VII. Capital Budgeting: Elementary Concepts

A: INTRODUCTION

The first of the two primary corporate finance decisions is the capital budgeting (investment) decision. The financial manager's capital budgeting decision concerns which projects (or other investments) will be undertaken by the firm, how much capital will be budgeted toward each of these projects and when these investments will be undertaken. This capital budgeting decision is most important because the investments made by the firm determine that firm's operations and activities. This chapter will be concerned with four popular capital budgeting techniques and will discuss a number of important considerations relevant to the capital budgeting decision.

B: THE PAYBACK METHOD

The payback method is one of the simplest and most commonly used of all capital budgeting techniques. This technique is concerned with the length of time required for an investor to recapture his original investment in a project. The payback method decision rules are as follows:

1. Given two or more alternative projects, the project with the shorter payback period is preferred.
2. A single project should be undertaken if its payback period is shorter than some maximum acceptable length of time previously designated by management.

Consider the two projects (A) and (B) whose annual cash flows and cumulative cash flows are summarized in Table 1. Each project requires an initial investment of $10,000, which is expected to be paid off over time. Assume in this example that cash flows from projects are received in equal amounts throughout the year. For example, a project throws off the same cash flow each day during a particular year. Thus, project A, which requires an initial outlay of $10,000 pays off $2,000 in equal daily increments in the first year, $5,000 in the second, $6,000 in the third and $1,000 in the fourth year. In this case, the payback period for project (A) is 2.5 years. As we can see from the cumulative cash flows, the firm requires all of the cash flows received from the project in the first two years plus fifty percent of the third year's cash flows to recapture its initial $10,000 investment. The payback period for project (B) is 3.1 years. According to decision rule one, project (A) is preferred to project (B) because the company recaptures its initial $10,000 investment faster. If the company requires projects to have payback periods of less than three years, project (A) would be acceptable while project (B) would not be according to the second decision rule. In fact, in this case, project (B) would remain unacceptable even if its third year cash flow were $10,000,000; its payback period would still exceed the three-year maximum allowed by management. This example points to a major weakness of the payback method for capital budgeting decision-making: the payback method does not consider any cash flows received after the payback period.

Consider the mutually exclusive projects (C) and (D) (mutually exclusive means that at most one project is acceptable) presented in Table 2. Given that the firm must invest in only one of the two projects, which will be preferred? Since project (C) has the lower payback period, according to the payback rule, it is preferred to project (D). However, the net cash flows generated by project (D) exceed those generated by project (C). Thus, if the firm invests in project (D), its cash flows will be $11,000, compared to $6000 from project (C). If the firm prefers projects with higher total profitability, project (D) will be preferred to project (C). This example implies that the payback rule may not be appropriate for comparing mutually exclusive projects requiring substantially different initial investments.

The payback method has two primary advantages over many other capital budgeting techniques:

1. Payback periods are easy to compute and to compare.
2. Payback periods provide readily available information as to the length of time a corporation must wait to enjoy the benefits of its investments. Projects generating cash flows are potentially more likely to have shorter payback periods. Thus, in a sense, the payback period rule might roughly account for the time value of money, though not in a consistent manner.

Because of these advantages, the payback method is one of the most popular of all capital budgeting techniques. This technique is commonly used by many governments as well as corporations. However, the payback method also has a number of serious weaknesses. Among these are:

1. The payback rules do not consider cash flows received after the payback period.
2. The payback rules do not consider the timeliness of cash flows within the payback period. For example cash flows received in the second year of a project's life is valued as highly as cash flows received in its first year when the payback period exceeds two years.
3. The payback rules do not properly consider the riskiness of cash flows.
4. The payback rules may be inappropriate for comparing mutually exclusive projects when their initial investment levels are substantially different. In this case, another rule should be used when management wishes to maximize the value of the firm.

.

t	Project 'A' Cash Flow	Project 'A' Cumulative Cash Flow	Project 'B' Cash Flow	Project 'B' Cumulative Cash Flow
1	2,000	2,000	0	0
2	5,000	7,000	6,000	6,000
3	6,000	13,000*	3,000	9,000
4	1,000	14,000	10,000	19,000*
5	0	14,000	10,000	29,000

Table 1: Determining Payback Periods

Only 1/2 of the third year $13,000 cash flow is needed to enable Project A's recapture of its initial $10,000 investment. Therefore, assuming that cash flows are received in equal amounts in each fractional time period, Project A's payback period is 2.5 years. Only 1/10 of the fourth year $10,000 cash flow is needed to enable Project B's recapture of its initial $10,000 investment. Thus, its payback period is 3.1 years.

.

t	Project "C" cash flows	Project "D" cash flows
0	(10,000)	(20,000)
1	7,000	13,000
2	3,000	6,000
3	6,000	12,000

Project "C" payback period: 2.0 yrs | Project "D" payback period: 2.067 yrs
Project "C" profits: $6000 | Project "D" profits: $11,000
Project "C" return on Investment: .20 | Project "D" return on Investment: .183

Table 2: Cash flows on Projects "C" and "D"

C: EXPECTED VERSUS REQUIRED RETURN METHOD

Chapter 8 was concerned with the development of a minimum rate of return required for acceptance of an investment. If this required return is exceeded by the expected return associated with an investment, that investment is acceptable. Either the project's expected return on investment (ROI or accounting rate of return) or its expected internal rate of return (IRR) may be compared with the project's required return. The primary advantage of internal rate of return over return on investment is that IRR values cash flows to be received in the near future more highly than those in the more distant future. Thus, if the internal rate of return can be computed for a project, it will be a preferred measure of the expected economic efficiency of that investment; otherwise, the project's ROI will have to suffice.

The decision rules for the expected versus required return method are as follows:

1. Given two or more alternative projects, that project with the higher expected return (ROI or IRR) is preferred.
2. A single project is acceptable if its expected return is higher than some target level designated by management. This target level is frequently equal to the discount rate k that may be assigned to the project.

.

t	Project 'A' cash flows	Project 'B' cash flows
0	-10,000	-10,000

1	2,000	0
2	5,000	6,000
3	6,000	3,000
4	1,000	10,000
5	0	10,000
	Project 'A' Net Cash Flows Total \$4,000; $ROI_A = .08$	Project 'B' Net Cash Flows Total \$19,000; $ROI_B = .38$

Table 3: Cash Flows on Projects 'A' and 'B'

.

We can compute project ROIs from data given in Table 3 as follows:

$$ROI_A = (2{,}000+5{,}000+6{,}000+1{,}000+0 - 10{,}000)/(5*10{,}000) = .08$$
$$ROI_B = (0+6{,}000+3{,}000+10{,}000+10{,}000 - 10{,}000)/(5*10{,}000) = .38$$

Thus, if management compares ROI levels of these projects to choose between alternative investments, project (B) with an expected ROI of 38% will be preferred to project (A) with an expected ROI of 8%. Internal rates of returns for these projects are computing by solving the following for r:

$$NPV_A=0= -10{,}000 + [2{,}000/(1+r)+5{,}000/(1+r)^2+6{,}000/(1+r)^3+1{,}000/(1+r)^4]$$
$$NPV_B=0= -10{,}000 + [6{,}000/(1+r)^2+3{,}000/(1+r)^3+10{,}000/(1+r)^4+10{,}000/(1+r)^5]$$

The IRR for Project A is approximately 15.2% and the IRR for Project B equals approximately 34%. If management compares levels of IRR, project (B) will still be preferred. Notice that both of these decision rules directly conflict with the payback method results for this example. Both projects will be acceptable if the minimum return designated by management is 4%; neither is acceptable if this required return is 40%.

