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CHAPTER 1 RELEVANT COSTS FOR DECISION MAKING

Introduction

Managers must decide what products to sell, whether to make or buy component parts, what prices to charge, what channels of distribution to use, whether to accept special orders at special prices, and so forth. Making such decisions is often a difficult task that is complicated by numerous alternatives and massive amounts of data, only some of which may be relevant.

Every decision involves choosing from among at least two alternatives. In making a decision, the costs and benefits of one alternative must be compared to the costs and benefits of other alternatives. Costs that differ between alternatives are called relevant costs. Distinguishing between relevant and irrelevant costs and benefits is critical for two reasons. First, irrelevant data can be ignored—saving decision makers tremendous amounts of time and effort. Second, bad decisions can easily result from erroneously including irrelevant costs and benefits when analyzing alternatives. To be successful in decision making, managers must be able to tell the difference between relevant and irrelevant

data and must be able to correctly use the relevant data in analyzing alternatives. The purpose of this chapter is to develop these skills by illustrating their use in a wide range of decision-making situations. These decision-making skills are as important in your personal life as they are to managers. After completing your study of this chapter, you should be able to think more clearly about decisions in many facets of your life.

Cost Concepts for Decision Making

Four cost terms are particularly applicable to this chapter. These terms are differential costs, incremental costs, opportunity costs, and sunk costs.

Identifying Relevant Costs and Benefits

Only those costs and benefits that differ in total between alternatives are relevant in a decision. If the total amount of a cost will be the same regardless of the alternative selected, then the decision has no effect on the cost, so the cost can be ignored. For example, if you are trying to decide whether to go to a movie or rent a DVD for the

evening, the rent on your apartment is irrelevant. Whether you go to a movie or rent a DVD, the rent on your apartment will be exactly the same and is therefore irrelevant to the decision. On the other hand, the cost of the movie ticket and the cost of renting the DVD would be relevant in the decision because they are avoidable costs.

An avoidable cost is a cost that can be eliminated in whole or in part by choosing one alternative over another. By choosing the alternative of going to the movie, the cost of renting the DVD can be avoided. By choosing the alternative of renting the DVD, the cost of the movie ticket can be avoided. Therefore, the cost of the movie ticket and the cost of renting the DVD are both avoidable costs. On the other hand, the rent on your apartment is not an avoidable cost of either alternative. You would continue to rent your apartment under either alternative. Avoidable costs are relevant costs. Unavoidable costs are irrelevant costs.

Two broad categories of costs are never relevant in decisions. These irrelevant costs are:

1. Sunk costs.

2. Future costs that do not differ between the alternatives.

As we learned in an earlier chapter, a sunk cost is a cost that has already been incurred and cannot be avoided regardless of what a manager decides to do. For example, suppose a used car dealer purchased a five-year-old Toyota Camry for $12,000. The amount paid for the Camry is a sunk cost because it has already been incurred and the transaction cannot be undone. Sunk costs are always the same no matter what alternatives are being considered; therefore, they are irrelevant and should be ignored when making decisions. Future costs that do not differ between alternatives should also be ignored when making decisions. Continuing with the example discussed earlier, suppose you intend to order a pizza after you go to the movie theater or you rent a DVD. In that case, if you are going to buy the same pizza regardless of your choice of entertainment, its cost is irrelevant to the choice of whether you go to the movie theater or rent a DVD.

Notice, the cost of the pizza is not a sunk cost because it has not yet been incurred. Nonetheless, the cost of the pizza is irrelevant to the entertainment decision because it is a future cost that does not differ between the alternatives.

the terms avoidable cost, differential cost, incremental cost, and relevant cost are often used interchangeably. To identify the costs that are avoidable in a particular decision situation and are therefore relevant, these steps should be followed:

1. Eliminate costs and benefits that do not differ between alternatives. These irrelevant costs consist of (a) sunk costs and (b) future costs that do not differ between alternatives.

2. Use the remaining costs and benefits that do differ between alternatives in making the decision. The costs that remain are the differential, or avoidable, costs.

Different Costs for Different Purposes

We need to recognize a fundamental concept of accounting from the outset of our discussion—costs that are relevant in one decision situation are not necessarily relevant in another. This means that managers need different costs for different purposes. For one purpose, a particular group of costs may be relevant; for another purpose, an entirely different group of costs may be relevant. Thus, each decision situation must be carefully analyzed to isolate the relevant costs. Otherwise, irrelevant data may cloud the situation and lead to a bad decision.

The concept of "different costs for different purposes" is basic to decision making; we shall frequently see its application in the pages that follow.

An Example of Identifying Relevant Costs and Benefits

Cynthia is currently a student in an MBA program in Boston and would like to visit a friend in New York City over the weekend. She is trying to decide whether to drive or take the train. Because she is on a tight budget, she

wants to carefully consider the costs of the two alternatives. If one alternative is far less expensive than the other, that may be decisive in her choice. By car, the distance between her apartment in Boston and her friend's apartment in New York City is 230 miles. Cynthia has compiled the following list of items to consider:

Automobile Costs

	Item	**Annual Cost of Fixed Items**	**Cost per Mile (based on 10,000 miles per year)**
(a)	Annual straight-line depreciation on car [($24,000 original cost - $10,000 estimated resale value in 5 years)/5 years]	$2,800	$0.280
(b)	Cost of gasoline ($2.70 per gallon + 27 miles per gallon)		0.100
(c)	Annual cost of auto insurance and license	$1,380	0.138
(d)	Maintenance and repairs		0.065
(e)	Parking fees at school ($45 per month **x** 8 months)	$360	0.036
(f)	Total average cost per mile		$0.619

Additional Data

	Item		
(g)	Reduction in the resale value of car due solely to wear and tear	$0.026	per-mile
(h)	Cost of round-trip Amtrak ticket from Boston to		

	New York City	$104
(i)	Benefit of relaxing and being able to study during the train ride rather than having to drive	?
(i)	Cost of putting the dog in a kennel while gone	$40
(k)	Benefit of having a car available in New York City	?
(1)	Hassle of parking the car in New York City	?
(m)	Cost of parking the car in New York City	$25 per day

Which costs and benefits are relevant in this decision? Remember, only those costs and benefits that differ between alternatives are relevant. Everything else is irrelevant and can be ignored.

Start at the top of the list with item (a): the original cost of the car is a sunk cost. This cost has already been incurred and therefore can never differ between alternatives. Consequently, it is irrelevant and should be ignored. The same is true of the accounting depreciation of $2,800 per year, which simply spreads the sunk cost across five years.

Item (b), the cost of gasoline consumed by driving to New York City, is a relevant cost. If Cynthia takes the train, this cost would not be incurred. Hence, the cost differs between alternatives and is therefore relevant.

Item (c), the annual cost of auto insurance and license, is not relevant. Whether Cynthia takes the train or drives on this particular trip, her annual auto insurance premium and her auto license fee will remain the same.

Item (d), the cost of maintenance and repairs, is relevant. While maintenance and repair costs have a large random component, over the long run they should be more or less proportional to the number of miles the car is driven. Thus, the average cost of $0.065 per mile is a reasonable estimate to use.

Item (e), the monthly fee that Cynthia pays to park at her school during the academic year is not relevant. Regardless of which alternative she selects—driving or taking the train—she will still need to pay for parking at school.

Item (f) is the total average cost of $0.619 per mile. As discussed above, some elements of this total are relevant, but some are not relevant. Because it contains some irrelevant costs, it would be incorrect to estimate the cost of driving to New York City and back by simply

multiplying the $0.619 by 460 miles (230 miles each way X 2). This erroneous approach would yield a cost of driving of $284.74. Unfortunately, such mistakes are often made in both personal life and in business. Because the total cost is stated on a per-mile basis, people are easily misled. Often people think that if the cost is stated as $0.619 per mile, the cost of driving 100 miles is $61.90. But it is not. Many of the costs included in the $0.619 cost per mile are sunk and/or fixed and will not increase if the car is driven another 100 miles. The $0.619 is an average cost, not an incremental cost. Beware of such unitized costs (i.e., costs stated in terms of a dollar amount per unit, per mile, per direct labor-hour, per machine-hour, and so on)—they are often misleading.

Item (g), the decline in the resale value of the car that occurs as a consequence of driving more miles, is relevant in the decision. Because she uses the car, its resale value declines, which is a real cost of using the car that should be taken into account. Cynthia estimated this cost by accessing the Kelly Blue Book website at www.kbb.com.

The reduction in resale value of an asset through use or over time is often called real or economic depreciation. This is different from accounting depreciation, which attempts to match the sunk cost of an asset with the periods that benefit from that cost.

Item (h), the $104 cost of a round-trip ticket on Amtrak, is relevant in this decision. If she drives, she would not have to buy the ticket.

Item (i) is relevant to the decision, even if it is difficult to put a dollar value on relaxing and being able to study while on the train. It is relevant because it is a benefit that is available under one alternative but not under the other.

Item (j), the cost of putting Cynthia's dog in the kennel while she is gone, is irrelevant in this decision. Whether she takes the train or drives to New York City, she will still need to put her dog in a kennel.

Like item (i), items (k) and (l) are relevant to the decision even if it is difficult to measure their dollar impacts.

Item (m), the cost of parking in New York City, is relevant to the decision.

Bringing together all of the relevant data, Cynthia would estimate the relevant costs of driving and taking the train as follows:

Relevant financial cost of driving to New York City:	
-Gasoline (460 miles x $0.100 per mile)	$46
-Maintenance and repairs (460 miles x $0.065 per mile)	29.9
-Reduction in the resale value of car due solely to wear and tear (460 miles X $0.026 per mile)	11.96
- Cost of parking the car in New York City (2 days x $25 per day)	50
total	$137.86
Relevant financial cost of taking the train to New York City:	
Cost of round-trip Amtrak ticket from Boston to New York City	$104

What should Cynthia do? From a purely financial standpoint, it would be cheaper by $33.86 ($137.86 - $104.00) to take the train than to drive. Cynthia has to decide if the convenience of having a car in New York City outweighs the additional cost and the disadvantages of being unable to relax and study on the train and the hassle of finding parking in the city.

In this example, we focused on identifying the relevant costs and benefits—everything else was ignored. In the next example, we include all of the costs and benefits—relevant or not. Nonetheless, we'll still get the correct answer because the irrelevant costs and benefits will cancel out when we compare the alternatives.

Reconciling the Total and Differential Approaches

Oak Harbor Woodworks is considering a new labor-saving machine that rents for $3,000 per year. The machine will be used on the company's butcher block production line. Data concerning the company's annual sales and costs of butcher blocks with and without the new machine are shown next:

	Current Situation	Situation withthe New Machine
Units produced and sold	5,000	5,000
Selling price per unit	$40	$40
Direct materials cost per unit	$14	$14
Direct labor cost per unit	$8	$5
Variable overhead cost per unit	$2	$2
Fixed costs, other	$62,000	$62,000
Fixed costs, rental of new machine	—	$3,000

Given the data above, the net operating income for the product under the two alternatives can be computed as shown below

Note that the net operating income is $12,000 higher with the new machine, so that is the better alternative. Note also that the $12,000 advantage for the new machine can be obtained in two different ways. It is the difference between the $30,000 net operating income with the new machine and the $18,000 net operating income for the current situation. It is also the sum of the differential costs and benefits as shown in the last column. A positive number in the Differential Costs and Benefits column indicates that the difference between the alternatives favors the new machine; a negative number indicates that the difference

favors the current situation. A zero in that column simply means that the total amount for the item is exactly the same for both alternatives. Thus, because the difference in the net operating incomes equals the sum of the differences for the individual items, any cost or benefit that is the same for both alternatives will have no impact on which alternative is preferred. This is the reason that costs and benefits that do not differ between alternatives are irrelevant and can be ignored. If we properly account for them, they will cancel out when we compare the alternatives.

Exhibit 1

	Current Situation	Situation with New Machine	Differential Costs and Benefits
Sales (5,000 units **x** $40 per unit)	$200,000	$200,000	$ 0
Variable expenses:			
Direct materials (5,000 units **x** $14 per unit)	70,000	70,000	0
Direct labor (5,000 units **x** $8 per unit; 5,000 units **x** $5 per unit)	40,000	25,000	*15,000*
Variable overhead (5,000 units **x** $2 per unit)	10,000	10,000	0
Total variable expenses	120,000	105,000	
Contribution margin	80,000	95,000	
Fixed expenses:			
Other	62,000	62,000	0
Rent of new machine	0	3,000	*(3,000)*
Total fixed expenses	$62,000	$65,000	
	$18000	$30000	$12,000

We could have arrived at the same solution much more quickly by completely ignoring the irrelevant costs and benefits.

