Capital Budgeting: The Dominance of Net Present Value

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Executive Summary

- The time value of money is highly relevant.
- Net present value (NPV) is a very reliable method of analysis.
- Use incremental cash flows.
- NPV profile is an excellent summary.

Introduction

A capital budgeting decision is characterized by costs and benefits that are spread out over several time periods. This leads to a requirement that the time value of money be considered in order to evaluate the alternatives correctly. Although to make decisions we must consider risks as well as time value, I restrict the discussion to situations in which the costs and benefits are known with certainty. There are sufficient difficulties in just taking the time value of money into consideration. Moreover, when the cash flows are allowed to be uncertain, I would suggest the use of procedures that are based on the initial recommendations made with the certainty assumption, so nothing is lost by making the assumption of certainty.

A financial executive made the following interesting observation (Bierman, 1986):

“The real challenge is creativity and invention, not analysis. Timely execution of projects by entrepreneurial managers is also more critical than sophistication of analytical budgeting techniques.”

Rate of Discount

We shall use the term time value of money to describe the discount rate. One possibility is to use the rate of interest associated with default-free securities. This rate does not include an adjustment for the risk of default; thus risk, if present, would be handled separately from the time discounting. In some situations, it is convenient to use the firm’s borrowing rate (the marginal cost of borrowing funds). The objective of the discounting process is to take the time value of money into consideration. We want to find the present equivalent of future sums, neglecting risk considerations.

Although the average cost of capital is an important concept that should be understood by all managers and is useful in deciding on the financing mix, I do not advocate its general use in evaluating all investments. Different investments have different risks.

Dependent and Independent Investments

In evaluating the investment proposals presented to management, it is important to be aware of the possible interrelationships between pairs of investment proposals. An investment proposal will be said to be economically independent of a second investment if the cash flows (or equivalently the costs and benefits) expected from the first investment would be the same regardless of whether the second investment were accepted or rejected. If the cash flows associated with the first investment are affected by the decision to accept or reject the second investment, the first investment is said to be economically dependent on the second.

In order for investment A to be economically independent of investment B, two conditions must be satisfied. First, it must be technically possible to undertake investment A whether or not investment B is accepted. Second, the net benefits to be expected from the first investment must not be affected by the acceptance or rejection of the second. The dependency relationship can be classified further. In the extreme case where the potential benefits to be derived from the first investment will completely disappear if the second investment is accepted, or where it is technically impossible to undertake the first when the second has been accepted, the two investments are said to be mutually exclusive.

Statistical Dependence

It is possible for two or more investments to be economically independent but statistically dependent. Statistical dependence is said to be present if the cash flows from two or more investments would be affected by some external event or happening whose occurrence is uncertain. For example, a firm could produce high-priced yachts and expensive cars. The investment decisions affecting these two product lines are economically independent. However, the fortunes of both activities are closely associated with high business activity and a large amount of discretionary income for the “rich” people. This statistical dependence may affect the risk of investments in these product lines because the swings of profitability of a firm with these two product lines will be wider than those of a firm with two product lines having less statistical dependence.

Incremental Cash Flows

Investments should be analyzed using after-tax incremental cash flows. Although we shall assume zero taxes so that we can concentrate on the technique of analysis, it should be remembered that the only relevant cash flows of a period are after all tax effects have been taken into account.

The definition of incremental cash flows is relatively straightforward: If the item changes the bank account or cash balance, it is a cash flow. This definition includes opportunity costs (the value of alternative uses). For example, if a warehouse is used for a new product and the alternative is to rent the space, the lost rentals should be counted as an opportunity cost in computing the incremental cash flows of using the space.

The computations in this article make several assumptions that are convenient and that simplify the analysis:

- Capital can be borrowed and lent at the same rate.
- The cash inflows and outflows occur at the beginning or end of each period, rather than continuously during the periods.
- The cash flows are certain, and no risk adjustment is necessary.