The expected versus required return capital budgeting technique has several advantages over the payback method. First, the expected versus required return method accounts for all of the cash flows associated with an investment. Second, the method can consider the risk of an investment by selecting a risk-adjusted target or required return. Furthermore, the IRR versus required return method considers the timeliness of cash flows.

Unless IRR is computed to compare with the project's required return, this method may not account for the timeliness of cash flows; however, in many instances, a project will have multiple rates of return. If a firm is considering mutually exclusive projects with different risk levels, the projects will have different required returns. Simply comparing the ROI or IRR levels of the projects will not account for differences in their required returns. Thus, the expected versus required return method may be inappropriate for comparing projects with different risk levels. Furthermore, this method suffers from the same scale of investment problem as does the payback rule. In the example presented in Table 2, project (C) will have both a higher return on investment and a higher internal rate of return than will project (D). According to the expected versus required return rules, project (C) is preferred to project (D) even though its acceptance results in lower net profitability. In this example, management should not use the expected versus required return rule to compare mutually exclusive investments if its objective is to maximize net cash flows to shareholders. Thus, the expected versus required return rules are most appropriate when:

1. management is considering mutually exclusive projects with similar initial investment and risk levels, and either
2. a. management can determine the internal rates of return for the projects it is considering (e.g.: no multiple rates), or
   b. management considers ease of computation to be of more importance than considering the timing of cash flows, thus comparing project average rates of return on investment.

Conditions (2.a) and (b) apply when management is considering a single project whose expected return will be compared to a required or target rate of return.

D: THE NET PRESENT VALUE METHOD

The net present value capital budgeting technique simply considers the present value of a project net of its initial investment. The net present value (NPV) of a project is simply:

$$(1)\qquad NPV=\sum_{t=0}^{n}\frac{CF_t}{(1+k)^t}$$

Notice that the summation begins at time zero, denoting that the project's initial investment is deducted from the present value of future cash flows. The NPV rules are:

1. Any project is acceptable if its NPV exceeds zero.
2. Given mutually exclusive projects, the project with the higher NPV will be preferred.

The net present value technique has a number of advantages over other capital budgeting techniques presented here:

1. If a risk-adjusted discount rate is used, the NPV rule considers project risk.
2. The NPV rules consider the timeliness of all cash flows.
3. The NPV rules can be used to compare projects with different risk levels and requiring different initial investments.

The primary disadvantage of the NPV rules is that project NPV's may be slightly more difficult or time-consuming to compute than their payback periods or expected returns. In many instances, the most difficult computations will be those required for deriving discount rates. Computing the beta associated with a new machine or product line may be quite difficult when there is no historical data upon which to base computations. This problem can be alleviated by using firm required rates of return or cost of capital values as discount rates. (Cost of capital will be dealt with in later chapters.)

In most instances when discount rates can be relatively easily determined and when there are no binding budget constraints, the net present value method is usually the better capital budgeting technique. There are a number of instances when the NPV method must be modified to adjust for complicating circumstances.

E: THE PROFITABILITY INDEX METHOD

The Profitability Index provides a means of comparing the present value of cash flows associated with a project to its initial investment amount. The Profitability Index is written:

$$PI = \frac{PV(CashFlows)}{P_0} = \frac{\dfrac{\sum_{t=1}^{n} CF_t}{(1+k)^t}}{P_0} \tag{2}$$

The Profitability Index rules are as follows:

1. Any project whose PI > 1 is acceptable.
2. Higher PI projects are preferred to lower PI projects.

The Profitability Index provides a useful measure for comparing the relative efficiency of projects. All of the computations that are required for calculating a project NPV are also required for the computation of the Profitability Index. The Profitability Index may be inappropriate for choosing among mutually exclusive projects requiring different initial investment levels. However, when projects must be ranked according to their efficiency, the Profitability Index can be useful because it provides comparison of project cash outflows with the present value of cash inflows. Project ranking may be quite useful when the firm faces capital constraints or capital rationing (that is, when the firm has a limited amount of funds available for investing). When the firm must choose among large numbers of possible combinations, the Profitability Index can be most useful for ranking projects and narrowing down the set of projects to be considered.

Consider the Cleveland Company (represented in Table 4 which has \$200,000 available for investment in any combination of five Projects A through E. The number of possible combinations of projects taken from five totals 32 (that is, 2^5). Consideration of and NPV computations for all possible thirty-two combinations of projects will be quite time-consuming. However, many possible combinations will not be feasible because the sums of their initial investments exceed the total available of \$200,000. Furthermore, some combinations will be more efficient than other combinations, as we will see when computing profitability indices.

Initial investments required for the five investments as well as cash flows present values, Profitability Indices and Net Present Values are listed in Table 4. Notice that Projects B, E and D have the highest NPV's. Investment in these projects will exhaust the firm's $200,000 available capital and represent a total NPV of $56,500. However, if the firm ranks projects according to their Profitability Indices, Projects D,E,C and A will be chosen. The total NPV associated with these projects is $59,250. Here, again, the firm exhausts its available capital. Notice that ranking projects according to their Profitability indices results in higher total NPV's than ranking projects according to their individual NPV's. If the Cleveland Company had no capital constraints, all five projects would have been acceptable since they all had positive NPV's and Profitability Indices that exceeded one. Again, the profitability index is most useful when the firm has several positive NPV investments available to it but cannot afford to invest in all of them. The PI enables us to rank the projects to help locate the best combination.

Project	Initial Outflow	Present Value Inflow	NPV	Rank	PI	Rank
A	$ 25,000	$ 31,250	$ 6,250	5	1.25	3
B	100,000	120,000	20,000	1	1.20	5
C	75,000	91,500	16,500	4	1.22	4
D	25,000	42,750	17,750	3	1.71	1
E	75,000	93,750	18,750	2	1.25	2

Capital Budgeting Rules with $200,000 outflow constraint:

1. NPV rule: choose project B with highest NPV, using $100,000. Then choose project E with next highest NPV, which, when combined with project B, uses $175,000. Then choose project D, using all of the available $200,000. Total NPV of $200,000 investment is $56,500.

2. PI rule: choose project D, with highest PI, using 25,000. Then choose projects E, A and C, using all of the available $200,000. Total NPV of $200,000 investment is $59,250, exceeding that derived using the NPV rule. Thus, the Profitability Index may enable us to more efficiently choose among projects given a capital constraint.

Table 4: Capital Budgeting Under Capital Constraints

F: IMPORTANT CAPITAL BUDGETING DECISION FACTORS

When the firm is able to calculate and compare project NPV's, the NPV technique usually results in the most economically sound capital budgeting decisions. However, forecasting project cash flows can be as difficult as generating project discount rates. Whatever capital budgeting technique the firm chooses to use should account for all of the cash flows resulting from the acceptance of a project. Among the factors affecting the capital budgeting decision should be:

1. Total revenues and costs generated by the project: These figures should account only for those cash flows attributable to the project. For example, many companies will allocate

some fraction of their overhead costs such as utilities, research and management expenses to new projects. This is an acceptable practice when the analyst believes that the fraction of overhead allocated to the project equals the actual increase in overhead expenses. In addition, project profits are only important to the extent that they affect cash flows. "Paper" profits are irrelevant unless they result in increased cash flows.