- The selling price per unit and the number of units sold do not differ between the alternatives. Therefore, the total sales revenues are exactly the same for the two alternatives as shown in Exhibit 1. Because the sales

revenues are exactly the same, they have no effect on the difference in net operating income between the two alternatives. That is shown in the last column in Exhibit 1, which shows a $0 differential benefit.

- The direct materials cost per unit, the variable overhead cost per unit, and the number of units produced and sold do not differ between the alternatives. Consequently, the total direct materials cost and the total variable overhead cost is the same for the two alternatives and can be ignored.

- The “other” fixed expenses do not differ between the alternatives, so they can be ignored as well.

Indeed, the only costs that do differ between the alternatives are direct labor costs and the fixed rental cost of the new machine. Hence, the two alternatives can be compared based only on these relevant costs:

Net Advantage of Renting the New Machine

Decrease in direct labor costs (5,000 units at a cost savings of $3 per unit)	15000
Increase in fixed expenses	(3000)
Net annual cost savings from renting the new machine	$12000

If we focus on just the relevant costs and benefits, we get exactly the same answer as when we listed all of the costs and benefits—including those that do not differ between the alternatives and hence are irrelevant. We get the same answer because the only costs and benefits that matter in the final comparison of the net operating incomes are those that differ between the two alternatives and hence are not zero in the last column. Those two relevant costs are both listed in the above analysis showing the net advantage of renting the new machine.

Why Isolate Relevant Costs?

In the preceding example, we used two different approaches to analyze the alternatives. First, we considered all costs, both those that were relevant and

those that were not; and second, we considered only the relevant costs. We obtained the same answer under both approaches. It would be natural to ask, “Why bother to isolate relevant costs when total costs will do the job just as well?” Isolating relevant costs is desirable for at least two reasons.

First, only rarely will enough information be available to prepare a detailed income statement for both alternatives. Assume, for example, that you are called on to make a decision relating to a portion of a single business process in a multidepartmental, multi-product company. Under these circumstances, it would be virtually impossible to prepare an income statement of any type. You would have to rely on your ability to recognize which costs are relevant and which are not in order to assemble the data necessary to make a decision.

Second, mingling irrelevant costs with relevant costs may cause confusion and distract attention from the information that is really critical. Furthermore, the danger always exists that an irrelevant piece of data may be used

improperly, resulting in an incorrect decision. The best approach is to ignore irrelevant data and base the decision entirely on relevant data.

Relevant cost analysis, combined with the contribution approach to the income statement, provides a powerful tool for making decisions. We will investigate various uses of this tool in the remaining sections of this chapter.

Adding and Dropping Product Lines and Other Segments

Decisions relating to whether product lines or other segments of a company should be dropped and new ones added are among the most difficult that a manager has to make. In such decisions, many qualitative and quantitative factors must be considered. Ultimately, however, any final decision to drop a business segment or to add a new one is going to hinge primarily on the impact the decision will have on net operating income. To assess this impact, costs must be carefully analyzed.

An Illustration of Cost Analysis

Exhibit 2 provides sales and cost information for the preceding month for the Discount Drug Company and its three major product lines—drugs, cosmetics, and housewares. A quick review of this exhibit suggests that dropping the housewares segment would increase the company's overall net operating income by $8,000. However, this would be a flawed conclusion because the data in Exhibit do not distinguish between fixed expenses that can be avoided if a product line is dropped and common fixed expenses that cannot be avoided by dropping any particular product line.

In this scenario, the two alternatives under consideration are keeping the housewares product line and dropping the housewares product line. Therefore, only those costs that differ between these two alternatives (i.e., that can be avoided by dropping the house-wares product line) are relevant. In deciding whether to drop housewares, it is crucial to identify which costs can be avoided, and hence are relevant to the decision, and which costs cannot be

avoided, and hence are irrelevant. The decision should be analyzed as follows.

If the housewares line is dropped, then the company will lose $20,000 per month in contribution margin, but by dropping the line it may be possible to avoid some fixed costs such as salaries or advertising costs. If dropping the housewares line enables the company to avoid more in fixed costs than it loses in contribution margin, then its overall net operating income will improve by eliminating the product line. On the other hand, if the company is not able to avoid as much in fixed costs as it loses in contribution margin, then the housewares line should be kept. In short, the manager should ask, “What costs can I avoid if I drop this product line?”

As we have seen from our earlier discussion, not all costs are avoidable. For example, some of the costs associated with a product line may be sunk costs. Other costs may be allocated fixed costs that will not differ in total regardless of whether the product line is dropped or retained.

To show how to proceed in a product-line analysis, suppose that Discount Drug Company has analyzed the fixed costs being charged to the three product lines and has determined the following:

1. The salaries expense represents salaries paid to employees working directly on the product. All of the employees working in housewares would be discharged if the product line is dropped.

2. The advertising expense represents advertisements that are specific to each product line and are avoidable if the line is dropped.

3. The utilities expense represents utilities costs for the entire company. The amount charged to each product line is an allocation based on space occupied and is not avoidable if the product line is dropped.

4. The depreciation expense represents depreciation on fixtures used to display the various product lines. Although the fixtures are nearly new, they are custom-

built and will have no resale value if the housewares line is dropped.

Exhibit -2

		Product Line		
	Total	**Drugs**	**Cosmetics**	**House-wares**
Sales	$250,000	$125,000	$75,000	$50,000
Variable expenses	105,000	50,000	25,000	30,000
Contribution margin	145,000	75,000	50,000	20,000
Fixed expenses:				
Salaries	50,000	29,500	12,500	8,000
Advertising	15,000	1,000	7,500	6,500
Utilities	2,000	500	500	1,000
Depreciation—fixtures	5,000	1,000	2,000	2,000
Rent	20,000	10,000	6,000	4,000
Insurance	3,000	2,000	500	500
General administrative	30,000	15,000	9,000	6,000
Total fixed expenses	125,000	59,000	38,000	28,000
Net operating income (loss)	$ 20,000	$ 16,000	$12,000	$ (8,000)

5. The rent expense represents rent on the entire building housing the company; it is allocated to the product lines on the basis of sales dollars. The monthly rent of $20,000 is fixed under a long-term lease agreement.

6. The insurance expense is for insurance carried on inventories within each of the three product lines. If housewares is dropped, the related inventories will be liquidated and the insurance premiums will decrease accordingly.

7. The general administrative expense represents the costs of accounting, purchasing, and general management, which are allocated to the product lines on the basis of sales dollars. These costs will not change if the housewares line is dropped.

With this information, management can determine that $15,000 of the fixed expenses associated with the housewares product line is avoidable and $13,000 are not:

Fixed Expenses	Total Cost Assigned to Housewares	Not Avoidable*	Avoidable
Salaries	$ 8,000		$ 8,000
Advertising	6,500		6,500
Utilities	1,000	$ 1,000	
Depreciation-fixtures	2,000	2,000	
Rent	4,000	4,000	
Insurance	500		500
General administrative	6,000	6,000	
Total	$28,000	$13000	$15,000

*These fixed costs represent either sunk costs or future costs that will not change whether the housewares line is retained or discontinued

As stated earlier, if the housewares product line were dropped, the company would lose the product's contribution margin of $20,000, but would save its associated avoidable fixed expenses. We now know that those avoidable fixed expenses total $15,000. Therefore, dropping the housewares product line would result in a $5,000 reduction in net operating income as shown below:

Contribution margin lost if the housewares line is discontinued	$(20000)
Less fixed costs that can be avoided if the housewares line is discontinued(see above)	15000
Decrease in overall company net operating income	($5000)

In this case, the fixed costs that can be avoided by dropping the housewares product line ($15,000) are less than the contribution margin that will be lost ($20,000). Therefore, based on the data given, the housewares line should not be discontinued unless a more profitable use can be found for the floor and counter space that it is occupying.

A Comparative Format

This decision can also be approached by preparing comparative income statements showing the effects of either keeping or dropping the product line. Exhibit below contains such an analysis for the Discount Drug Company. As shown in the last column of the exhibit, if the housewares line is dropped, then overall company net operating income will decrease by $5,000 each period.

This is the same answer, of course, as we obtained when we focused just on the lost contribution margin and avoidable fixed costs.

A Comparative Format for Product-Line Analysis-Exhibit 3

	Keep Housewares	Drop Housewares	Difference: Net Operating Income Increase (or Decrease)
Sales	$50,000	$ 0	$(50,000)
Variable expenses	30,000	0	30,000
Contribution margin	20,000	0	(20,000)
Fixed expenses:			
Salaries	8,000	0	8,000
Advertising	6,500	0	6,500
Utilities	1,000	1,000	0
Depreciation—fixtures	2,000	2,000	0
Rent	4,000	4,000	0
Insurance	500	0	500
General administrative	6,000	6,000	0
Total fixed expenses	28,000	13,000	15,000
Net operating income (loss)	$ (8,000)	$(13,000)	$ (5,000)

Beware of Allocated Fixed Costs

Go back to Exhibit 2. Does this exhibit suggest that the housewares product line should be kept—as we have just concluded? No, it does not. Exhibit 2 suggests that the housewares product line is losing money. Why keep a product line that is showing a loss? The explanation for this apparent inconsistency lies in part with the common fixed costs that are being allocated to the product lines. one of the great dangers in allocating common fixed costs is that such allocations can make a product line (or other segment of a business) look less profitable than it really is. In this instance, allocating the common fixed costs among all product lines makes the house-wares product line appear to be unprofitable. However, as we have shown above, dropping the product line would result in a decrease in the company's overall net operating income. This point can be seen clearly if we redo Exhibit 2 by eliminating the allocation of the common fixed costs. Exhibit 4 uses the segmented approach from to estimate the profitability of the product lines.

Exhibit 4 gives us a much different perspective of the housewares line than does Exhibit 2. As shown in Exhibit 4, the housewares line is covering all of its own traceable fixed costs and generating a $3,000 segment margin toward covering the common fixed costs of the company. Unless another product line can be found that will generate a segment margin greater than $3,000, the company would be better off keeping the housewares line. By keeping the product line, the company's overall net operating income will be higher than if the product line were dropped.

Additionally, managers may choose to retain an unprofitable product line if the line helps sell other products or if it serves as a "magnet" to attract customers. Bread, for example, may not be an especially profitable line in some food stores, but customers expect it to be available, and many of them would undoubtedly shift their buying elsewhere if a particular store decided to stop carrying it.

Exhibit-4

	Product line			
	Total	**Drugs**	**Cosmetics**	**House-wares**
Sales	$250,000	$125,000	$75,000	$50,000
Variable expenses	105,000	50,000	25,000	30,000
Contribution margin	145,000	75,000	50,000	20,000
Traceable fixed expenses				
salaries	50,000	29,500	12,500	8,000
advertising	15,000	1,000	7,500	6,500
Depreciation-fixtures	5,000	1,000	2,000	2,000
insurance	3,000	2,000	500	500
Total traceable fixed expenses	73,000	33,500	22,500	17,000
Product-line segment margin	72,000	$ 41,500	$27,500	$ 3,000*

Common fixed expenses	
utilities	2000
Rent	20000
General administrative	30000
Total common fixed expenses	52000
Net operating income	$20000

*If the housewares line is dropped, this $3,000 in segment margin will be lost to the company. In addition, we have seen that the $2,000 depreciation on the fixtures is a sunk cost that cannot be avoided. The sum of these two figures ($3,000 + $2,000 = $5,000) would be the decrease in the company's overall profits if the housewares line were discontinued. Of course, the company may later choose to drop the product if circumstances change—such as a pending decision to replace the fixtures.

The Make or Buy Decision

Providing a product or service to a customer involves many steps. For example, consider all of the steps that are necessary to develop and sell a product such as tax preparation software in retail stores. First the software must be developed, which involves highly skilled software engineers and a great deal of project management effort. Then the product must be put into a form that can be delivered to customers. This involves burning the application onto a blank CD or DVD, applying a label, and packaging the result in an attractive box. Then the product must be distributed to retail stores. Then the product must be sold. And finally, help lines and other forms of after-sale service may have to be provided. And we should not forget that the blank CD or DVD, the label, and the box must of course be made by someone before any of this can happen. All of these activities, from development, to production, to after-sales service are called a value chain.