In addition, in choosing the methods of analysis and implementation, it is assumed that the objective is to maximize the wellbeing of stockholders, and more wealth is better than less.

Two Discounted Cash Flow Methods

The two primary discounted cash flow investment evaluation procedures are net present value (NPV) and internal rate of return (IRR). We shall conclude that the net present value method is better than the other possible methods of analyzing investments.

Net Present Value

The two most important measures of investment worth are called the discounted cash flow (DCF), measures. It is desirable to explain the concept of the present value of a future sum because in one way or another this concept is utilized in both these measures.

The present value of $100 payable in two years can be defined as that quantity of money necessary to invest today at compound interest in order to have $100 in two years. The rate of interest at which the money will grow and the frequency at which it will be compounded will determine the present value. I shall assume that funds are compounded annually. Assume that we are given a 0.10 annual rate of interest. Let us examine how the present value of a future sum can be computed by using that rate of interest.

Suppose that an investment promises to return a total of $100 at the end of two years. Because $1.00 invested today at 10% compounded annually would grow to $1.21 in two years, we can find the present value at 10% of $100 in two years by dividing $100 by 1.21 or by multiplying by the present value factor, 0.8264. This gives $82.64. Therefore, a sum of $82.64 that earns 10% interest compounded annually will be worth $100 at the end of two years. By repeated applications of this method, we can convert any series of current or future cash payments (or outlays) into an equivalent present value. Because tables, hand calculators, and computers are available that give the appropriate conversion factors for various rates of interest, the calculations involved are relatively simple.

The net present value method is a direct application of the present value concept. Its computation requires the following steps:

1. Choose an appropriate rate of discount.
2. Compute the present value of the cash proceeds expected from the investment.
3. Compute the present value of the cash outlays required by the investment.
4. Add all the present value equivalents to obtain the net present value.

The sum of the present values of the proceeds minus the present value of the outlays is the net present value of the investment. The recommended accept or reject criterion is to accept all independent investments whose net present value is greater than or equal to zero and to reject all investments whose net present value is less than zero.

With zero taxes, the net present value of an investment may be described as the maximum amount a firm could pay for the opportunity of making the investment without being financially worse off. If no such payment must be made, the expected net present value is an unrealized capital gain from the investment, over and above the cost of the investment used in the calculation. The capital gain will be realized if the expected cash proceeds materialize.

The following example illustrates the basic computations for discounting cash flows—that is, adjusting future cash flows for the time value of money, using the net present value method.

Assume that there is an investment opportunity with the cash flows given in Table 1.

Table 1. An investment's cash flows

		Period	
	0	1	2
Cash flow	–$12,337	$10,000	$5,000

We want first to compute the net present value of this investment using 0.10 as the discount rate. The present value of $1 due zero periods from now discounted at any interest rate is 1.000. The present value of $1 due one period from now discounted at 0.10 is 0.9091 or $(1.10)^{-1}$. The present value of $1 due two periods from now discounted at 0.10 is 0.8264 or $(1.10)^{-2}$.

The net present value of the investment is the algebraic sum of the three present values of the cash flows (Table 2).

Table 2. Present value calculations

	(1)	(2)	(3)
	Cash flow	Present value factor	Present value
Period			(col. 1 × col. 2)
0	#$12,337	1.0000	#$12,337
1	10,000	0.9091	9,091
2	5,000	0.8264	4,132
		Net present value =	**$886**

The net present value is positive, indicating that the investment is acceptable. Any investment with a net present value equal to or greater than zero is acceptable using this single criterion. Since the net present value is $886, the firm could pay an amount of $886 in excess of the cost of $12,337 and still break even economically by undertaking the investment. The net present value calculation is a reliable method for evaluating investments.

Internal Rate of Return

Many different terms are used to describe the internal rate of return concept. Among these terms are: yield, interest rate of return, rate of return, return on investment, present value return on investment, discounted cash flow, investor's method, time-adjusted rate of return, and marginal efficiency of capital. IRR and internal rate of return may be used interchangeably.