2. Taxes
    a. income taxes
    b. tax write-offs from any depreciation that may be claimed if the project is accepted
    c. capital gains taxes that must be paid (or capital loss write-offs that may be taken) from any sale of assets. However, if a partly or fully depreciated asset has been traded in for a newly acquired asset for a capital gain or loss, the depreciable basis of the new asset may have to be adjusted. See Example III, the Equipment Replacement Decision.
    d. investment tax credit and any other credits or government subsidies that may be claimed. Tax credits are reductions in the firm's tax liability granted by the tax authority. Because credits are direct reductions in taxes, they represent positive cash flows. The Investment Tax Credit is of somewhat less importance after the passage of the 1986 Tax Act. However, its treatment is similar to that of other credits. Furthermore, similar credits are given by many state tax authorities and foreign governments. Furthermore, there is some possibility that the Investment Tax Credit will be reinstated at the U.S. Federal level.

3. Working capital requirements: The acceptance of a project may require that the firm maintain an increased balance in one of its current asset accounts such as cash, accounts receivable or inventory. For example, the purchase of a machine may require that the firm keep an inventory of machine parts. This inventory may be sold when the machine is no longer used. The present value of the sale proceeds should be included in the capital budgeting calculations in addition to the funds used to purchase the inventory early in the project's life. Typically, a working capital requirement provides for a negative cash flow at the initiation of the project and a positive cash flow when the project terminates.

4. Cash flows generated from the sale of assets no longer required by the firm. For example, if the firm purchases a new machine, it may be able to sell an old machine it no longer needs.

5. Installation and transactions costs. Installation costs of equipment will usually be depreciated over time. Thus, they are generally treated similarly to the purchase price of the equipment itself. Tax code provides for specific rules on whether transactions costs will be depreciated or expensed when the project is initiated.

6. Cash flows generated from the future sale of the newly acquired assets (This may include the salvage value associated with a machine.)

7. Changes in economies of scale: For example, if a firm purchases a subsidiary, increased efficiency may result from the firms' abilities to use each other’s assets. Thus, the new, larger firm may enjoy economies of scale, resulting in higher net cash flows. In some cases,

mergers between firms may result in diseconomies of scale; the new, larger firm is less efficient than the original smaller firms operating independently. Types of synergies which might result from a merger include those related to:

1. Revenue enhancement: Marketing gains due to the merger, strategic benefits, market power (by taking over competing firms), improved research and development
2. Cost reduction: Economies of scale in production, economies of vertical integration (benefits realized from taking over a potential client or supplier), complementary resources
3. Reduced taxes resulting from unused tax credits and deductions
4. Lowered cost of capital and better access to financial markets that larger firms enjoy

8. Side effects. Certain investments may affect favorably or unfavorably the cash flows in other areas of the firm. For example, the investment may enhance or make more efficient operations in other divisions of the firm. On the other hand, the project under consideration may compete with other projects of the firm, to the detriment of their profitability. For example, in 1983, when Coca-Cola initiated production and sales of Diet Coke, its sales within one year exceeded those of any other diet soft drink. However, a large fraction of those sales came at the expense of Coca-Cola's other diet soft drink, Tab. Firms frequently introduce new products which can compete with existing products. Lost sales of the existing product should be accounted for in the capital budgeting decision process for a new product.

9. Risk and the time value of money. A risk-adjusted discount rate or target rate is often used to reflect risk and time value.

10. Only present and future cash flows are relevant. Past cash flows are relevant only to the extent that they affect future cash flows. Thus, sunk costs which have already been incurred should be regarded as irrelevant. For example, the four thousand dollars that a company might have paid four years ago for a computer that is now obsolete should not be considered in the decision to purchase a new computer. An exception to this would occur if the company is still depreciating the old computer - the firm's future cash flows will be affected by the tax effect of the depreciation.

11. Inflation. Either discount nominal cash flows with nominal discount rates or discount real ash flows with real discount rates:

$$NPV = \sum_{t=0}^{n} \frac{CF_{nominal,t}}{(1+k_{nominal})^t} = \sum_{t=0}^{n} \frac{CF_{real,t}(1+g)^t}{(1+k_{real})^t(1+g)^t} = \sum_{t=0}^{n} \frac{CF_{real,t}}{(1+k_{real})^t}$$

where discount rates and cash flows are expressed in real (deducting the inflation) and nominal terms (including the impact of inflation) and g represents the inflation rate. One should bear in mind that certain cash flows such as the tax savings associated with accounting depreciation will not be affected by inflation.

12. Opportunity costs. If the firm is unable to obtain certain cash flows because of investment in the project, this opportunity cost should be considered.

EXAMPLE I: MERGER DECISION

In 2000, the Washington Electronics Corporation merged with the Adams Wire Company (See Table 5). Adams was a smaller company than Washington with projected annual revenues of \$800,000 (Rev_1) for 2001. Washington Company managers projected \$500,000 annual cost levels ($Costs_1$) for the Adams Company; however, the proposed merger was expected to reduce these annual costs by \$100,000 ($Synergies_1$). All revenues, costs and cost reductions were projected to grow at the 10% rate (g=.10) of inflation indefinitely. Both companies operated in the 40% corporate marginal income tax bracket (τ_c=.40). To complete the merger, shareholders of the former Adams Company were compensated with \$4,200,000 in Washington Company common stock and cash (P_0=\$4,200,000). Washington Company management determined that the appropriate discount rate for cash flows resulting from the merger was 15% (k=.15). Was Washington's decision to merge with the Adams Company appropriate given the facts and projections that were available in 2000?

The NPV technique can be used quite easily to evaluate this merger (See Table 5). Cash flows generated by this merger can be classified into two streams: the initial \$4,200,000 investment and a growing perpetuity (since the purchased company has an indefinite life expectancy) reflecting the cash flows resulting from revenues, costs and corporate income taxes. The gross profits (before taxes) generated by this perpetuity in 1991 were projected to be \$400,000:

$$(\$800,000 - \$500,000 + \$100,000) = \$400,000$$

Because corporate income taxes must be paid on this \$400,000 increase in gross profits, Washington's taxes must increase by \$160,000 (40% × \$400,000). Therefore, Washington's net cash flows (after taxes) will increase by \$240,000:

$$\left[\$400,000 \cdot (1 - .40)\right] = \$240,000$$

These net cash flows were projected to grow at a rate of 10% per year indefinitely. They were to be discounted at a rate of 15% in a growing perpetuity model. The value of this growing perpetuity is \$4,800,000:

$$PV_{gp} = \frac{\$240,000}{.15 - .10}$$

Therefore, the net present value of this merger was \$600,000, indicating that it was a wise investment for the Washington Corporation:

$$NPV = -\$4,200,000 + \$4,800,000 = \$600,000$$

.

Rev_1 = \$800,000	P_0 = \$4,200,000	□ $\tau = .40$
$Costs_1$ = \$500,000	k = .15	
$Synergies_1$ = \$100,000	g = .10	

$$NPV = -\$4{,}200{,}000 + \frac{[\$800{,}000 - \$500{,}000 + \$100{,}000][1 - .4]}{(.15 - .10)} = \$600{,}000$$

Since NPV > 0, the merger should be consummated.

Table 5 : The Merger Decision

.

EXAMPLE II: NEW EQUIPMENT DECISION

The Jefferson Company is considering the purchase of a new machine enabling the company to expand its product line. This new machine has a life expectancy of ten years (n=10 in Table 6), at which time it can be salvaged for \$200,000 = SV. The machine's purchase price P_0 is \$1,300,000, and it will be depreciated using the straight line method. This machine is expected to increase the company's annual revenues by \$300,000 while increasing annual operating costs by \$100,000; that is, Rev = \$300,000 and costs = \$100,000. Purchase of this machine entitles the Jefferson Company to a 10% investment tax credit (ITC = 10%). The company operates in the forty percent tax bracket and will discount this machine at a rate of ten percent (τ =.40 and k=.10). Given the results of an NPV analysis, should the Jefferson Company purchase this new machine?