Separate companies may carry out each of the activities in the value chain or a single company may carry out several. When a company is involved in more than one activity in the entire value chain, it is vertically integrated. Vertical integration is very common.

Some companies control all of the activities in the value chain from producing basic raw materials right up to the final distribution of finished goods and provision of after-sales service. Other companies are content to integrate on a smaller scale by purchasing many of the parts and materials that go into their finished products. A decision to carry out one of the activities in the value chain internally, rather than to buy externally from a supplier, is called a make or buy decision. Quite often these decisions involve whether to buy a particular part or to make it internally. Make or buy decisions also involve decisions concerning whether to outsource development tasks, after-sales service, or other activities.

Strategic Aspects of the Make or Buy Decision

Vertical integration provides certain advantages. An integrated company is less dependent on its suppliers and may be able to ensure a smoother flow of parts and materials for production than a nonintegrated company. For example, a strike against a major parts supplier can interrupt the operations of a nonintegrated company for many months, whereas an integrated company that is producing its own parts would be able to continue operations. Also, some companies feel that they can control quality better by producing their own parts and materials, rather than by relying on the quality control standards of outside suppliers. In addition, an integrated company realizes profits from the parts and materials that it is "making" rather than "buying," as well as profits from its regular operations.

The advantages of vertical integration are counterbalanced by the advantages of using external suppliers. By pooling demand from a number of companies, a supplier may be able to enjoy economies of scale. These economies of

scale can result in higher quality and lower costs than would be possible if the company were to attempt to make the parts or provide the service on its own. A company must be careful, however, to retain control over activities that are essential to maintaining its competitive position. For example, Hewlett-Packard controls the software for laser printers that it makes in cooperation with Canon Inc. of Japan. The present trend appears to be toward less vertical integration, with companies like Sun Microsystems and Hewlett-Packard concentrating on hardware and software design and relying on outside suppliers for almost everything else in the value chain. These factors suggest that the make or buy decision should be weighed very carefully.

An Example of Make or Buy

To provide an illustration of a make or buy decision, consider Mountain Goat Cycles. The company is now producing the heavy-duty gear shifters used in its most popular line of mountain bikes. The company's

Accounting Department reports the following costs of producing 8,000 units of the shifter internally each year:

	per unit	8000 units
Direct materials	$6	$48000
Direct labor	4	32000
Variable overhead	1	8000
Supervisor's salary	3	24000
Depreciation of special equipment	2	16000
Allocated general overhead	5	40000
Total cost	$21	$168000

An outside supplier has offered to sell 8,000 shifters a year to Mountain Goat Cycles at a price of only $19 each. Should the company stop producing the shifters internally and buy them from the outside supplier? As always, the focus should be on the relevant costs—those that differ between the alternatives. And the costs that differ between the alternatives consist of the costs that could be avoided by purchasing the shifters from the outside supplier. If the costs that can be avoided by purchasing the shifters from the outside supplier total less than $19, then the company should continue to manufacture its own shifters and reject the outside supplier's offer. On the other hand, if the costs that can be avoided by purchasing the shifters from the

outside supplier total more than $19, the outside supplier's offer should be accepted.

Mountain Goat Cycles Make or Buy Analysis

Exhibit-5

	Total relevant costs-8000 units	
	make	**buy**
Direct materials(8000unit x$6per unit)	$48000	
Direct labor(8000units x$4per unit)	32000	
Variable overhead(8000units x$1per unit)	8000	
Supervisor's salary	24000	
Depreciation of special equipment(not relevant)		
Allocated general overhead(not relevant)		
Outside purchase price		$152000
Total cost	$112000	$152000
Difference in favor of continuing to make	$40000	

Note that depreciation of special equipment is listed as one of the costs of producing the shifters internally. Because the equipment has already been purchased, this depreciation is a sunk cost and is therefore irrelevant. If the equipment could be sold, its salvage value would be relevant. Or if the machine could be used to make other products, this could be relevant as well. However, we will assume that the equipment has no salvage value and that it

has no other use except making the heavy-duty gear shifters.

Also note that the company is allocating a portion of its general overhead costs to the shifters. Any portion of this general overhead cost that would actually be eliminated if the gear shifters were purchased rather than made would be relevant in the analysis. However, it is likely that the general overhead costs allocated to the gear shifters are in fact common to all items produced in the factory and would continue unchanged even if the shifters were purchased from the outside. Such allocated common costs are not relevant costs (because they do not differ between the make or buy alternatives) and should be eliminated from the analysis along with the sunk costs.

The variable costs of producing the shifters can be avoided by buying the shifters from the outside supplier so they are relevant costs. We will assume in this case that the variable costs include direct materials, direct labor, and variable overhead. The supervisor's salary is also relevant if it could be avoided by buying the shifters. Exhibit 5

contains the relevant cost analysis of the make or buy decision assuming that the supervisor's salary can indeed be avoided.

Because it costs $40,000 less to make the shifters internally than to buy them from the outside supplier, Mountain Goat Cycles should reject the outside supplier's offer. However, the company may wish to consider one additional factor before coming to a final decision—the opportunity cost of the space now being used to produce the shifters.

Opportunity Cost

If the space now being used to produce the shifters would otherwise be idle, then Mountain Goat Cycles should continue to produce its own shifters and the supplier's offer should be rejected, as stated above. Idle space that has no alternative use has an opportunity cost of zero.

But what if the space now being used to produce shifters could be used for some other purpose? In that case, the space would have an opportunity cost equal to the segment

margin that could be derived from the best alternative use of the space.

To illustrate, assume that the space now being used to produce shifters could be used to produce a new cross-country bike that would generate a segment margin of $60,000 per year. Under these conditions, Mountain Goat Cycles should accept the supplier's offer and use the available space to produce the new product line:

	make		**buy**
Total annual cost(see Exhibit-5)	$112000		$152000
Opportunity cost-segment margin forgone on a potential new product line	60000		
Total cost	$172000		$152000
Difference in favor of purchasing from the outside supplier		$20000	

Opportunity costs are not recorded in the organization's general ledger because they do not represent actual dollar outlays. Rather, they represent economic benefits that are forgone as a result of pursuing some course of action. The opportunity cost for Mountain Goat Cycles is sufficiently large in this case to change the decision.

Special Orders

Managers must often evaluate whether a special order should be accepted, and if the order is accepted, the price that should be charged. A special order is a one-time order that is not considered part of the company's normal ongoing business. To illustrate, Mountain Goat Cycles has just received a request from the Seattle Police Department to produce 100 specially modified mountain bikes at a price of $558 each. The bikes would be used to patrol some of the more densely populated residential sections of the city. Mountain Goat Cycles can easily modify its City Cruiser model to fit the specifications of the Seattle Police. The normal selling price of the City Cruiser bike is $698, and its unit product cost is $564 as shown below:

Direct materials	$372
Manufacturing overhead	102
Unit product cost	$564

The variable portion of the above manufacturing overhead is $12 per unit. The order would have no effect on the company's total fixed manufacturing overhead costs.

The modifications requested by the Seattle Police Department consist of welded brackets to hold radios, nightsticks, and other gear. These modifications would require $34 in incremental variable costs. In addition, the company would have to pay a graphics design studio $2,400 to design and cut stencils that would be used for spray painting the Seattle Police Department's logo and other identifying marks on the bikes.

This order should have no effect on the company's other sales. The production manager says that she can handle the special order without disrupting any of the company's regular scheduled production.

What effect would accepting this order have on the company's net operating income?

Only the incremental costs and benefits are relevant. Because the existing fixed manufacturing overhead costs would not be affected by the order, they are not relevant. The incremental net operating income can be computed as follows:

	per unit	Total 100 bikes
Incremental revenue	$558	$55800
Less incremental costs:		
Variable costs:		
Direct materials	372	37200
Direct labor	90	9000
Variable manufacturing overhead	12	1200
Special modifications	34	3400
Total variable cost	$508	50800
Fixed cost:		
Purchase of stencils		2400
Total incremental cost		53200
Incremental net operating income		$2600

Therefore, even though the $558 price on the special order is below the normal $564 unit product cost and the order would require additional costs, the order would increase net operating income. In general, a special order is profitable if the incremental revenue from the special order exceeds the incremental costs of the order. However, it is important to make sure that there is indeed idle capacity and that the special order does not cut into normal unit sales or undercut prices on normal sales. For example, if the company was operating at capacity, opportunity

costs would have to be taken into account as well as the incremental costs that have already been detailed above.

Utilization of a Constrained Resource

Managers routinely face the problem of deciding how constrained resources are going to be used. A department store, for example, has a limited amount of floor space and therefore cannot stock every product that may be available. A manufacturer has a limited number of machine-hours and a limited number of direct labor-hours at its disposal. When a limited resource of some type restricts the company's ability to satisfy demand, the company has a constraint. Because the company cannot fully satisfy demand, managers must decide which products or services should be cut back. In other words, managers must decide which products or services make the best use of the constrained resource. Fixed costs are usually unaffected by such choices, so the course of action that will maximize the company's total contribution margin should ordinarily be selected.

Contribution Margin per Unit of the Constrained Resource

If some products must be cut back because of a constraint, the key to maximizing the total contribution margin may seem obvious—favor the products with the highest unit contribution margins. Unfortunately, that is not quite correct. Rather, the correct solution is to favor the products that provide the highest contribution margin per unit of the constrained resource. To illustrate, in addition to its other products, Mountain Goat Cycles makes saddlebags for bicycles called panniers. These panniers come in two models—a touring model and a mountain model. Cost and revenue data for the two models of panniers follow:

	Mountain Pannier	Touring Pannier
Selling price per unit	$25	$30
Variable cost per unit	10	18
Contribution margin per unit	$15	$12
Contribution margin (CM) ratio	60%	40%

The mountain pannier appears to be much more profitable than the touring pannier. It has a $15 per unit contribution

margin as compared to only $12 per unit for the touring model, and it has a 60% CM ratio as compared to only 40% for the touring model.

But now let us add one more piece of information—the plant that makes the panniers is operating at capacity. This does not mean that every machine and every person in the plant is working at the maximum possible rate. Because machines have different capacities, some machines will be operating at less than 100% of capacity. However, if the plant as a whole cannot produce any more units, some machine or process must be operating at capacity. The machine or process that is limiting overall output is called *the bottleneck*—it is the constraint.

At Mountain Goat Cycles, the bottleneck (i.e., constraint) is a stitching machine. The mountain pannier requires two minutes of stitching time per unit, and the touring pannier requires one minute of stitching time per unit. By definition, because the stitching machine is a bottleneck, the stitching machine does not have enough capacity to satisfy the existing demand for mountain panniers and

touring panniers Therefore, some orders for the products will have to be turned down. Naturally, managers will want to know which product is less profitable. To answer this question, they should focus on the contribution margin per unit of the constrained resource. This figure is computed by dividing a product's contribution margin per unit by the amount of the constrained resource required to make a unit of that product. These calculations are carried out below for the mountain and touring panniers:

	Mountain Pannier	**Touring Pannier**
Contribution margin per unit (a)	$15.00	$12.00
Stitching machine time required to produce one unit (b)	2 minutes	1 minute
Contribution margin per unit of the constrained resource, (a) / (b)	$7.50 per minute	$12.00 per minute

It is now easy to decide which product is less profitable and should be deemphasized. Each minute on the stitching machine that is devoted to the touring pannier results in an increase of $12.00 in contribution margin and profits. The

comparable figure for the mountain pannier is only $7.50 per minute. Therefore, the touring model should be emphasized. Even though the mountain model has the larger contribution margin per unit and the larger CM ratio, the touring model provides the larger contribution margin in relation to the constrained resource.

To verify that the touring model is indeed the more profitable product, suppose an hour of additional stitching time is available and that unfilled orders exist for both products. The additional hour on the stitching machine could be used to make either 30 mountain panniers (60 minutes - 2 minutes per mountain pannier) or 60 touring panniers (60 minutes - 1 minute per touring pannier), with the following profit implications:

	Mountain Pannier	**Touring Pannier**
Contribution margin per unit	$ 15	$ 12
Additional units that can be processed in one hour	**X** 30	**X** 60
Additional contribution margin	$450	$720

Because the additional contribution margin would be $720 for the touring panniers and only $450 for the mountain panniers, the touring panniers make the most profitable use of the company's constrained resource—the stitching machine.