The internal rate of return method utilizes present value concepts. The procedure is to find a rate of discount that will make the present value of the cash proceeds expected from an investment equal to the present value of the cash outlays required by the investment. Such a rate of discount may be found by trial and error. For example, with a conventional investment, if we know the cash proceeds and the cash outlays in each future year, we can start with any rate of discount and find for that rate the present value of the cash proceeds and the present value of the outlays. If the net present value of the cash flows is positive, then using some higher rate of discount would make them equal. By a process of trial and error, an approximately correct rate of discount can be determined. This rate of discount is referred to as the internal rate of return of the investment, or its IRR.

The IRR method is commonly used in security markets in evaluating bonds and other debt instruments. The yield to maturity of a bond is the rate of discount that makes the present value of the payments promised to the bondholder equal to the market price of the bond. The yield to maturity on a $1,000 bond having a coupon rate of 10% will be equal to 10% only if the current market value of the bond is $1,000. If the current market value is greater than $1,000, the IRR to maturity will be something less than the coupon rate; if the current market value is less than $1,000, the IRR will be greater than the coupon rate.

The internal rate of return may also be described as the rate of growth of an investment. This is more easily seen for an investment with one present outlay and one future benefit. For example, assume that an investment with an outlay of $1,000 today will return $1,331 three years from now.

Table 3 shows a 0.10 internal rate of return, and it is also a 0.10 growth rate per year.

Table 3. Cash flow

Beginning-of-time period	Growth of cash investment	Growth	Growth divided by beginning-of-period flow investment
0	$1,000	$100	100 ÷ 1,000 = 0.10
1	$1,100	$110	110 ÷ 1,100 = 0.10
2	$1,210	$121	121 ÷ 1,210 = 0.10
3	$1,331	—	—

The internal rate of return of a conventional investment represents the highest rate of interest an investor could afford to pay, without losing money, if all the funds to finance the investment were borrowed and the loan (principal and accrued interest) was repaid by application of the cash proceeds from the investment as they were earned.

We shall illustrate the internal rate of return calculation using the example of the previous section where the investment had a net present value of $886 using 0.10 as the discount rate.

We want to find the rate of discount that causes the sum of the present values of the cash flows to be equal to zero. Assume that our first choice (an arbitrary guess) is 0.10. In the preceding situation, we found that the net present value using 0.10 is a positive $886. We want to change the discount rate so that the present value is zero. Since the cash flows are conventional (negative followed by positive), to decrease the present value of the future cash flows we should increase the rate of discount (thus causing the present value of the future cash flows that are positive to be smaller).

In Table 4 we try 0.20 as the rate of discount.

Table 4. NPV using 0.20

		Present value	
Period	Cash flow	factor	Present value

0	#$12,337	1.0000	#$12,337
1	10,000	0.8333	8,333
2	5,000	0.6944	3,472
		Net present value =	**$532**

The net present value is negative, indicating that the 0.20 rate of discount is too large. We shall try a value between 0.10 and 0.20 for our next estimate. Assume that we try 0.16 (Table 5).

Table 5. NPV using 0.16

		Present value	
Period	Cash flow	factor	Present value
0	#$12,337	1.0000	#$12,337
1	10,000	0.8621	8,621
2	5,000	0.7432	3,716
		Net present value =	**0**

The net present value is zero using 0.16 as the rate of discount, which by definition means that 0.16 is the internal rate of return of the investment.

Although tables give only present value factors for select interest rates, calculators and computers can be used for any interest rate.

Net Present Value Profile

The net present value profile is one of the more useful devices for summarizing the profitability characteristics of an investment. On the horizontal axis we measure different discount rates; on the vertical axis we measure the net present value of the investment. The net present value of the investment is plotted for all discount rates from zero to some reasonably large rate. The plot of net present values will cross the horizontal axis (have zero net present value) at the rate of discount that is called the internal rate of return of the investment.