Purchasing this new machine requires an initial investment of \$1,300,000, which is partially offset by the \$130,000 investment tax credit ($10\% \cdot \$1{,}300{,}000$). Notice that this investment tax credit does not reduce taxable income; it simply reduces the actual tax obligation of the corporation. Since the credit reduces the tax obligation of the corporation, it represents a positive cash flow to the corporation. This credit should be discounted according to when its benefits are actually realized, such as when the corporation makes its next estimated tax payment. Thus, the period of time elapsing before realization of the benefits of the investment tax credit may be quite short, perhaps only a few weeks or months. Rather than discount these benefits in this example, we will assume they are realized immediately (even though they may actually be realized in a few weeks). Therefore, the time zero cash flow associated with the investment in this machine is -\$1,170,000:

$$CF_0 = [-\$1{,}300{,}000 + \$130{,}000] = -\$1{,}170{,}000$$

The before-tax profit generated by this machine over the next ten years will be \$200,000 (revenues minus operating costs), yielding a \$120,000 annual after-tax profit, exclusive of depreciation:

$$(\$300{,}000 - \$100{,}000) \cdot (1 - 0.4) = \$120{,}000$$

Notice that the before-tax profits are multiplied by one minus the tax rate, denoting that of the \$200,000 gross profit, the government gets forty percent. The annual depreciation will be

$110,000, determined using the straight-line basis:

(3) $$\text{Depr.} = (P_0 - SV)/\ n$$

$$\text{Depr.} = (\$1{,}300{,}000 - \$200{,}000)/10 = \$110{,}000$$

Unlike revenues and operating costs, depreciation taken alone does not represent an actual cash flow. Depreciation is merely an artificial cost contrived by corporations to enable them to take a tax deduction. This tax deduction is permitted because the firm will not be permitted to expense a major outlay for a machine with a long life-expectancy. Thus, the cash flow associated with depreciation will be the corporation's tax savings. In this example, the annual cash flow realized due to depreciation will be $44,000:

$$(\$110{,}000 \cdot 0.4) = \$44{,}000$$

Claiming depreciation allows the corporation to reduce its taxable income by $110,000, thus reducing its taxes payable by forty percent of this sum. Since depreciation results in a tax savings to the firm, cash flows associated with it will be positive. Because depreciation is not an actual cash flow as are revenues and operating costs, we multiply depreciation by .4 (not [1-.4]) to derive its associated cash flow.

The present value of the ten-year annuity generated by this machine is $1,007,714:

$$\left\{\left[(\$300{,}000 - \$100{,}000) \cdot (1 - .4)\right] + \left[\$110{,}000 \cdot .4\right]\right\} \cdot \left[\frac{1}{.10} - \frac{1}{.10(1 + .10)^{10}}\right]$$

$$= \{\$120{,}000 + \$44{,}000\} \cdot 6.1446 = \$1{,}007{,}714$$

In addition to this ten year annuity, the corporation will receive $200,000 when the machine is salvaged. Because this cash flow will not be received for ten years, its present value is $77,109:

$$\$200{,}000/(1 + .10)^{10} = \$77{,}109$$

Therefore, the net present value of all cash flows associated with this machine is -$85,177:

$$-\$1{,}170{,}000 + \$1{,}007{,}714 + \$77{,}109 = -\$85{,}177$$

Because this value is less than zero, the machine should not be purchased.

.

P_0	=	$1,300,000	Costs_1 =	$100,000	n = 10
SV	=	$ 200,000	ITC	= 10%	□ = .40
Rev_1	=	$ 300,000	k = .10		

$$Depr = \frac{\$1300{,}000 - \$200{,}000}{10} = \$110{,}000\,; \quad ITC = 10\% \cdot \$1{,}300{,}000 = 1$$

$$NPV = -1{,}300{,}000 + 130{,}000 + \left[\left[(300{,}000 - 100{,}000)(1-.4)\right] + \left[110{,}000 \cdot .4\right]\right]\left[\frac{1}{.1} - \frac{1}{.1(1.1)^{10}}\right] + \frac{200{,}000}{1.1^{10}}$$

$$= -1{,}170{,}000 + 1{,}007{,}714 + 77{,}109 = -85{,}177.$$

Since NPV < 0, the machine should not be purchased.

Table 6: New Equipment Decision

.

EXAMPLE III: EQUIPMENT REPLACEMENT DECISION

The Madison Company is considering the purchase for \$600,000 of a machine to replace the machine with which it currently operates (P_0=\$600,000). As we see from Table 7, the old machine was purchased five years ago for \$500,000 (P_{-5}=\$500,000) and, at the time, had a life expectancy of twelve years (n_{old}=12). Purchase of the new machine, which has a life expectancy of seven years (n_{new}), qualifies the company for a ten percent investment tax credit (ITC=.10). The new machine is capable of producing 200,000 widgets per year (#units), compared to the 150,000 unit operating capacity of the old machine. Furthermore, the new machine can produce these widgets for five dollars apiece whereas the per unit operating cost of the old machine is six dollars. All widgets produced by either machine can be sold for ten dollars apiece. The current trade-in value of the old machine is TIV = \$350,000. Both machines will be depreciated on the straight-line basis. The anticipated salvage value (SV) of the old machine is \$100,000; the anticipated salvage value of the new machine is \$200,000. The company will operate in the thirty percent tax bracket and will discount all cash flows at a rate of twelve percent (τ =.30, k=.12). Should the Madison Company continue to operate with the old machine or replace it with the new one?

The Madison Company has two alternatives from which to choose: either it continues to operate with the old machine or it trades in the old machine and operates with a new one. Madison should determine the NPV of cash flows received from manufacturing with the old machine and compare this value to the NPV of cash flows associated with the new machine.

The old machine is capable of producing annual revenues of \$1,500,000 while generating annual operating costs of \$900,000. Thus, exclusive of depreciation, the annual after-tax profits generated by the old machine are \$420,000:

$$\text{REV} = (\text{price} \cdot Q) = (\$10 \cdot 150{,}000) = \$1{,}500{,}000 \quad ,$$

$$\text{TVC} = (\text{VC} \cdot Q) = (\$6 \cdot 150{,}000) = \$900{,}000 \quad ,$$

$$\text{profit} = (\$1{,}500{,}000 - \$900{,}000) \cdot (1-.3)) = \$420{,}000\,.$$

The annual depreciation claimed by the company will be \$33,333, allowing a \$10,000 reduction in taxes payable by Madison:

$$\text{Depr.} = (\$500{,}000 - \$100{,}000)/12 = \$33{,}333$$

$$\text{tax reduction} = (\$33{,}333 \cdot .3) = \$10{,}000$$

When the machine is no longer usable after seven years (the machine's remaining life expectancy [12 - 5]), it will be salvaged for \$100,000. Because this sum will not be received for seven years, it must be discounted. Therefore the present value of cash flows generated by this

$$NPV_{old} = [\$420{,}000 + \$10{,}000] \cdot \left[\frac{1}{.12} - \frac{1}{.12(1+.12)^7} \right] + \frac{\$100{,}000}{(1+.12)^7}$$
$$= \$2{,}007{,}650.20$$

machine over its seven years of remaining life expectancy is \$2,007,650.20:

The old machine should be retained if the NPV associated with its cash flows exceeds the NPV of cash flows generated by trading it in and operating a new machine.