This example clearly shows that looking at unit contribution margins alone is not enough; the contribution margin must be viewed in relation to the amount of the constrained resource each product requires.

Managing Constraints

Effectively managing an organization's constraints is a key to increased profits. Effective management of a bottleneck constraint involves selecting the most profitable product mix and finding ways to increase the capacity of the bottleneck operation. As discussed above, if the constraint is a bottleneck in the production process, the most profitable product mix consists of the products with the highest contribution margin per unit of the constrained resource. In addition, as discussed below, increasing the capacity of the bottleneck operation should lead to

increased production and sales. Such efforts will often pay off in an almost immediate increase in profits.

It is often possible for a manager to increase the capacity of the bottleneck, which is called *relaxing (or elevating) the constraint*. For example, the stitching machine operator could be asked to work overtime. This would result in more available stitching time and hence the production of more finished goods that can be sold. The benefits from relaxing the constraint are often enormous and can be easily quantified. The manager should first ask, "What would I do with additional capacity at the bottleneck if it were available?" In our example, if unfilled orders exist for both the touring and mountain panniers, the additional capacity would be used to process more touring panniers because they earn a contribution margin of $12 per minute, or $720 per hour. Given that the overtime pay for the operator is likely to be much less than $720 per hour, running the stitching machine on overtime would be an excellent way to increase the company's profits while at the same time satisfying more customers.

To reinforce this concept, suppose that there are only unfilled orders for the mountain pannier. How much would it be worth to the company to run the stitching machine overtime in this situation? Because the additional capacity would be used to make the mountain pannier, the value of that additional capacity would drop to $7.50 per minute or $450 per hour. Nevertheless, the value of relaxing the constraint would still be quite high.

These calculations indicate that managers should pay great attention to the bottleneck operation. If a bottleneck machine breaks down or is ineffectively utilized, the losses to the company can be quite large. In our example, for every minute the stitching machine is down due to breakdowns or setups, the company loses between $7.50 and $12.00.2 The losses on an hourly basis are between $450 and $720! In contrast, there is no such loss of contribution margin if time is lost on a machine that is not a bottleneck—such machines have excess capacity anyway.

The implications are clear. Managers should focus much of their attention on managing the bottleneck. As we have discussed, managers should emphasize products that most profitably utilize the constrained resource. They should also make sure that products are processed smoothly through the bottleneck, with minimal lost time due to breakdowns and setups. And they should try to find ways to increase the capacity at the bottleneck.

The capacity of a bottleneck can be effectively increased in a number of ways, including:

- Working overtime on the bottleneck.
- Subcontracting some of the processing that would be done at the bottleneck.
- Investing in additional machines at the bottleneck.
- Shifting workers from processes that are not bottlenecks to the process that is the bottleneck.
- Focusing business process improvement efforts such as Six Sigma on the bottleneck.

- Reducing defective units. Each defective unit that is processed through the bottleneck and subsequently scrapped takes the place of a good unit that could have been sold.

The last three methods of increasing the capacity of the bottleneck are particularly attractive because they are essentially free and may even yield additional cost savings.

The methods and ideas discussed in this section are all part of the Theory of Constraints, which was introduced in Chapter 1. A number of organizations have successfully used the Theory of Constraints to improve their performance, including Avery Dennison, Bethlehem Steel, Binney & Smith, Boeing, Champion International, Ford Motor Company, General Motors, ITT, Monster Cable, National Semiconductor, Pratt and Whitney Canada, Pretoria Academic Hospital, Procter and Gamble, Texas Instruments, United Airlines, United Electrical Controls, the United States Air Force Logistics Command, and the United States Navy Transportation Corps.

Activity-Based Costing and Relevant Costs

Activity-based costing can be used to help identify potentially relevant costs for decision-making purposes. Activity-based costing improves the trace-ability of costs by focusing on the activities caused by a product or other segment. However, managers should exercise caution against reading more into this “traceability” than really exists. People have a tendency to assume that if a cost is traceable to a segment, then the cost is automatically an avoidable cost. That is not true. the costs provided by a well-designed activity-based costing system are only potentially relevant. Before making a decision, managers must still decide which of the potentially relevant costs are actually avoidable. Only those costs that are avoidable are relevant and the others should be ignored.

To illustrate, refer again to the data relating to the housewares line in Exhibit 4. The $2,000 fixtures depreciation is a traceable cost of the housewares lines because it directly relates to activities in that department. We found, however, that the $2,000 is not avoidable if the

housewares line is dropped. The key lesson here is that the method used to assign a cost to a product or other segment does not change the basic nature of the cost. A sunk cost such as depreciation of old equipment is still a sunk cost regardless of whether it is traced directly to a particular segment on an activity basis, allocated to all segments on the basis of labor-hours, or treated in some other way in the costing process. Regardless of the method used to assign costs to products or other segments, the principles discussed in this chapter must be applied to determine the costs that are avoidable in each situation.

General example

Charter Sports Equipment manufactures round, rectangular, and octagonal trampolines. Sales and expense data for the past month follow:

		Trampoline		
	Total	**Round**	**Rectangular**	**Octagonal**
sales	$1,000,000	$140,000	$500,000	$360,000
Variable expenses	410,000	60,000	200,000	150,000
Contribution margin	590,000	80,000	300,000	210,000
Fixed expenses:				
Advertising- traceable	216,000	41,000	110,000	65,000
Dep. Of special equp.	95,000	20,000	40,000	35,000
Line supervisors' salaries	19,000	6,000	7,000	6,000
General factory overhead	200,000	28,000	100,000	72,000
Total fixed expenses	530,000	95,000	257,000	178,000
Net operating income (loss)	$ 60,000	$ (15,000)	$ 43,000	$ 32,000

Management is concerned about the continued losses shown by the round trampolines and wants a recommendation as to whether or not the line should be discontinued. The special equipment used to produce the trampolines has no resale value. If the round trampoline model is dropped, the two line supervisors assigned to the model would be discharged.

Required:

1. Should production and sale of the round trampolines be discontinued? The company has no other use for the

capacity now being used to produce the round trampolines. Show computations to support your answer.

2. Recast the above data in a format that would be more useful to management in assessing the profit-ability of the various product lines.

Solution

1. No, production and sale of the round trampolines should not be discontinued. Computations to support this answer follow:

Contribution margin lost if the round trampolines are discounted		$(80000)
Less fixed costs that can be avoided		
Advertising-traceable	$41000	
Line supervisors' salaries	6000	47000
Decrease in net operating income for the company as a whole		$(33000)

The depreciation of the special equipment is a sunk cost, and therefore it is not relevant to the decision. The general factory overhead is allocated and will presumably continue

regardless of whether or not the round trampolines are discontinued; thus, it is not relevant.

If management wants a clearer picture of the profitability of the segments, the general factory overhead should not be allocated. It is a common cost and therefore should be deducted from the total product-line segment margin, A more useful income statement format would be as follows:

			Trampoline	
	Total	**Round**	**Rectangular**	**Octagonal**
sales	$1,000,000	$140,000	$500,000	$360,000
Variable expenses	410,000	60,000	200,000	150,000
Contribution margin	590,000	80,000	300,000	210,000
Traceable Fixed expenses:				
Advertising- traceable	216,000	41,000	110,000	65,000
Dep. Of special equp.	95,000	20,000	40,000	35,000
Line supervisors' salaries	19,000	6,000	7,000	6,000
Total traceable fixed expenses	330000	67000	157000	106000
Product –line segment margin	260000	$13000	$143000	$104000
Common fixed expenses	200000			
Net operating income (loss)	$ 60,000			

Questions:

1- Boa Mining Company currently is operating at less than 50% of practical capacity. The management of the company expects sales to drop below the present level of 10,000 tons of ore per month very soon. The sales price per ton is $3 and the variable cost per ton is $2. Fixed costs per month total $10,000.

Management is concerned that a further drop in sales volume will generate a loss and accordingly is considering temporarily suspending operations until demand in the metals markets rebounds and prices once again rise. Management has implemented a cost reduction program over the past year, but at this point suspension of operations appears to be the only viable alternative. Management estimates that suspension of operations would reduce fixed costs from $10,000 to $4,000 per month.

Required:

a. Why does management believe that the fixed costs will persist at $4,000 even though the mine is temporarily closed?

b. At what sales volume per month will the company be indifferent between continuing to operate the mine and closing it?

2- Adamyan Co. manufactures and sells medals for winners of athletic and other events. Its manufacturing plant has the capacity to produce 15,000 medals each month; current monthly production is 12,750 medals. The company normally charges $120 per medal. Cost data for the current level of production are shown below:

Variable costs:

Direct materials	$624,750
Direct labor	$306,000
Selling and administrative	$15,300

Fixed costs:

Manufacturing	$506,175
Selling and administrative	$123,675

The company has just received a special one-time order for 700 medals at $83 each. For this particular order, no variable selling and administrative costs would be incurred. This order would also have no effect on fixed costs.

Required:

Should the company accept this special order? Why?

3- Fothergill Company makes 40,000 units per year of a part it uses in the products it manufactures. The unit product cost of this part is computed as follows:

Direct materials	$23.40
Direct labor	22.30
Variable manufacturing overhead	1.40
Fixed manufacturing overhead	24.60
Unit product cost	$71.70

An outside supplier has offered to sell the company all of these parts it needs for $59.20 a unit. If the company accepts this offer, the facilities now being used to make the part could be used to make more units of a product that is in high demand. The additional contribution margin on this other product would be $352,000 per year.

If the part were purchased from the outside supplier, all of the direct labor cost of the part would be avoided. However, $21.90 of the fixed manufacturing overhead cost being applied to the part would continue even if the part were purchased from the outside supplier. This fixed manufacturing overhead cost would be applied to the company's remaining products.

Required:

a. How much of the unit product cost of $71.70 is relevant in the decision of whether to make or buy the part?

b. What is the net total dollar advantage (disadvantage) of purchasing the part rather than making it?

c. What is the maximum amount the company should be willing to pay an outside supplier per unit for the part if the supplier commits to supplying all 40,000 units required each year?

4- Gluth Company makes three products in a single facility. These products have the following unit product costs:

	Products		
	A	B	C
Direct materials	$22.50	$22.4	$29.20
Direct labor	13.60	11.4	12.50
Variable manufacturing overhead	3.00	3.4	4.50
Fixed manufacturing overhead	19.20	20.10	26.50
Unit product cost	$58.30	$57.30	$72.70

Additional data concerning these products are listed below.

	Products		
	A	B	C
Mixing minutes per unit	3.30	1.70	1.80
Selling price per unit	$74.70	$76.10	$87.50
Variable selling cost per unit	$1.80	$2.40	$2.90
Monthly demand in units	4000	2000	4000

The mixing machines are potentially the constraint in the production facility. A total of 23,200 minutes are available per month on these machines. Direct labor is a variable cost in this company.

Required:

a. How many minutes of mixing machine time would be required to satisfy demand for all four products?

b. How much of each product should be produced to maximize net operating income? (Round off to the nearest whole unit.)

c. Up to how much should the company be willing to pay for one additional hour of mixing machine time if the company has made the best use of the existing mixing machine capacity? (Round off to the nearest whole cent.)

5- Holtz Company makes three products in a single facility. Data concerning these products follow:

	Products		
	A	B	C
Selling price per unit	$75.90	$71.10	$73.40
Direct materials	$29.70	$30.20	$33.40
Direct labor	$21.20	$19.80	$19.60
Variable manufacturing overhead	$4.90	$5.60	$7.60
Variable selling cost per unit	$1.30	$3.90	$1.80
Mixing minutes per unit	2.10	1.7	1.30
Monthly demand in units	4000	1000	2000

The mixing machines are potentially the constraint in the production facility. A total of 12,500 minutes are available per month on these machines. Direct labor is a variable cost in this company.

Required:

a. How many minutes of mixing machine time would be required to satisfy demand for all four products?

b. How much of each product should be produced to maximize net operating income? (Round off to the nearest whole unit.)

c. Up to how much should the company be willing to pay for one additional hour of mixing machine time if the company has made the best use of the existing mixing machine capacity? (Round off to the nearest whole cent.)

6- Wright, Inc. produces three products. Data concerning the selling prices and unit costs of the three products appear below:

	Products		
	A	B	C
Selling price	$90	$30	$60
Variable costs	$35	$10	$20
Fixed costs	$45	$15	$30
Tapping machine time (minutes)	5	4	2

Fixed costs are applied to the products on the basis of direct labor hours.