Figure 1 shows the net present value profile for the investment discussed in the previous two sections. If we add the cash flows, assuming a zero rate of discount, we obtain

#$12,337 + $10,000 + $5,000 = $2,663

The $2,663 is the intersection of the graph with the Y axis. We know that the graph has a height of $886 at a 0.10 rate of discount and crosses the X axis at 0.16, since 0.16 is the internal rate of return of the investment. For interest rates greater than 0.16, the investment's net present value is negative.

Note that for a conventional investment (negative cash flows followed by positive cash flows), the net present value profile slopes downward to the right.

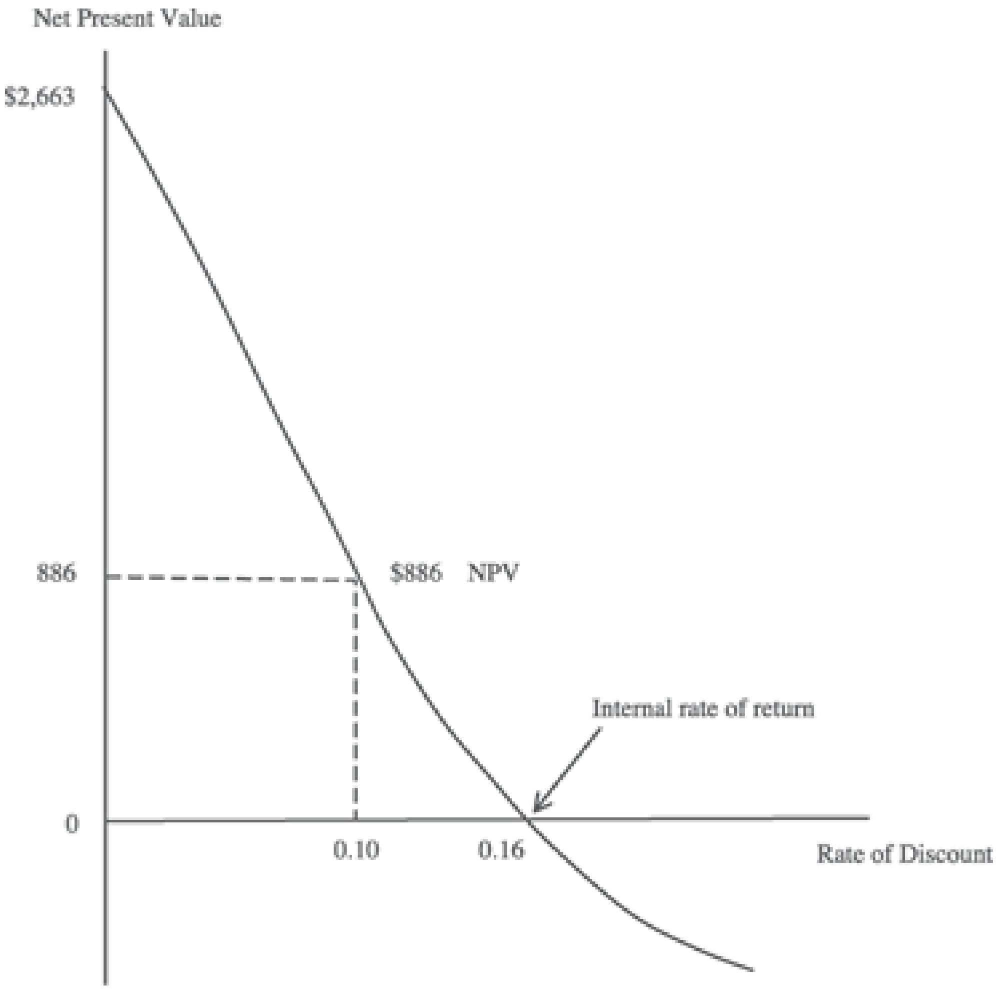

Figure 1. Net present value profile

The Rollback Method

On a simple hand calculator that lacks a present value button, it is sometimes convenient to use a rollback method of calculation to compute the net present value of an investment. One advantage of this procedure is that the present values at different moments in time are obtained. Consider the investment in Table 6.