If the Madison Company purchases the new machine, it must make an initial investment of \$600,000. However, this negative cash flow is partially offset by a \$60,000 investment tax credit and the \$350,000 trade-in value of the old machine. However, trading in the old machine may result in a capital gains or loss to the company, the sum of which will have tax implications. The amount of capital gains (or loss) is determined by deducting the book value of the machine from its trade-in value. The current book value of this five year-old machine is \$333,333 - its purchase price less accumulated depreciation:

$$\text{accu. depr.} = (\text{age} \cdot Depr) = (5 \cdot \$33{,}000) = \$166{,}667$$

$$BV = (P_0 - \text{accu.} \cdot depr.) = (\$500{,}000 - \$166{,}667) = \$333{,}333$$

By trading in the old machine for \$350,000, the company incurs a \$16,667 capital gain. This gain will be deducted from the depreciable basis (P_0 - SV) of the new machine to decrease its annual depreciation write-off and increase annual taxes. Thus, the capital gains tax is "spread out" over the life of the new machine. This gain does not result in additional cash flows already reflected in its trade-in value at the time of purchase; it merely decreases the book value or depreciable basis of the new machine. Thus, the time zero cash flows generated by the purchase of the new machine are \$190,000:

$$\{-\$600{,}000 + \$60{,}000 + \$350{,}000\} = -\$190{,}000$$

The new machine will generate annual revenues and costs of \$2,000,000 and \$1,000,000:

$$REV = (\$10 \cdot 200{,}000) = \$2{,}000{,}000$$

$$TVC = (\$5 \cdot 200{,}000) = \$1{,}000{,}000$$

Exclusive of depreciation, the after-tax profits generated by the new machine will be \$700,000. Annual depreciation on the new machine will be \$54,962, determined as follows:

$$(P - SV - Cap.\ Gain)/n = (600{,}000 - 200{,}000 - 16{,}667)/n = 54{,}962$$

The annual tax savings associated with the annual depreciation is ($.3 \times 54{,}962$) or 16,488. Thus,

$$NPV_{old} = [\$700{,}000 + \$16{,}488] \cdot \left[\frac{1}{.12} - \frac{1}{.12(1+.12)^7}\right] = \$716{,}488 \cdot 4.5638$$

$$= \$3{,}269{,}908$$

the present value of the seven year annuity generated by this machine is \$3,269,908:

The present value of the \$200,000 received when the machine is traded in is \$90,469.84. Thus, the NPV of all cash flows associated with the new machine is \$3,170,075:

$$NPV_{new} = -\$190{,}000 + \$3{,}269{,}908 + \$90{,}470 = \$3{,}170{,}075.$$

Because the net present value of cash flows associated with the new machine exceeds that for the old machine, the firm should operate with the new machine.

.

OLD MACHINE			NEW MACHINE		
P_{-5}	=	\$500,000	P_0	=	\$600,000
Age	=	5	n	=	7
n	=	12	ITC	=	10%
Q	=	150,000	Q	=	200,000
VC	=	\$6	VC	=	\$5
TIV	=	\$350,000	SV	=	\$200,000
SV	=	\$100,000			

K = .12
Price =\$10
τ = .30
Depr = SL

$$NPV_{old} = [\$420{,}000 + \$10{,}000] \cdot \left[\frac{1}{.12} - \frac{1}{.12(1+.12)^7}\right] + \frac{\$100{,}000}{(1+.12)^7} = \$2{,}007{,}650.20$$

……………………………………………………………………

-190000 716428.56 3269605.525 904698.84

$$NPV_{new} = - \$600{,}000 + (.1 \cdot \$600{,}000) + \$350{,}000$$

$$+ [(\$10 - \$5) \cdot (200{,}000)(1-.30)] + \left[\frac{\$600{,}000 - \$200{,}000 - \$16{,}667}{7}\right] \cdot .3 \cdot \left[\frac{1}{.12} - \frac{1}{.12(1.12)^7}\right] + \frac{\$200{,}(}{(1.12}$$

$$= -190{,}000 + 716{,}428 \cdot 4.5637 + 90{,}469 = -190{,}000 + 3{,}269{,}605 + 90{,}469 = 3{,}170{,}075$$

Since $NPV_{new} > NPV_{0ld}$, the new machine should be purchased.

Table 7: Equipment Replacement Decision

.

EXAMPLE IV: THE LEASE VERSUS BUY DECISION

In this example, we will use the NPV technique to solve a different type of problem. We will attempt to determine the maximum price a firm should be willing to pay for a truck which it could otherwise lease. In this example, the manager of a delivery company is considering the purchase of a truck, although he may consider a five year lease of a similar truck from a leasing firm. If he leases the truck, his monthly payment will be \$1000; ownership of the truck after the lease period will revert back to the leasing company. If he purchases the truck, its value after its useful (and depreciable) life of five years will be \$10,000. Annual maintenance payments on the truck will be \$1000, regardless of whether the truck is purchased or leased. If the truck is purchased, it will be depreciated on a straight line basis. The delivery company is in the thirty percent tax bracket and discounts all cash flows at a 10% discount rate. What is the maximum price that the company will pay for the truck, given the cash flows associated with leasing the truck?

In certain respects, this problem is more difficult than the preceding examples. To solve this problem, we first solve for the NPV associated with leasing the truck. First, since lease payments will be made monthly, we need to convert the annual discount rate of 10% into a monthly rate:

$$10\% \div 12 = .0083333$$

Thus, the \$1000 lease payment will be made for 60 months and will be discounted at a monthly rate of .0083333. After accounting for the tax deductibility of the lease payment at 30%, we determine the present value of lease payments as follows:

$$PV_{lease} = [-\$1{,}000 \cdot .7] \cdot \left[\frac{1}{.008333} - \frac{1}{.008333(1.008333)^{60}}\right] = -\$32{,}945.78$$

Because the maintenance payments on the truck are the same whether the truck is purchased or leased, and the discount rate, life expectancies and tax rate are all unaffected by whether the truck is leased or purchased, the maintenance payments need not be considered. Thus, -\$32,945.78 is the present value associated with leasing the truck.

Next, we need to set up a function for evaluating the cash flows associated with purchasing the truck. That purchase price for the truck which yields the same NPV (-\$32,945.78) as obtained by leasing the truck is the maximum price the firm should be willing to pay. Determining the maximum acceptable purchase price for the truck is complicated by the fact that the depreciation associated with the truck is a function of its purchase price:

$$Depr. = \frac{P_0 - \$10{,}000}{5}$$

Thus, to find the NPV associated with the truck purchase, we set up the following:

$$PV_{Buy} = -P_0 + \left[.3 \cdot \frac{P_0 - \$10{,}000}{5}\right]\left[\frac{1}{.1} - \frac{1}{.1(1+.1)^5}\right] + \frac{\$10{,}000}{(1+.1)^5} = -\$32{,}945.$$

We solve the equation above for P_0 to find that the maximum price that the company would pay for the truck:

$$PV_{Buy} = -P_0 + \left[.3 \cdot \frac{P_0 - \$10{,}000}{5}\right] \cdot 3.79 + \$6{,}209.21 = -\$39{,}154.99 - .7726P_0$$

$$= -\$36{,}880.99; P_0 = \$47{,}736.20.$$

Therefore, if the firm were to pay \$47,736.20 for the truck, the NPV of the purchase would equal the NPV of the lease. This is the maximum sum the firm should be willing to pay to purchase the truck.

.

LEASE		BUY	
Lease Payment:	\$1000 per month	P_0:	Unknown
Maintenance:	\$1000 per year	Maintenance:	\$1000 per year
n:	60 months	n:	5 years
k:	.008333 per month	k:	.10 per year
τ_c:	.30	τ_c:	.30
		SV:	\$10,000
		Depr.: SL	

Table 8: The Lease Versus Buy Decision

.