Demand for the three products exceeds the company's productive capacity. The tapping machine is the constraint,

with only 2,400 minutes of tapping machine time available this week.

Required:

a. Given the tapping machine constraint, which product should be emphasized?

b. Assuming that there is still unfilled demand for the product that the company should emphasize in part (a) above, up to how much should the company be willing to pay for an additional hour of tapping machine time?

7- Pilgrim Corporation makes a range of products. The company's predetermined overhead rate is $23 per direct labor-hour, which was calculated using the following budgeted data:

Variable manufacturing overhead	$200,000
Fixed manufacturing overhead	$375,000
Direct labor-hours	25,000

Management is considering a special order for 800 units of product N89E at $69 each. The normal selling price of

product N89E is $88 and the unit product cost is determined as follows:

Direct materials	$28.00
Direct labor	22.50
Manufacturing overhead applied	34.50
Unit product cost	$85.00

If the special order were accepted, normal sales of this and other products would not be affected. The company has ample excess capacity to produce the additional units. Assume that direct labor is a variable cost, variable manufacturing overhead is really driven by direct labor-hours, and total fixed manufacturing overhead would not be affected by the special order.

Required:

If the special order were accepted, what would be the impact on the company's overall profit?

8- Lakeshore Tours Inc., operates a large number of tours throughout the United States. A study has indicated that

some of the tours are not profitable, and consideration is being given to dropping these tours in order to improve the company's overall operating performance. One such tour is a two-day Battlefields of the French and Indian Wars bus tour. An income statement from one of these tours is given below:

Ticket revenue (100 seats × 45% occupancy × $80 ticket price)		$3600	100%
Less variable expenses ($24 per person)		1080	30%
Contribution margin		2520	70%
Less fixed tour expenses:			
Tour promotion	$620		
Salary of bus driver	400		
Fee, tour guide	825		
Fuel for bus	100		
Depreciation of bus	400		
Liability insurance, bus	250		
Overnight parking fee, bus	50		
Room and meals, bus driver and tour guide	75		
Bus maintenance and preparation	325		
Total fixed tour expenses		3045	

Net operating loss	$(525)

Dropping this tour would not affect the number of buses in the company's fleet or the number of bus drivers on the company's payroll. Buses do not wear out through use; rather, they eventually become obsolete. Bus drivers are paid fixed annual salaries; tour guides are paid for each tour conducted. The “Bus maintenance and preparation” cost above is an allocation of the salaries of mechanics and other service personnel who are responsible for keeping the company's fleet of buses in good operating condition. There would be no change in the number of mechanics and other service personnel as a result of dropping this tour. The liability insurance depends upon the number of buses in the company's fleet and not upon how much they are used.

Required:

a. Prepare an analysis showing what the impact will be on company profits if this tour is discontinued.

b. The company's tour director has been criticized because only about 50% of the seats on the company's tours are

being filled as compared to an average of 60% for the industry. The tour director has explained that the company's average seat occupancy could be improved considerably by eliminating about 10% of the tours, but that doing so would reduce profits. Do you agree with the tour director's conclusion? Explain your response.

9- The Regal Cycle Company manufactures three types of bicycles—a dirt bike, a mountain bike, and a racing bike. Data on sales and expenses for the past quarter follow:

		Product Line		
	Total	**Direct Bikes**	**Mountain Bikes**	**racing bikes**
Sales	$300000	$90000	$150000	$60000
Variable manufacturing and selling expenses	120000	27000	60000	33000
Contribution margin	180000	63000	90000	27000
Fixed expenses:				
Advertising , traceable	30000	10000	14000	6000
Dep. Of special equipment	23000	6000	9000	8000
Salaries of product-line mangers	35000	12000	13000	10000
Allocated common fixed expenses*	60000	18000	30000	12000
Total fixed expenses	148000	46000	66000	36000
Net operating income (loss)	$32000	$17000	$24000	$(9000)

*'Allocated on the basis of sales dollars

Management is concerned about the continued losses shown by the racing bikes and wants a recommendation as to whether or not the line should be discontinued. The special equipment used to produce racing bikes has no resale value and does not wear out.

Required:

1. Should production and sale of the racing bikes be discontinued? Explain.

2. Recast the above data in a format that would be more usable to management in assessing the long-run profitability of the various product lines.

10- Troy Engines, Ltd., manufactures a variety of engines for use in heavy equipment. The company has always produced all of the necessary parts for its engines, including all of the carburetors. An outside supplier has offered to sell one type of carburetor to Troy Engines, Ltd., for a cost of $35 per unit. To evaluate this offer, Troy Engines, Ltd., has gathered the following information

relating to its own cost of producing the carburetor internally:

	per unit	15000 units Per year
Direct materials	$14	$210000
Direct labor	10	150000
Variable manufacturing overhead	3	45000
fixed manufacturing overhead traceable	6*	90000
fixed manufacturing overhead, allocated	9	135000
Total cost	$42	$630000

Required:

1. Assuming that the company has no alternative use for the facilities that are now being used to produce the carburetors, should the outside supplier's offer be accepted? Show all computations.

2. Suppose that if the carburetors were purchased, Troy Engines, Ltd., could use the freed capacity to launch a new product. The segment margin of the new product would be $150,000 per year. Should Troy Engines, Ltd., accept the offer to buy the carburetors for $35 per unit? Show all computations

True/False Questions

1. Fixed costs are sunk costs and are therefore irrelevant in decisions.

2. A complete income statement must be prepared as part of a differential cost analysis.

3. Future costs that do not differ between the alternatives in a decision are avoidable costs.

4. The book value of an old machine is always considered a sunk cost in a decision.

5. A product that does not cover its allocated share of general corporate administrative expenses should be dropped.

6. In a decision to drop a product, the product should be charged for rent in proportion to the space it occupies even if the space has no alternative use and the rental payment is unavoidable.

7. Making rather than buying a part that goes into one of the company's products would increase the company's degree of vertical integration.

8. In a special order situation that involves using existing idle capacity, opportunity costs are zero.

9. When a company has a production constraint, the product with the highest contribution margin per unit of the constrained resource should be given highest priority.

10.Payment of overtime to a worker in order to relax a production constraint could increase the profits of a company.

11. In a plant operating at capacity, every machine and person in the plant would be working at the maximum possible rate.

12. Lumber produced in a lumber mill results in several different products being produced from each log; such products are called joint products.

13. In a sell or process further decision, an avoidable fixed production cost incurred after the split-off point is relevant to the decision.

14. Joint processing after the split-off point is profitable if the incremental revenue from such processing exceeds the incremental processing costs.

15. A cost that is traceable to a segment through activity-based costing is always an avoidable cost for decision making.

Multiple Choice Questions

16. Hal Etoesus currently works as the fry guy at Burger Breath Drive Thru but is thinking of quitting his job to attend college full time next semester. Which of the following would be considered an opportunity cost in this decision?

A) the cost of the textbooks

B) the cost of the cola that Hal will consume during class

C) Hal's lost wages at Burger Breath

D) both A and B above

17. Which of the following would be relevant in the decision to sell or throw out obsolete inventory? Direct material cost assigned to inventory, fixed overhead cost assigned to inventory, respectively.

A) Yes Yes

B) Yes No

C) No Yes

D) No No

18. Buff Corp. is considering replacing an old machine with a new machine. Which of the following items is relevant to Buff's decision? Book value of old machine, Disposal value of new machine (Ignore income tax considerations.)

A) Yes No

B) No Yes

C) No No

D) Yes Yes

19. In a make-or-buy decision, relevant costs include:

A)unavoidable fixed costs

B)avoidable fixed costs

C)fixed factory overhead costs applied to products

D)fixed selling and administrative expenses

20. In situations where management must decide between accepting or rejecting a onetime-only special order where there is sufficient idle capacity to fill the order, which one of the following is NOT relevant in making the decision?

A)absorption costing unit product costs

B)variable costs

C)incremental costs

D)differential costs

21. When a multi-product factory operates at full capacity, decisions must be made about what products to emphasize. In making such decisions, products should be ranked based on:

A)selling price per unit

B)contribution margin per unit

C)contribution margin per unit of the constraining resource

D)unit sales volume

22.Two or more products produced from a common input are called:

A)common costs.

B)joint products.

C)joint costs.

D)sunk costs.

23. Wenig Inc. has some material that originally cost $73,500. The material has a scrap value of $45,600 as is, but if reworked at a cost of $6,600, it could be sold for $58,100. What would be the incremental effect on the company's overall profit of reworking and selling the material rather than selling it as is as scrap?

A)-$22,000

B)-$67,600

C)$51,500

D)$5,900

24. Narciso Corporation is preparing a bid for a special order that would require 880 liters of material R19S. The company already has 280 liters of this raw material in stock that originally cost $6.20 per liter. Material R19S is used in the company's main product and is replenished on a periodic basis. The resale value of the existing stock of the material is $5.45 per liter. New stocks of the material can be readily purchased for $6.20 per liter. What is the relevant cost of the 880 liters of the raw material when deciding how much to bid on the special order?

A) $5,006

B) $5,456

C) $4,796

D) $5,456

25. Kahn Company produces and sells 8,000 units of Product X each year. Each unit of Product X sells for $10 and has a contribution margin of $6. It is estimated that if

Product X is discontinued, $50,000 of the $60,000 in fixed costs charged to Product X could be eliminated. These data indicate that if Product X is discontinued, overall company net operating income should:

A) increase by $2,000 per year

B) decrease by $2,000 per year

C) increase by $38,000 per year

D) decrease by $38,000 per year

26.The Milham Company has two divisions - East and West. The divisions have the following revenues and expenses:

	East	West
sales	$720000	$350000
Variable costs	370000	240000
Traceable fixed costs	130000	80000
Allocated common corporate costs	120000	50000
Net operating income(loss)	$100000	$(20000)

Management at Milham is pondering the elimination of the West Division since it has shown an operating loss for

the past several years. If the West Division were eliminated, its traceable fixed costs could be avoided. Total common corporate costs would be unaffected by this decision. Given these data, the elimination of the West Division would result in an overall company net operating income of:

A) $100,000

B) $80,000

C) $120,000

D) $50,000

27- The following information relates to next year's projected operating results of the Aluminum Division of Wroclaw Corporation:

Contribution margin	$1500000
Fixed expenses	1700000
Net operating loss	$(200000)

If Aluminum Division is dropped, $1,000,000 of the above fixed costs would be eliminated. What will be the effect on

Wroclaw's profit next year if Aluminum Division is dropped instead of being kept?

A) $500,000 decrease

B) $800,000 increase

C) $1,000,000 increase

D) $1,200,000 increase

28. Jordan Company budgeted sales of 400,000 calculators at $40 per unit last year. Variable manufacturing costs were budgeted at $16 per unit, and fixed manufacturing costs at $10 per unit. A special order for 40,000 calculators at $23 each was received by Jordan in March. Jordan has sufficient plant capacity to manufacture the additional quantity without incurring any additional fixed manufacturing costs; however, the production would have to be done on an overtime basis at an estimated additional cost of $3 per calculator. Acceptance of the special order would not affect Jordan's normal sales and no selling expenses would be incurred. What would be the effect on net operating income if the special order were accepted?

A) $120,000 decrease

B) $160,000 increase

C) $240,000 decrease

D) $280,000 increase

Use the following to answer questions 29-30:

The Talbot Company makes wheels that it uses in the production of bicycles. Talbot's costs to produce 100,000 wheels annually are:

Direct materials	$30,000
Direct labor	$50,000
Variable overhead	$20,000
Fixed overhead	$70,000

An outside supplier has offered to sell Talbot similar wheels for $1.25 per wheel. If the wheels are purchased from the outside supplier, $15,000 of annual fixed overhead could be avoided and the facilities now being used could be rented to another company for $45,000 per year.

29. If Talbot chooses to buy the wheel from the outside supplier, then the change in annual net operating income due to accepting the offer is a:

A) $35,000 increase

B) $10,000 decrease

C) $45,000 increase

D) $70,000 increase

30. What is the highest price that Talbot could pay the outside supplier for the wheel and still be economically indifferent between making or buying the wheels?