Table 6. The rollback example

Time	Cash flow
1	#$7,000
1	5,000
2	2,300
3	1,100

Assume that the discount rate is 0.10.

The first step is to place the cash flow of period 3 ($1,100) in the calculator and divide by 1.10 to obtain $1,000, the value at time 2. Add $2,300 and divide the sum by 1.10 to obtain $3,000, the value at time 1. Add $5,000 and divide by 1.10 to obtain $7,273, the value of time 0. Subtract $7,000 to obtain the net present value of $273.

Case Study

A chemical company had sales of $14 billion and net earnings of $380 million in 20X1. Sales grew at 8% in the period 2001–20X1 and earnings at 10%.

Management was concerned that the firm's growth rates would fall as its product lines were maturing and the firm was finding it difficult to develop desirable investments. Management wanted the firm to grow at least 10% per year.

The firm used a 15% (after tax) hurdle rate as the required return.

The European plant was designed to manufacture a new proprietary polyethylene terephthalate (PET) that could be used, if successful, to package bottled water. A test tube quantity had been prepared but the new product had never been manufactured.

Demand for water bottles was expected to double in the next six years. The materials currently being used were neither environmentally sound nor safe. The new bottle would also have a better appearance. The average European drinks three times as much bottled water as the average resident in the United States.

The economic analysis presented for this plant was as given in Table 7.

Question: Should the plant being considered be accepted?

Answer: The plant has risk (the product has never been manufactured), but the likely profits look good. Accept. For all the listed events, the outcomes are acceptable.

Conclusion

There are many different ways of evaluating investments. In some situations, several of the methods will lead to identical decisions. We shall consistently recommend the net present value method as the primary means of evaluating investments.

The net present value method ensures that future cash flows are brought back to a common moment in time called time 0. For each future cash flow, a present value equivalent is found. These present value equivalents are summed to obtain a net present value. If the net present value is positive, the investment is acceptable.

The transformation of future flows back to the present is accomplished using the mathematical relationship $(1 + r)^{\#n}$, which we shall call the present value factor for r rate of interest and n time periods.

In cases of uncertainty, additional complexities must be considered, but the basic framework of analysis will remain a discounted present value method.

A Stanford Research Institute publication (1966) stated the situation well (p. 3): "The growth in corporate long range planning has intensified interest in corporate objectives, and has created a critical need to evaluate the financial impact of alternative courses of action."

More Info

Books:

- Bierman, Harold. *Implementation of Capital Budgeting Techniques*. Financial Management Survey & Synthesis Series, FMA, Tampa, FL, 1986.
- Bierman, Harold, Jr, and Seymour Smidt. *The Capital Budgeting Decision*. 9th ed. New York: Routledge, 2007.
- Bierman, Harold, Jr, and Seymour Smidt. *Advanced Capital Budgeting*. New York: Routledge, 2007.
- Stanford Research Institute. *Financial Management in Transition.* Menlo Park, CA, 1966.

Articles:

- Graham, John R., and Campbell R. Harvey. "The theory and practice of corporate finance: Evidence from the field." *Journal of Financial Economics* 60 (2001): 187–243.

- Hastie, K. L. “One businessman’s view of capital budgeting.” *Financial Management* 3 (Winter 1974): 36–44.

See Also

Best Practice

- Comparing Net Present Value and Internal Rate of Return

Calculations

- Net Present Value

Finance Library

- Financial Control for Non-Financial Managers

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http://www.qfinance.com/balance-sheets-best-practice/capital-budgeting-the-dominance-of-net-present-value?full