H. CONCLUSIONS

This chapter has discussed four primary capital budgeting techniques. The first is the payback rule, which is concerned only with the length of time required for a firm to recapture its initial investment. Because it does not properly account for the time value of money, its application can be improved if the firm discounts cash flows before computing payback periods. However, this so-called discount payback method still will not properly account for cash flows received after the payback period.

Next, we considered two variations of the expected versus required return rule. This rule can be accommodated with use of ROI (also known as accounting rate of return) or IRR. Normally, the IRR rule is more appropriate because it accounts for the time value of money. In fact, the IRR rule will often generate the same results as the NPV rule, except in those instances where single IRRs cannot be computed.

We emphasized the NPV rule here because it most appropriately accounts for time value of money and the scale of the investment. It is only slightly more complex than the simple payback rule and will usually lead to optimal decisions. Nonetheless, managers may benefit from using a combination of rules to make investment decisions because of difficulties in estimating inputs such as discount rates or because of the varying constraints and objectives existing in the firm, its divisions and departments.

Finally, the Profitability Index rule is most useful to the firm facing a capital constraint. Such a firm may be unable to accept all positive NPV projects because of limited funding. Thus the firm selects that combination of projects from a potentially large number based on their Profitability Indices; higher PI projects are preferred and, if selected, will usually lead to the highest NPV combination of projects.

QUESTIONS AND PROBLEMS

1. The Hegel Company is considering operating in a new market area at an initial cost of $100,000. The company expects to realize after tax cash flows from this operation as summarized in the following chart:

Year	Cash Flow
1	$10,000
2	$40,000
3	$40,000
4	$40,000
5	$10,000

Under which of the following decision rules will this project be accepted by the Hegel Company?

a. Payback Rule; three year cut-off point.
b. Expected Versus Required Return Rule; 7% required return on investment.
c. Expected Versus Required Return Rule; 7% required internal rate of return.
d. Net Present Value Rule.(Assume a 5% discount rate)
e. Profitability Index Rule. (Assume a 5% discount rate)
f. The most appropriate rule.

2. The Mill Printing Company is considering the investment in one of two copying machines, A or B. Machine A is more efficient than is B since it is capable of making 100,000 copies per year at a per unit cost of $.01; machine B is capable of only making 50,000 copies per year at a per unit cost of $.015. Each copy yields a before-tax cash flow of $.08, and each machine will produce at its full capacity. The Mill Company can purchase Machine A for $16,000 and can purchase Machine B for half as much. The life expectancy of either machine is five years, at which time, either can be salvaged for $2000. The machines will be depreciated on the straight line basis, and the corporation operates in the thirty percent marginal tax bracket.

a. Construct tables for each of the two machines summarizing their associated after-tax cash flows for years zero through five. (See Problem 1 for table format.)
b. Calculate the payback period, expected return on investment and expected internal rate of return for each of the machines.
c. Calculate the NPV for each of the machines assuming a discount rate of ten percent.
d. Calculate profitability indices for each of the machines assuming a discount rate of ten percent.
e. Given only your calculations in parts a through d, which of the machines represents the better investment?

3. The Thoreau Company is considering the purchase of a new machine to replace the one with which it currently operates. The old machine was purchased four years ago for $600,000 and can be traded in now for $400,000. Both machines may be depreciated on a straight line basis; both have expected salvage values of $100,000. The old machine had a life expectancy when purchased of ten years and is capable of producing 50,000 units per year. Each unit can be sold for $10. The new machine can be purchased for $800,000 and qualifies the company to an investment tax credit totaling $40,000. The new machine has a life expectancy of six years and is capable of producing 80,000 units. The company operates in the forty percent marginal income tax bracket and discounts all of its cash flows at twelve percent. Annual operating costs are the same for both

machines. Should the Thoreau Company purchase the new machine or continue to operate with the old machine? Would your answer change if the company discounted all of its cash flows at a twenty percent rate?

4. A consumer currently renting an apartment is considering the purchase of a condominium for $100,000. His choice between renting and owning his own home is determined entirely by the extent to which his cash flows are affected. If he continues to rent, his current $5000 annual rent bill can be expected to increase at the annual inflation rate of 6%. If he purchases, he can expect the value of his home to increase at the rate of inflation. The condominium can be purchased with a $20,000 down payment and a ten percent, ten year mortgage. The consumer will live in his apartment or condominium for forty years at which time he will move into a retirement home. Purchasing the condominium will subject the consumer to annual maintenance payments of $1000 which can be expected to grow at the inflation rate and will not be tax deductible. All interest payments on the mortgage will be tax deductible. The consumer is in the thirty percent tax bracket and discounts all cash flows at the 10% interest rate he earns on his bond fund. Should the consumer purchase the condominium or continue to rent?

5. Russell Company management wishes to decide whether to purchase or lease a fleet of ten automobiles. The automobiles can be purchased for $10,000 apiece, qualifying the company for eight hundred dollars per car in investment tax credits. Each automobile has a life expectancy of five years at which time it can be salvaged for $1,500. The per-automobile maintenance costs are projected to be $80 in the first year, $160 in the second, and continue to double each year thereafter. The company will depreciate the automobiles using the straight line basis. Annual lease payments will be $2000 per car. All lease and maintenance costs are fully tax deductible. Maintenance payments will be made even if the automobiles are leased. The company operates in the thirty percent income tax bracket and discounts its cash flows at a ten percent rate. Should the fleet be purchased or leased?

6. The Smith Company is considering the purchase of a new machine to replace the one with which it currently operates. The old machine was purchased four years ago for $700,000 and can be traded in now for $300,000. Both machines may be depreciated on a straight line basis; both have expected salvage values of $100,000. The old machine had a life expectancy when purchased of ten years and is capable of producing 60,000 units per year. Each unit can be sold for $9. The new machine can be purchased for $900,000 and qualifies the company to an investment tax credit totaling $45,000. The new machine has a life expectancy of six years and is capable of producing 100,000 units. The company operates in the forty percent marginal income tax bracket and discounts all of its cash flows at eleven percent. Annual operating costs are the same ($300,000) for both machines. Should the Smith Company purchase the new machine or continue to operate with the old machine?

7. You are considering entering into the Ivy University MBA program in September 1995. This is a two year program, with tuition expected to be $14,000, payable in September 1995 and again in September 1996. By entering this program, you will delay entry into the job market. If you were to enter the job market in September 1995 instead of getting your MBA, your starting salary would be $20,000 (assume for sake of simplicity, payable in September 1995) and is expected to grow at an annual rate of 5% until you retire in September 2038. (Again, assume that all annual salaries are

paid in September of each year. The salary compensates for work of the following year.) The tax rate on your salary is assumed to be 25%, regardless of your income. No tax deductions will be allowed. If you enter the MBA program, you would enter the job market in September 1997 at a starting salary of $30,000, which will grow at an annual rate of 6% until you retire in September 2038. Assume that all cash flows are to be discounted at a rate of ten percent. From a financial perspective, does the MBA seem to be an attractive investment? By how much does it increase the NPV of your lifetime earnings?