A) $1.70

B) $1.60

C) $1.55

D) $1.15

Use the following to answer questions 31-32:

Melbourne Company has traditionally made a subcomponent of its major product. Annual production of 30,000 subcomponents results in the following costs:

Direct materials	$250,000
Direct labor	$200,000
Variable overhead	$190,000
Fixed overhead	$120,000

Melbourne has received an offer from an outside supplier who is willing to provide the 30,000 units of the subcomponent each year at a price of $28 per unit. Melbourne knows that the facilities now being used to manufacture the subcomponent could be rented to another company for $80,000 per year if the subcomponent were purchased from the outside supplier. Otherwise, there would be no effect of this decision on the total fixed overhead of the company.

31. If Melbourne decides to purchase the subcomponent from the outside supplier, what would be the impact on the company's net operating income for the year?

A) $120,000 higher

B) $20,000 higher

C) $120,000 lower

D) $20,000 lower

32. At what price per unit charged by the outside supplier would Melbourne be economically indifferent between making the subcomponent or buying it from outside?

A) $29

B) $25

C) $21

D) $24

Use the following to answer questions 33-34:

Regis Company makes the plugs it uses in one of its products at a cost of $36 per unit. This cost includes $8 of fixed overhead. Regis needs 30,000 of these plugs annually, and Orlan Company has offered to sell them to Regis at $33 per unit. If Regis decides to purchase the plugs, $60,000 of the annual fixed overhead will be

eliminated, and the company may be able to rent the facility previously used for manufacturing the plugs.

33. If Regis Company purchases the plugs but does not rent the unused facility, the company would:

A) save $3.00 per unit.

B) lose $6.00 per unit.

C) save $6.00 per unit.

D) lose $3.00 per unit

34. If the plugs are purchased and the facility rented, Regis Company wishes to realize $100,000 in savings annually. To achieve this goal, the minimum annual rent on the facility must be:

A) $10,000

B) $40,000

C) $70,000

D) $190,000

35. Assume the company has 50 units left over from last year which have small defects and which will have to be

sold at a reduced price for scrap. The sale of these defective units will have no effect on the company's other sales. What cost is relevant as a guide for setting a minimum price?

A) $5.50

B) $5.90

C) $2.00

D) $3.50

Use the following to answer questions 36-38:

Elferts Company produces a single product. The cost of producing and selling a single unit of this product at the company's normal activity level of 70,000 units per month is as follows:

Direct materials	$41.40
Direct labor	7.10
Variable manufacturing overhead	2.40
Fixed manufacturing overhead	18.30
Variable selling & administrative expense	1.00
Fixed selling & administrative expense	6.10

The normal selling price of the product is $85.80 per unit.

An order has been received from an overseas customer for 4,000 units to be delivered this month at a special discounted price. This order would have no effect on the company's normal sales and would not change the total amount of the company's fixed costs. The variable selling and administrative expense would be $0.60 less per unit on this order than on normal sales.

Direct labor is a variable cost in this company.

36. Suppose there is ample idle capacity to produce the units required by the overseas customer and the special discounted price on the special order is $80.60 per unit. By how much would this special order increase (decrease) the company's net operating income for the month?

A) $44,000

B) $(18,400)

C) $117,200

D) $17,200

37. Suppose the company is already operating at capacity when the special order is received from the overseas customer. What would be the opportunity cost of each unit delivered to the overseas customer?

A) $9.50

B) $10.10

C) $5.20

D) $33.90

38. Suppose there is not enough idle capacity to produce all of the units for the overseas customer and accepting the special order would require cutting back on production of 100 units for regular customers. The minimum acceptable price per unit for the special order is closest to:

A) $69.20

B) $76.30

C) $85.80

D) $52.15

39. Suppose Melrose can sell 68,000 units of Product C to regular customers next year. If Moore Company offers to buy the special order units at $95 per unit, the effect of accepting the special order for 7,000 units on Melrose's net operating income for next year will be a:

A) $93,500 increase

B) $104,000 increase

C) $114,500 increase

D) $294,000 increase

Use the following to answer questions 40-41:

The Madison Company produces three products with the following costs and selling prices:

	product		
	A	B	C
Selling price per unit	$15	$20	$20
Variable cost per unit	$8	$10	$12
Direct labor hours per unit	1	1.5	2
Machine hours per unit	3.5	2	2.5

40. If Madison has a limit of 10,000 direct labor hours but no limit on machine hours, then the three products should be produced in the order:

A) A, B, C

B) B, C, A

C) C, A, B

D) A, C, B

41. If Madison has a limit of 15,000 machine hours but no limit on direct labor hours, then the three products should be produced in the order:

A) A, B, C

B) B, C, A

C) A, C, B

D) C, A, B

CHAPTER 2 CAPITAL BUDGETING DECISIONS

Introduction

The term capital budgeting is used to describe how managers plan significant outlays on projects that have long-term implications such as the purchase of new equipment and the introduction of new products. Most companies have many more potential projects than can actually be funded. Hence, managers must carefully select those projects that promise the greatest future return. How well managers make these capital budgeting decisions is a critical factor in the long-run profitability of the company.

Capital budgeting involves investment—a company must commit funds now in order to receive a return in the future. Investments are not limited to stocks and bonds. Purchase of inventory or equipment is also an investment. For example, Tri-Con Global Restaurants, Inc. makes an investment when it opens a new Pizza Hut restaurant. L. Bean makes an investment when it installs a new computer to handle customer billing. DaimlerChrysler makes an investment when it redesigns a product such as the Jeep Eagle and must retool its production lines. Merck & Co.

invests in medical research. Amazon.com makes an investment when it redesigns its website. All of these investments are characterized by a commitment of funds today in the expectation of receiving a return in the future in the form of additional cash inflows or reduced cash outflows.

Capital Budgeting—Planning Investments

Typical Capital Budgeting Decisions

What types of business decisions require capital budgeting analysis? Virtually any decision that involves an outlay now in order to obtain some return (increase in revenue or reduction in costs) in the future. Typical capital budgeting decisions include:

1. Cost reduction decisions. Should new equipment be purchased to reduce costs?

2. Expansion decisions. Should a new plant, warehouse, or other facility be acquired to increase capacity and sales?

3. Equipment selection decisions. Which of several available machines should be purchased?

4. Lease or buy decisions. Should new equipment be leased or purchased?

5. Equipment replacement decisions. Should old equipment be replaced now or later?

Capital budgeting decisions tend to fall into two broad categories—screening decisions and preference decisions. Screening decisions relate to whether a proposed project passes a preset hurdle. For example, a company may have a policy of accepting projects only if they promise a return of 20% on the investment. The required rate of return is the minimum rate of return a project must yield to be acceptable.

Preference decisions, by contrast, relate to selecting from among several competing courses of action. To illustrate, a company may be considering several different machines to replace an existing machine on the assembly line. The

choice of which machine to purchase is a preference decision.

In this chapter, we initially discuss ways of making screening decisions. Preference decisions are discussed toward the end of the chapter.

The Time Value of Money

As stated earlier, investments commonly involve returns that extend over fairly long periods of time. Therefore, in approaching capital budgeting decisions, it is necessary to use techniques that best recognize the time value of money. A dollar today is worth more than a dollar a year from now. The same concept applies in choosing between investment projects. Projects that promise earlier returns are preferable to those that promise later returns.

The capital budgeting techniques that recognize the above two characteristics of business investments are those that involve discounted cash flows. We will spend most of this chapter showing how to use discounted cash flow methods in making capital budgeting decisions.

Two approaches to making capital budgeting decisions use discounted cash flows. One is the net present value method, and the other is the internal rate of return method (sometimes called the time-adjusted rate of return method). The net present value method is discussed in this section; the internal rate of return method is discussed in the following section

The Net Present Value Method Illustrated

Under the net present value method, the present value of a project's cash inflows is compared to the present value of the project's cash outflows. The difference between the present values of these cash flows, called the net present value, determines whether or not the project is an acceptable investment. To illustrate, consider the following data:

Example A: Harper Company is contemplating the purchase of a machine capable of performing certain operations that are now performed manually. The machine will cost $50,000, and it will last for five years. At the end of the five-year period, the machine will have a zero scrap

value. Use of the machine will reduce labor costs by $18,000 per year. Harper Company requires a minimum pretax return of 20% on all investment projects.

Net Present Value Analysis of a Proposed Project

Initial cost	$50,000
Life of the project	5 years
Annual cost savings	$18,000
Salvage value	$0
Required rate of return	20%

item	years	Amount of cash flow	20% factor	Present value of cash flow
Annual cost savings	1-5 y	$18000	2.991	$53838
Initial investment	now	($50000)	1.000	(50000)
Net present value				$3838

Should the machine be purchased? Harper Company must determine whether a cash investment now of $50,000 can be justified if it will result in an $18,000 reduction in cost each year over the next five years. It may appear that the answer is obvious since the total cost savings is $90,000 ($18,000 per year X 5 years). However, the company can earn a 20% return by investing its money elsewhere. It is not enough that the cost reductions cover just the original cost of the machine; they must also yield a return of at least 20% or the company would be better off investing the money elsewhere.

To determine whether the investment is desirable, the stream of annual $18,000 cost savings should be discounted to its present value and then compared to the cost of the new machine. Since Harper Company requires a minimum return of 20% on all investment projects, this rate is used in the discounting process and is called the discount rate.

According to the analysis, Harper Company should purchase the new machine. The present value of the cost

savings is $53,838, whereas the present value of the required investment (cost of the machine) is only $50,000. Deducting the present value of the required investment from the present value of the cost savings gives the net present value of $3,838. Whenever the net present value is zero or greater, as in our example, an investment project is acceptable. Whenever the net present value is negative (the present value of the cash outflows exceeds the present value of the cash inflows), an investment project is not acceptable. In sum:

If the Net Present Value Is	Then the Project Is
Positive	Acceptable, since it promises a return greater than the required rate of return.
Zero	Acceptable, since it promises a return equal to the required rate of return.
Negative	Not acceptable, since it promises a return less than the required rate of return.

There is another way to interpret the net present value. The new machine promises more than the required 20% rate of return. This is evident from the positive net present value of $3,838. Harper Company could spend up to $53,838 for the new machine and still obtain the minimum required 20% rate of return. The net present value of $3,838, therefore, shows the amount of "cushion" or "margin of error." One way to look at this is that the company could underestimate the cost of the new machine by up to $3,838, or overestimate the net present value of the future cash savings by up to $3,838, and the project would still be financially attractive.

Emphasis on Cash Flows

In capital budgeting decisions, the focus is on cash flows and not on accounting net income. The reason is that accounting net income is based on accruals that ignore the timing of cash flows into and out of an organization. From a capital budgeting standpoint, the timing of cash flows is important, since a dollar received today is more valuable

than a dollar received in the future. Therefore, even though accounting net income is useful for many things, it is not ordinarily used in discounted cash flow analysis. Instead of focusing on accounting net income, the analyst should concentrate on identifying the specific cash flows of the investment project.

What kinds of cash flows should the analyst look for? Although the specific cash flows will vary from project to project, certain types of cash flows tend to recur as explained in the following paragraphs.

Typical Cash Outflows Most projects will have an immediate cash outflow in the form of an initial investment in equipment or other assets. Any salvage value realized from the sale of old equipment can be recognized as a cash inflow or as a reduction in the required investment. In addition, some projects require that a company expand its working capital. Working capital is current assets (cash, accounts receivable, and inventory) less current liabilities. When a company takes on a new project, the balances in the current asset accounts

will often increase. For example, opening a new Nordstrom's department store would require additional cash in sales registers and more inventory. These additional working capital needs should be treated as part of the initial investment in a project. Also, many projects require periodic outlays for repairs and maintenance and for additional operating costs. These should all be treated as cash outflows for capital budgeting purposes.

Typical Cash Inflows On the cash inflow side, a project will normally either increase revenues or reduce costs. Either way, the amount involved should be treated as a cash inflow for capital budgeting purposes. Notice that from a cash flow standpoint, a reduction in costs is equivalent to an increase in revenues. Cash inflows are also frequently realized from selling equipment for its salvage value when a project ends, although the company may actually have to pay to dispose of some low-value or hazardous items. In addition, any working capital that was tied up in the project can be released for use elsewhere at the end of the project and should be treated as a cash

inflow at that time. Working capital is released, for example, when a company sells off its inventory or collects its accounts receivable.

In summary, the following types of cash flows are common in business investment projects:

Cash outflows:

Initial investment (including installation costs).

Increased working capital needs.

Repairs and maintenance.

Incremental operating costs.

Cash inflows:

Incremental revenues.

Reduction in costs.

Salvage value.

Release of working capital.

Recovery of the Original Investment

When computing the net present value of a project, depreciation is not deducted for two reasons.

