty attached to many of the cash flow estimates which comprise the inputs to the evaluation process. Here again, the payback tabulations we advocate can frequently be of help, by providing the analyst with some appreciation for the sensitivity of his decision to alternative possible forecasts.

As an illustration, let us suppose that a division manager calculates the payback period of a proposed investment to be three years, based on his best early-year operating earnings estimates, but that he is unsure of either its precise economic life or its likely terminal salvage value. Specifically, let us assume he anticipates a life of somewhere between seven and ten years, and a salvage value in the range of 10 to 25% of the initial capital outlay. If he should find in the table of payback maxima which corporate headquarters has supplied that even a seven-year project having a 10% salvage potential would be acceptable to the enterprise if it promised no more than a four year payback, he could be quite confident that the investment he has under scrutiny *does* merit adoption. Equivalently, he might identify in the same tabulation the array of economic-life/salvage-value combinations for which a three-year payback would be *just* acceptable, and appraise the likelihood that the project at hand could conceivably fall outside the indicated boundaries. With either approach, the decision-maker gains a much improved feeling for the importance, or lack thereof, of the contingencies he faces, and thereby for his room to maneuver in project selection.

All these observations build on a point made previously. By presenting the line manager with a decent tabular overview of the relevant dimensions of investment attractiveness in a form which forces him to contemplate issues of earnings duration, salvage, working capital, *et. al.*, explicitly, his grasp of the essentials of a proper decision can only be enhanced. Indeed, this inevitable "educational" payoff may alone be a sufficient justification for creating and disseminating the payback guidelines described.

Implementation

Those guidelines, of course, must be custom-fitted to the circumstances of the individual corporation. The first step would be a preliminary analysis to determine the broad earnings-time-shape categories into which the majority of the firm's investment opportunities seem to fall. The focus of such an effort would be a sampling of past projects which have arisen in the divisions or profit-center units where future capital expenditure choices will be made. An audit of this sort should make possible the identification of recurring project patterns having enough generality to permit the selection of a few standard classes for each decision-making locale in the organization, although those classes may well not be uniform across all segments of the enterprise. Once this initial staff study is made, payback maxima tabulations can be created which reflect the firm's tax, depreciation, and cost-of-capital situation, as we have outlined above. In effect, each manager with capital expenditure authority would thereupon be given several exhibits resembling an expanded Exhibit 2 against which to test the respective payback prospects of the investment opportunities he would subsequently confront.

Now, it is obvious that this framework will not eliminate all of the firm's project selection difficulties. Every conceivable future proposal will not fit exactly into one of the pre-specified standard evaluation categories, and many projects will be sufficiently large or cut across organizational lines in such a way that they will require explicit individual DCF attention at a central staff locale. Nonetheless, there are some real decision improvements attainable with much less cost than that of attempting a commensurate crash program of DCF education at all levels of the corporation. The payback tabulations are easily generated, given only a few parameters of the firm's circumstances. We have, for example, in assaying this approach, constructed an extensive array of those tabulations from a relatively simple computer program which allows a wide variety of operating-earnings time profiles, tax rates, costs of capital, salvage values, and depreciation schedules to be assumed. Once in place, the counterpart tabulations for the individual company could simply be reviewed periodically to ensure their continued relevance and revised, if necessary, to recognize any evolving changes in the underlying corporate environment. That process itself may well contribute some substantial insights into the firm's appropriate capital investment posture.

Summary

We subscribe, therefore, to the viewpoint that the logic of DCF techniques argues strongly for their application to problems of capital expenditure evaluation and selection. We sympathize, however, with the practical business considerations which have caused payback calculations to be more popular in actual use. Accordingly, our objective has been to suggest a framework for rendering the two approaches operationally equivalent. The proposal contains no dramatic theoretical breakthroughs. The technology involved is drawn entirely from received doctrine, and it will not fit every segment of every enterprise. Nonetheless, we feel it does provide some efficiencies that can in many situations have a practical payoff. In the broadest sense, it represents an effort to allow the business firm to have its DCF conceptual cake, while simultaneously consuming the flavorful portions of payback to which it is accustomed. Our recommendations are designed to improve the nutritional content of the latter.

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