8. The Morrison Shoe Company is considering expanding its shoe retail business. This expansion will increase its retail shoe sales from $800,000 per year to $1,500,000. However, this increased business means that the retail must move out of its current location to a larger one. The current building cost the Morrison Company $800,000 ten years ago, is depreciated on a straight line basis, and when purchased, had a life expectancy of fifty years along with a salvage value of $100,000. The current market value of the old retail outlet building is $900,000. It will be sold if it is to be replaced by a new building. The building for the new outlet will cost $1,800,000, will be depreciated on a straight-line basis, will have a salvage value of $300,000 and will have a life expectancy of forty years. Costs of operating the expanded retail outlet will increase from $400,000 per year to $700,000 per year. The company operates in a forty percent tax bracket and discounts all cash at a rate of ten percent. Should the Morrison Company sell its old building, purchase the new one and expand its business?

9. Orvis Car Rental Company, a 100% equity financed firm is considering the purchase of a fleet of new trucks for lease to the public. The firm's only line of business at present is leasing automobiles to the public. This fleet will cost $4,000,000 and has a risk level comparable to the car fleet currently owned by the firm. The fleet of trucks is projected to generate revenues totaling $2,000,000 for each of the next five years. Operating costs are projected to total $500,000 for the first year of operations and increase by 30% each year that the trucks are operated. The trucks will be depreciated on a straight line basis over a five year period with a salvage value of $1,000,000. The truck fleet purchase will necessitate an additional investment of $200,000 in an inventory of parts which will be released (in effect, the parts will be sold at cost) when the fleet of trucks is salvaged. The firm' current stock beta is 1.5 and the firm's projected net income from automobile leasing is expected to be $3,000,000 per year for each of the next five years. The firm is expected to operate in a forty percent tax bracket indefinitely and treasury rates are projected to be 5% for the foreseeable future. Economists project a ten percent market return for each of the next five years.

a. What is the NPV of the fleet purchase?
b. What is the IRR of the fleet purchase?

10. The Fox Company has the opportunity to merge with the Appling Company by purchasing its stock for $970,000. The Appling Company generated $150,000 last year in after tax income. However, this income is projected to decline each year at a rate of five percent from its level in the prior year. This decline is projected to continue indefinitely. The Fox Company discounts all of its cash flows at the same rate, determined by the Capital Asset Pricing Model. The riskless rate is five percent and the covariance of Fox Company returns with market returns has been shown to be 0. The current market value of Fox is $2,000,000, its level since the company was founded (All of its earnings are paid in dividends.). The standard deviation of market returns is .10. The required

return on the market portfolio is .08. Should the merger be completed? What is the present value of cash flows generated by Appling Company?

11.* The Belanger Company has the opportunity to purchase for $5,000,000 a machine which can produce units of the company's product at a cost of $20 per unit and sold for $35 per unit. This machine has a life expectancy of seven years, at which time it would be salvaged for $300,000. The machine would be depreciated on a straight line basis. Alternatively, the company could contract out the production of this commodity to another manufacturer at a cost of $25 per unit to be sold for $35. This contractual arrangement would also be expected to last seven years also. The company's profits are taxed at a rate of 30% and are discounted at a rate of 10%. The company expects that its profitability will be higher by purchasing the machine if it is able to produce enough output. Assuming that the company can sell all that it produces or purchases, what is the minimum number of units of the company's product that the machine be capable of producing if it is to be an acceptable purchase?

12. A firm needs to decide between the purchase of two computer systems. The first system, a Moon Microgalactica, currently sells for $25,000; the second, a Star Minicom sells for $30,000. Both systems have ten year life expectancies. The Moon system has an expected salvage value of $5,000 and the Star system has an expected salvage value of $10,000. The Moon system requires the firm to maintain a $5000 inventory of miscellaneous hardware on hand; this hardware can be sold when the system is salvaged. Thus, this inventory can be treated as a working capital requirement. Both systems have identical operating costs and will be depreciated on a straight line basis. The firm discounts all cash flows at a rate of ten percent and operates in a forty percent income tax bracket. Does the NPV of the Moon system exceed that of the Star system? If your answer is yes (or no), by how much do their prices differ?

Solutions

1. a. Payback period = 3.25 yrs ; reject

b. Expected return = 8% ; accept

c. $-100{,}000 + \$10{,}000/(1+r) + \$40{,}000/(1+r)^2 + \$40{,}000/(1+r)^3 + \$40{,}000/(1+r)^4 + \$10{,}000/(1+r)^5 = 0$

r = IRR = 12.1249% > .05 ; accept

d. $NPV = -100{,}000 + \$10{,}000/(1.05) + \$40{,}000/(1.05)^2 + \$40{,}000/(1.05)^3 + \$40{,}000/(1.05)^4 + \$10{,}000/(1.05)^5 = 21{,}100$

NPV = 21,100 > 0 ; accept

e. [\$10,000/(1.05)^1 + \$40,000/(1.05)^2 + \$40,000/(1.05)^3 + \$40,000/(1.05)^4 + \$10,000/(1.05)^5] / 100,000 = 1.211

PI = 1.211 > 1 ; accept

f. Use NPV ; accept

2 a.

Machine A	Cash Flow
Time 0 cash flow =	-16,000
Time 1 cash flow = [100,000(.08-.01)(1-.3)] + $\left[\frac{16{,}000-2000}{5} \times .3\right]$ =	+ 5,740
Time 2 cash flow = [100,000(.07 x .7)] + [2800 x .3]=	+ 5,740
Time 3 cash flow = 4900 + 840 =	+ 5,740
Time 4 cash flow =	+ 5,740
Time 5 cash flow = 5740 + 2000 =	+ 7,740

Machine B	
Time 0 cash flow =	- 8,000
Time 1 cash flow =	+ 2,635
Time 2 cash flow =	+ 2,635
Time 3 cash flow =	+ 2,635
Time 4 cash flow =	+ 2,635
Time 5 cash flow =	+ 4,635

b. Payback A = 2.787 yrs. Payback B = 3.036 yrs.

ROI_A = 18.375% ROI_B = 17.9375%

IRR_A = 25% IRR_B = 23%

c. A 10% discount rate was given.

$$NPV_A = -16{,}000 + \frac{5740}{1.1} + \frac{5740}{1.1^2} + \frac{5740}{1.1^3} + \frac{5740}{1.1^4} + \frac{7740}{1.1^5} = 7000.96$$

$$NPV_B = -8{,}000 + \frac{2635}{1.1} + \frac{2635}{1.1^2} + \frac{2635}{1.1^3} + \frac{2635}{1.1^4} + \frac{4635}{1.1^5} = 3230.57$$

d. $PI_A = \frac{22996.49}{16{,}000} = 1.43756$

$PI_B = \frac{11228.49}{8{,}000} = 1.4038213$

e. Machine A: Its NPV is higher.

3

OLD	NEW
P_{-4} = 600,000	Depr = SL
TIV = 400,000	SV = 100,000
Depr = SL	P_o = 800,000
SV = 100,000	Prod = 80,000
n = 6 yrs.	Price = 10
Prod. = 50,000	T = .4
Price = 10	K = .12
T = .4	ITC = 40,000
K = .12	n = 6 yrs.