First, depreciation is not a current cash outflow. As discussed above, discounted cash flow methods focus on cash flows. Although depreciation is used to compute net income for financial statements, it is not relevant in an analytical framework that focuses on cash flows.

A second reason for not deducting depreciation is that discounted cash flow methods automatically provide for return of the original investment, thereby making a deduction for depreciation unnecessary. To demonstrate this point, consider the following data:

Example B: Carver Hospital is considering the purchase of an attachment for its X-ray machine that will cost $3,170. The attachment will be usable for four years, after which time it will have no salvage value. It will increase net cash inflows by $1,000 per year in the X-ray

department. The hospital's board of directors requires a rate of return of at least 10% on investments.

Carver Hospital—Net Present Value Analysis of X-Ray Attachment

Initial cost	$3,170
Life of the project	4 years
Annual net cash inflow	$1,000
Salvage value	$0
Required rate of return	10%

Item	Year/s	Amount of Cash Flow	10% Factor	Present Value of Cash Flows
Annual net cash inflow .	1-4	$ 1,000	3.170	$3,170
Initial investment	Now	$(3,170)	1.000	(3,170)
Net present value				$ 0

A net present value analysis of the desirability of purchasing the X-ray attachment is presented in above.

Notice that the attachment promises exactly a 10% return on the original investment, since the net present value is zero at a 10% discount rate.

Each annual $1,000 cash inflow arising from use of the attachment is made up of two parts. One part represents a recovery of a portion of' the original $3,170 paid for the attachment, and the other part represents a return on this investment. The breakdown of each year's $1,000 cash inflow between recovery of investment and return on investment is shown below.

	(1)	(2)	(3)	(4)	(5)
				Recovery of	Unrecovered
	investment			Investment	Investment
	outstanding		Return on	during the	at the End of
	During the	Cash	Investment	Year	the Year
year	year	Inflow	(1) **x** 10%	(2) - (3)	(1) - (4)
1	$3170	$1,000	$317	$ 683	$2,487
2	2487	$1,000	$249	751	$1,736
3	1736	$1,000	$173	827	$909
4	909	$1,000	$91	909	$0
Total investment recovered				$3,170	

The first year's $1,000 cash inflow consists of interest in the amount of $317 that represents a 10% return on the $3,170 original investment, plus a $683 return of that investment. Since the amount of the unrecovered investment decreases over the four years, the dollar amount of the interest return also decreases. By the end of the fourth year, all $3,170 of the original investment has been recovered.

Simplifying Assumptions

Two simplifying assumptions are usually made in net present value analysis.

The first assumption is that all cash flows other than the initial investment occur at the end of periods. This is somewhat unrealistic in that cash flows typically occur throughout a period rather than just at its end. The purpose of this assumption is to simplify computations.

The second assumption is that all cash flows generated by an investment project are immediately reinvested at a rate of return equal to the discount rate. Unless these

conditions are met, the net present value computed for the project will not be accurate. We used a discount rate of 10% for Carver Hospital. Unless the cash flows in each period are immediately reinvested at a 10% return, the net present value computed for the X-ray attachment will be misstated.

Choosing a Discount Rate

A positive net present value indicates that the project's return exceeds the discount rate. A negative net present value indicates that the project's return is less than the discount rate. Therefore, if the company's minimum required rate of return is used as the discount rate, a project with a positive net present value is acceptable and a project with a negative net present value is unacceptable.

What is a company's minimum required rate of return? The company's cost of capital is usually regarded as the minimum required rate of return. The cost of capital is the average rate of return the company must pay to its long-term creditors and to shareholders for the use of their funds. The cost of capital is the minimum required rate of

return because if a project's rate of return is less than the cost of capital, the company does not earn enough to compensate its creditors and shareholders. Therefore, any project with a rate of return less than the cost of capital should not be accepted.

The cost of capital serves as a screening device in net present value analysis. When the cost of capital is used as the discount rate, any project with a negative net present value does not cover the company's cost of capital and should be discarded as unacceptable.

An Extended Example of the Net Present Value Method

To conclude our discussion of the net present value method, we present below an extended example of how it is used to analyze an investment proposal. This example will also help to tie together (and to reinforce) many of the ideas developed thus far.

Example C: Under a special licensing arrangement, Swinyard Company has an opportunity to market a new

product in the western United States for a five-year period. The product would be purchased from the manufacturer, with Swinyard Company responsible for promotion and distribution costs. The licensing arrangement could be renewed at the end of the five-year period. After careful study, Swinyard Company has estimated the following costs and revenues for the new product:

Cost of equipment needed	$60,000
Working capital needed	$100,000
Overhaul of the equipment in four years	$5,000
Salvage value of the equipment in five years	$10,000
Annual revenues and costs:	
Sales revenues	$200,000
Cost of goods sold	$125,000
Out-of-pocket operating costs (for salaries, advertising, and other direct costs)	$35,000

At the end of the five-year period, the working capital would be released for investment elsewhere if Swinyard

decides not to renew the licensing arrangement. Swinyard Company uses a 14% discount rate. Would you recommend that the new product be introduced?

This example involves a variety of cash inflows and cash outflows. The solution is given in next.

Sales revenues	$200,000
Less cost of goods sold	125,000
Less out-of-pocket costs for salaries, advertising, etc	35,000
Annual net cash inflows	$ 40,000

item	Year/s	Amount of cash flow	14% factor	Present value of cash flows
Purchase of equipment	Now	($60000)	1.000	$(60000)
Working capital needed	Now	($100000)	1.000	(100000)
Overhaul of equipment	4	($5000)	0.592	(2960)
Annual net cash inflows from sales of the product line	1-5	$40000	3.433	137320
Salvage value of the equipment	5	$10000	0.519	5190
Working capital released	5	$100000	0.519	51900
Net present value				$31450

Notice particularly how the working capital is handled in this exhibit. It is counted as a cash outflow at the beginning of the project and as a cash inflow when it is released at the end of the project. Also notice how the sales revenues, cost of goods sold, and out-of-pocket costs are handled. Out-of-pocket costs are actual cash outlays for salaries, advertising, and other operating expenses. Depreciation would not be an out-of-pocket cost, since it involves no current cash outlay.

Since the net present value is positive, the new product should be added assuming the company has no better use for the investment funds.

The Internal Rate of Return Method

The internal rate of return is the rate of return promised by an investment project over its useful life. It is sometimes referred to simply as the yield on a project. The internal rate of return is computed by finding the discount rate that equates the present value of a project's cash outflows with the present value of its cash inflows. In other words, the internal rate of return is the discount rate that will result in a net present value of zero.

The Internal Rate of Return Method Illustrated

To illustrate the internal rate of return method, consider the following data:

Example D: Glendale School District is considering the purchase of a large tractor-pulled lawn mower. At present, the lawn is mowed using a small hand-pushed gas mower. The large, tractor-pulled mower will cost $16,950 and will

have a useful life of 10 years. It will have a negligible scrap value, which can be ignored. The tractor-pulled mower would do the job much more quickly than the old mower, resulting in labor savings of $3,000 per year.

To compute the internal rate of return promised by the new mower, we must find the discount rate that will cause the net present value of the project to be zero. How do we do this? The simplest and most direct approach when the net cash inflow is the same every year is to divide the investment in the project by the expected net annual cash inflow. This computation will yield a factor from which the internal rate of return can be determined. The formula is as follows:

$$\text{Factor of the internal rate of return} = \frac{\text{investment required}}{\text{Net annual cash inflow}}$$

The factor derived from formula (1) is then located in the present value tables to see what rate of return it represents. Using formula (1) and the data for Glendale School District's proposed project, we get:

$$= \frac{\text{investment required}}{\text{Net annual cash inflow}}$$

$$= \$16950/\$3000 = 5.650$$

Thus, the discount factor that will equate a series of $3,000 cash inflows with a present investment of $16,950 is 5.650. Now we need to find this factor in Table to see what rate of return it represents. We should use the 10-period line in Table since the cash flows for the project continue for 10 years. If we scan along the 10-period line, we find that a factor of 5.650 represents a 12% rate of return. Therefore, the internal rate of return promised by the mower project is 12%. We can verify this by computing the project's net present value using a 12% discount rate. This computation is next.

Initial cost	$16,950
Life of the project	10 years

Annual cost savings	$3,000
Salvage value	$0

item	Year/s	Amount of Cash Flow	12% Factor	Present of Cash Flows
Annual cost savings	1-10	$3,000	5.650	$16,950
Initial investment	Now	$(16,950)	1.000	(16,950)
Net present value				$0

Notice from above that using a 12% discount rate equates the present value of the annual cash inflows with the present value of the investment required in the project, leaving a zero net present value. The 12% rate therefore represents the internal rate of return promised by the project.

Salvage Value and Other Cash Flows

The technique just demonstrated works very well if a project's cash flows are identical every year. But what if they are not? For example, what if a project will have some salvage value at the end of its life in addition to the

annual cash inflows? Under these circumstances, a trial-and-error process may be used to find the rate of return that will equate the cash inflows with the cash outflows. The trial-and-error process can be carried out by hand; however, computer software programs such as spreadsheets can perform the necessary computations in seconds. In short, erratic or uneven cash flows should not prevent an analyst from determining a project's internal rate of return.

Using the Internal Rate of Return

Once the internal rate of return has been computed, what do managers do with the information? The internal rate of return is compared to the company's required rate of return. The required rate of return is the minimum rate of return that an investment project must yield to be acceptable. If the internal rate of return is equal to or greater than the required rate of return, then the project is considered acceptable. If it is less than the required rate of return, then the project is rejected. Quite often, the company's cost of capital is used as the required rate of

return. The reasoning is that if a project can't provide a rate of return at least as great as the cost of the funds invested in it, then it is not profitable.

In the case of the Glendale School District example used earlier, let us assume that the district has set a minimum required rate of return of 15% on all projects. Since the large mower promises a rate of return of only 12%, it does not clear this hurdle and would therefore be rejected as a project.

The Cost of Capital as a Screening Tool

As we have seen in preceding examples, the cost of capital often operates as a screening device, helping the manager screen out undesirable investment projects. This screening is accomplished in different ways, depending on whether the company is using the internal rate of return method or the net present value method in its capital budgeting analysis.

When the internal rate of return method is used, the cost of capital is used as the hurdle rate that a project must clear

for acceptance. If the internal rate of return of a project is not great enough to clear the cost of capital hurdle, then the project is ordinarily rejected. We saw the application of this idea in the Glendale School District example, where the hurdle rate was set at 15%.

When the net present value method is used, the cost of capital is the discount rate used to compute the net present value of a proposed project. Any project yielding a negative net present value is rejected unless other factors are significant enough to warrant its acceptance.

The use of the cost of capital as a screening tool is summarized in below.

The cost of capital as a screening tool

The net present value method	The internal rate of return method
The cost of capital is used as the discount rate when computing the net present value of a project. Any project with a negative net present value is rejected unless other factors dictate its acceptance	The cost of capital is compared to the internal rate of return promised by a project. Any project whose internal rate of return is less than the cost of capital is rejected unless other factors dictate its acceptance

Comparison of the Net Present Value and the Internal Rate of Return Methods

The net present value method has several important advantages over the internal rate of return method.

First, the net present value method is often simpler to use. As mentioned earlier, the internal rate of return method may require hunting for the discount rate that results in a

net present value of zero. This can be a very laborious trial-and-error process, although it can be automated using a computer.

Second, the internal rate of return method makes a questionable assumption. Both methods assume that cash flows generated by a project during its useful life are immediately reinvested elsewhere. However, the two methods make different assumptions concerning the rate of return that is earned on those cash flows. The net present value method assumes the rate of return is the discount rate, whereas the internal rate of return method assumes the rate of return is the internal rate of return on the project. Specifically, if the internal rate of return of the project is high, this assumption may not be realistic. It is generally more realistic to assume that cash inflows can be reinvested at a rate of return equal to the discount rate—particularly if the discount rate is the company's cost of capital or an opportunity rate of return. For example, if the discount rate is the company's cost of capital, this rate of return can be actually realized by paying off the

company's creditors and buying back the company's stock with cash flows from the project. In short, when the net present value method and the internal rate of return method do not agree concerning the attractiveness of a project, it is best to go with the net present value method. Of the two methods, it makes the more realistic assumption about the rate of return that can be earned on cash flows from the project.