NPV_{old} = [(50,000 x 10)(1-.4) + (600,000-100,000)/10 x .4]

$$\times \left[\frac{1}{.12} - \frac{1}{.12(1.12)^6} + \frac{100{,}000}{1.12^6} \right]$$

= [300,000 + 20,000]x[4.1114] + 50,663 = 1,366,311

NPV_{new} = [-800,000 + 400,000 + 40,000]

+ [(80,000 x 10)(1.-.4) + (800,000-100,000)/6 x .4]

$$\times \frac{1}{.12} - \frac{1}{.12(1.12)^6} + \frac{100{,}000}{1.12^6}$$

= -360,000 + 2,165,333 + 50,663 = 1,856,000

BUY THE NEW MACHINE

Now, try the new discount rate of 20%:

$$NPV_{OLD} = [320{,}000 \times 3.3255] + 33{,}489.80 = 1{,}097{,}649.80$$

$$NPV_{new} = -360{,}000 + 1{,}884{,}450 + 33{,}489.80 = 1{,}424{,}919.80$$

The answer does not change

4

RENT	BUY
Rent = 5,000	P_o = 100,000
g = .06	g = .06
n = 40 yrs.	Down = 20,000
T = .3	i = 10%
K = .10	mort. n = 10 yrs.
	n = 40 yrs.
	maint. = 1000
	T = .3
	K = .10

Annual Mortgage Payment= 80,000 / $\left[\frac{1}{.1} - \frac{1}{.1(1.1)^{10}}\right]$=13,019.63

Amortization Table

t	Prin	Int	Pay. to Prin.
1	80,000	8000	5019
2	74,980	7498	5521
3	69,548	6945	6073
4	63,385	6338	6681
5	56,703	5670	7349
6	49,354	4935	8084
7	41,270	4127	8892
8	32,377	3237	9781
9	22,596	2259	10760
10	11,836	1183	11836

$$NPV_{rent} = -5000 \left[\frac{1}{.1-.06} - \frac{1.06^{40}}{(.1-.06)(1.1)^{40}}\right] = -98{,}200.21$$

. .

$$NPV_{buy} = -20{,}000 - 13{,}019.63 \times \left[\frac{1}{.10} - \frac{1}{.10(1.10)^{10}}\right]$$

$$- 1000 \times \left[\frac{1}{.1-.06} - \frac{1.06^{40}}{(.1-.06)(1.1)^{40}}\right]$$

$$+ \frac{.3 \times 8000}{1.1} + \frac{.3 \times 7498}{1.1^2} + \frac{.3 \times 6945}{1.1^3} + \frac{.3 \times 6338}{1.1^4} + \frac{.3 \times 5670}{1.1^5}$$

$$+ \frac{.3 \times 4935}{1.1^6} + \frac{.3 \times 4127}{1.1^7} + \frac{.3 \times 3237}{1.1^8} + \frac{.3 \times 2259}{1.1^9} + \frac{.3 \times 1183}{1.1^{10}}$$

$$+ \frac{(1.06^{40}) \times 100{,}000}{1.1^{40}} = 89{,}679$$

5 $$NPV_{lease} = -20000 \left[\frac{1}{.1} - \frac{1}{.1(1.1)^5}\right][1-.3] = -53{,}071$$

$$NPV_{buy} = [-100{,}000 + 8{,}000]$$

$$+ [(100{,}000-15{,}000)/5] \times .3 \times \left[\frac{1}{1} - \frac{1}{.1(1.1)^5}\right]$$

$$+ \frac{15000}{1.1^5} = -63{,}353.71$$

Leasing is preferred - its NPV is higher.

6 We evaluate cash flows on the old and new machines as follows:

$$NPV_{old} = [540{,}000(1-.4) + (\frac{700{,}000-100{,}000}{10} \times .4)][\frac{1}{.11} - \frac{1}{.11(1.11)^6}] + \frac{100{,}000}{(1+.11)^6} = 1{,}525{,}691.257$$

$$NPV_{new} = -900{,}000 + 45{,}000 + 300{,}000 + [(700{,}000 - 240{,}000 - 300{,}000) \times .4]$$

$$+ [900{,}000(1-.4) + (\frac{900{,}000-100{,}000}{6} \times .4)][\frac{1}{.11} - \frac{1}{.11(1.11)^6}] + \frac{100{,}000}{(1+.11)^6} = 2{,}027{,}583.21$$

Since $NPV_{NEW} > NPV_{OLD}$, the Smith Company should purchase the new machine.

7. First, evaluate cash flows associated with obtaining the MBA as follows:

NPV_{MBA} = -14,000*PVAF(.1,2)
+ [$30,000*(1.25)*PVGAF(.1,41,.06)]/[1.1]^2 = $338,771.5393

where PVAF(.1,2) is the two year present value annuity factor with a 10% discount rate and PVGAF (k = .1, n = 41 and g = .06) is the 41 year present value growing annuity factor with a 10% discount rate and a 6% growth rate. Next, evaluate the cash flows associated with working instead as follows:

NPV_{work} = +20,000*(1-.25)*PVGAF(.1,43,.05) = $259,414.06 ;

Select the higher NPV option; thus, the MBA is the appropriate alternative.

8. Evaluate cash flows on the alternatives as follows:

$$NPV_{old} = \{[(800{,}000-400{,}000)(1-.4)+(14{,}000\cdot.4)]\}[\frac{1}{.1}-\frac{1}{.1(1.1^{40})}]+\frac{100{,}000}{1.1^{40}} = 2{,}403{,}944.35$$

$$NPV_{new} = -1{,}800{,}000+900{,}000+\{[(,500{,}000-700{,}000)\cdot(1-.4)+((1{,}800{,}000-300{,}000-240{,}000)/40\cdot.4]\}$$
$$\cdot\left\{\frac{1}{.1}-\frac{1}{.1(1.1^{40)}}\right\}+\frac{300{,}000}{1.1^{40}} = 3{,}923{,}788.86$$

The new outlet should be purchased.

9.a. Net Present Value is determined as follows:

$$NPV = -4{,}000{,}000-200{,}000+[2{,}000{,}000(1-.4)+600{,}000\cdot.4]\left[\frac{1}{.125}-\frac{1}{.125(1.125)^5}\right]$$
$$-500{,}000\cdot(1-.4)\cdot\left[\frac{1}{.125-.3}-\frac{(1+.3)^5}{(.125-.3)(1.125^5)}\right]+\frac{(1{,}000{,}000+200{,}000)}{(1.125^{5)}} = -224{,}716.62$$

b. Set NPV equal to zero, solve for r and find that IRR = .1040408

10. First, determine an appropriate risk-adjusted discount rate for the Appling Company:

k_{Fox} = .05 + 0(.08-.05) = .05 ; $_{Fox}$=0 since cov[R_{Fox},R_M] = 0

Note that the anticipated growth rate for the Appling Company equals g_{Fox} = -.05. The present value associated with the merger is determined as follows:

$$NPV_{Fox} = -970{,}000+\frac{150{,}000}{.05-.05} = 530{,}000$$

The merger should be completed since NPV > 0. (Note that the first year cash flow reflects one year of growth: CF_1 = 142,500.)

11. First, set up appropriate NPV functions for the machine purchase and for contracting out production as follows:

$$NPV_{BUY} = -\$5{,}000{,}000 + \left\{ \left[(35-20)(\#units)(1-.3) \right] + \left(\frac{5{,}000{,}000 - 300{,}000}{7} \cdot .3 \right) \right\} \cdot \left[\frac{1}{.1} - \frac{1}{.1(1.1)^7} \right]$$

$$+ \frac{300{,}000}{(1+.1)^7} = -\$3{,}865{,}413.92 + (\$51.11839 \cdot \#units)$$

$$NPV_{CONTRACTOUT} = \left[(35-20)(\#units)(1-.3) \right] \left[\frac{1}{.1} - \frac{1}{.1(1.1)^7} \right] = 34.0789 \cdot \#unit$$

Solve for the number of units by setting equal the two NPVs:

$$-\$3{,}865{,}413.92 + (\$51.11839 \cdot \#units) = \$34.07893 \cdot \#units;$$

$$\#units = 226{,}850.75$$

12. The NPVs are the same. The working capital requirement offsets the difference between the purchase prices at time zero and the differences in salvage value in the tenth year. The depreciation write-offs are the same for both systems.