Expanding the Net Present Value Method

So far all of our examples have involved only a single investment alternative. We will now expand the net present value method to include two alternatives. In addition, we will integrate the concept of relevant costs into the discounted cash flow analysis.

The net present value method can be used to compare competing investment projects in two ways. One is the total-cost approach, and the other is the incremental-cost approach. Each approach is illustrated below.

The Total-Cost Approach

The total-cost approach is the most flexible method for comparing competing projects. To illustrate the mechanics of the approach, consider the following data:

Example E: Harper Ferry Company provides a ferry service across the Mississippi River. One of its small ferryboats is in poor condition. This ferry can be renovated at an immediate cost of $200,000. Further repairs and an overhaul of the motor will be needed five years from now at a cost of $80,000. In all, the ferry will be usable for 10 years if this work is done. At the end of 10 years, the ferry will have to be scrapped at a salvage value of approximately $60,000. The scrap value of the ferry right now is $70,000. It will cost $300,000 each year to operate the ferry, and revenues will total $400,000 annually.

As an alternative, Harper Ferry Company can purchase a new ferryboat at a cost of $360,000. The new ferry will have a life of 10 years, but it will require some repairs costing $30,000 at the end of 5 years. At the end of 10 years, the ferry will have a scrap value of $60,000. It will

cost $210,000 each year to operate the ferry, and revenues will total $400,000 annually.

Harper Ferry Company requires a return of at least 14% before taxes on all investment projects.

Should the company purchase the new ferry or renovate the old ferry? Below the solution using the total-cost approach.

	New Ferry	Old Ferry
Annual revenues	$400000	$400000
Annual cash operating costs	210000	300000
Net annual cash inflows	$190000	$100000

item	Year/s	Amount of Cash Flow	14% Factor	Present Value of Cash Flows
Buy the new ferry:				
Initial value of the old ferry	Now	($360000)	1.000	(360000)
Salvage value of old ferry	Now	70000	1.000	70000
Repairs in five years	5	(30000)	0.519	(15570)
Net annual cash inflows	1-10	190000	5.216	991040
Salvage value of the new ferry	10	60000	0.270	16200
Net present value				$701670

Keep the old ferry:

Renovation	Now	(200000)	1.000	(200000)
Repairs in five years	5	(80000)	0.519	(41520)
Net annual cash inflows	1-10	100000	5.216	521600
Salvage value of the old ferry	10	60000	0.270	16200
Net present value				296280
Net present value in favor of buying the new ferry				$405390

Second, notice that a net present value is computed for each of the two alternatives. This is a distinct advantage of the total-cost approach in that an unlimited number of alternatives can be compared side by side to determine the best option. For example, another alternative for Harper Ferry Company would be to get out of the ferry business entirely. If management desired, the net present value of this alternative could be computed to compare with the alternatives shown above. Still other alternatives might be open to the company. Once management has determined the net present value of each alternative that it wishes to consider, it can select the course of action that promises to be the most profitable. In the case at hand, given only two

alternatives, the data indicate that the most profitable choice is to purchase the new ferry.

The Incremental-Cost Approach

When only two alternatives are being considered, the incremental-cost approach offers a simpler and more direct route to a decision. Unlike the total-cost approach, it includes in the discounted cash flow analysis only those costs and revenues that differ between the two alternatives being considered. To illustrate, refer again to the data in Example E relating to Harper Ferry Company. The solution using only differential costs is presented in below.

item	Year/s	Amount of Cash Flow	14% Factor	Present of Cash Flows
-Incremental investment to buy the new ferry	Now	(160000)	1.000	(160000)
-Salvage value of the old ferry	Now	70000	1.000	70000
-Difference in repairs in five years	5	50000	0.519	25950
-Increase in net annual cash flow	1-10	90000	5.216	469440
-Difference in salvage value in 10 years	10	0	0.270	0
Net present value in favor of buying the new ferry				$405390

Two things should be noted from the data in this exhibit. First, notice that the net present value in favor of buying the new ferry of $405,390 agrees with the net present value shown under the total-cost approach. This agreement should be expected, since the two approaches are just different roads to the same destination.

Second, notice that the costs used incremental approach are just the differences between the costs shown for the two alternatives in the prior exhibit. For example, the

$160,000 incremental investment required to purchase the new ferry is the difference between the $360,000 cost of the new ferry and the $200,000 cost required to renovate the old ferry. The other figures have been computed in the same way.

Least-Cost Decisions

Revenues are not directly involved in some decisions. For example, a company that does not charge for delivery service may need to replace an old delivery truck, or a company may be trying to decide whether to lease or to buy its fleet of executive cars. In situations such as these, where no revenues are involved, the most desirable alternative will be the one that promises the least total cost from the present value perspective. Hence, these are known as least-cost decisions. To illustrate a least-cost decision, consider the following data:

Example F: Val-Tek Company is considering replacing an old threading machine with a new threading machine that would substantially reduce annual operating costs.

Selected data relating to the old and the new machines are presented below:

	Old machine	New machine
Purchase cost when new	$200000	$250000
Salvage value now	30000	----
Annual cash operating costs	150000	90000
Overhaul needed immediately	40000	----
Salvage value in six years	0	50000
Remaining life	6years	6years

Val-Tek Company uses a 10% discount rate

Analyzing the alternatives using the total-cost approach

item	Year/s	Amount of Cash Flow	14% 14% Factor	Present of Cash Flows
Buy the new machine:	Now	($250000)	1.000	($250000)
Salvage value of the old machine	Now	$30000	1.000	$30000
Annual cash operating costs	1-6	(90000)	4.355	(391950)
Salvage value of the new machine	6	50000	0.564	28200
Present value of net cash outflows				$583750
Keep the old machine:				
Overhaul needed now	Now	(40000)	1.000	(40000)
Annual cash operating costs	1-6	(150000)	4.355	(653250)
Present value of net cash outflows				(693250)
Net present value in favor of buying the new machine				$109500

As shown above, the new machine has the lowest total cost when the present value of the net cash outflows is considered. An analysis of the two alternatives using the incremental-cost approach is presented below. As before, the data in this exhibit represent the differences between the alternatives as shown under the total-cost approach.

item	Year/s	Amount of Cash Flow	14% 14% Factor	Present of Cash Flows
-Incremental investment required to Purchase the new machine	Now	($210000)	1.000	($210000)
-Salvage value of old machine	Now	30000	1.000	30000
-Savings in annual cash operating Costs	1-6	60000	4.355	261300
-Difference in salvage value in six Years	6	50000	0.564	28000
Net present value in favor of buying the new machine				$109500

Uncertain Cash Flows

Thus far, the chapter has assumed that all future cash flows are known with certainty. However, future cash flows are often uncertain or difficult to estimate. A number of techniques are available for handling this complication. Some of these techniques are quite technical—involving computer simulations or advanced mathematical skills—and are beyond the scope of this book. However, we can provide some very useful information to managers without getting too technical.

An Example

As an example of difficult-to-estimate future cash flows, consider the case of investments in automated equipment. The up-front costs of automated equipment and the tangible benefits, such as reductions in operating costs and waste, tend to be relatively easy to estimate. How-ever, the intangible benefits, such as greater reliability, greater speed, and higher quality, are more difficult to quantify in terms of future cash flows. These intangible benefits certainly impact future cash flows—particularly in terms of increased sales and perhaps higher selling prices—but the cash flow effects are difficult to estimate. What can be done?

A fairly simple procedure can be followed when the intangible benefits are likely to be significant. Suppose, for example, that a company with a 12% discount rate is considering purchasing automated equipment that would have a 10-year useful life. Also suppose that a discounted cash flow analysis of just the tangible costs and benefits shows a negative net present value of $226,000. Clearly, if

the intangible benefits are large enough, they could turn this negative net present value into a positive net present value. In this case, the amount of additional cash flow per year from the intangible benefits that would be needed to make the project financially attractive can be computed as follows:

Net present value excluding the intangible benefits (negative)	($226000)
Present value factor for an annuity at 12% for 10 periods	5.650

$$= \frac{\text{Negative net present value to be offset}}{\text{present value factor}}$$

Negative net present value to be offset, $226,000/ Present value factor, 5.650=$40000

Thus, if the intangible benefits of the automated equipment are worth at least $40,000 a year to the company, then the automated equipment should be purchased. If, in the judgment of management, these intangible benefits are not worth $40,000 a year, then the automated equipment should not be purchased.

This technique can be used in other situations in which future cash flows are difficult to estimate. For example, this technique can be used when the salvage value is difficult to estimate. To illustrate, suppose that all of the cash flows from an investment in a supertanker have been estimated—other than its salvage value in 20 years. Using a discount rate of 12%, management has determined that the net present value of all of these cash flows is a negative $1.04 million. This negative net present value would be offset by the salvage value of the supertanker. How large would the salvage value have to be to make this investment attractive?

Net present value excluding salvage value(negative)	($1040000)
Present value factor at 12% for 20 periods	0.104

Negative net present value to be offset, $1,040,000/ Present value factor, 0.104=$10,000,000

Thus, if the salvage value of the tanker is at least $10 million, its net present value would be positive and the investment would be made. However, if management believes the salvage value is unlikely to be as large as $10 million, the investment should not be made.

Real Options

The analysis in this chapter has assumed that an investment cannot be postponed and that, once started, nothing can be done to alter the course of the project. In reality, investments can often be postponed. Postponement is a particularly attractive option when the net present value of a project is modest using current estimates of future cash flows and the future cash flows involve a great deal of uncertainty that may be resolved over time. Similarly, once an investment is made, management can often exploit changes in the business environment and take actions that enhance future cash flows. For example, buying a supertanker provides management with a number of options, some of which may become more attractive as time unfolds. Instead of operating the supertanker itself,

the company may decide to lease it to another operator if the rental rates become high enough. Or, if a supertanker shortage develops, management may decide to sell the supertanker and take a gain. In the case of an investment in automated equipment, management may initially buy only the basic model without costly add-ons, but keep the option open to add more capacity and capability later. The ability to delay the start of a project, to expand it if conditions are favorable, to cut losses if they are unfavorable, and to otherwise modify plans as business conditions change adds value to many investments. These advantages can be quantified using what is called real options analysis, but the techniques are beyond the scope of this book

Preference Decisions—The Ranking of Investment Projects

Internal Rate of Return Method

When using the internal rate of return method to rank competing investment projects, the preference rule is: The higher the internal rate of return, the more desirable the

project. An investment project with an internal rate of return of 18% is usually considered preferable to another project that promises a return of only 15%. Internal rate of return is widely used to rank projects.

Net Present Value Method

Unfortunately, the net present value of one project cannot be directly compared to the net present value of another project unless the investments are equal. For example, assume that a company is considering two competing investments, as shown below:

	investment	
	A	B
Investment required	$(10000)	$(5000)
Present value of cash inflows	11000	6000
Net present value	$1000	$1000

Although each project has a net present value of $1,000, the projects are not equally desirable if the funds available for investment are limited. The project requiring an investment of only $5,000 is much more desirable than the

project requiring an investment of $10,000. This fact can be highlighted by dividing the net present value of the project by the investment required. The result, shown below in equation form, is called **the project profitability index**

Project profitability index= Net present value of the project/ Investment required

The project profitability indexes for the two investments above would be computed as follows:

	investment	
	A	B
Net present value(a)	$1000	$1000
Investment required(b)	$10000	$5000
Project profitability index,(a)/(b)	0.10	0.20

When using the project profitability index to rank competing investments projects, the preference rule is: The higher the project profitability index, the more desirable the project. Applying this rule to the two investments above, investment B should be chosen over investment A.

The project profitability index is an application of the techniques for utilizing constrained resources. In this case, the constrained resource is the limited funds available for investment, and the project profitability index is similar to the contribution margin per unit of the constrained resource.

A few details should be clarified with respect to the computation of the project profitability index. The "Investment required" refers to any cash outflows that occur at the beginning of the project, reduced by any salvage value recovered from the sale of old equipment. The "Investment required" also includes any investment in working capital that the project may need.

Other Approaches to Capital Budgeting Decisions

The net present value and internal rate of return methods are widely used as decision-making tools. Other methods of making capital budgeting decisions are also used, however, and are preferred by some managers. In this section, we discuss two such methods known as payback

and simple rate of return. Both methods have been used for many years, but have been declining in popularity.

The Payback Method

The payback method focuses on the payback period. The payback period is the length of time that it takes for a project to recoup its initial cost out of the cash receipts that it generates. This period is sometimes referred to as "the time that it takes for an investment to pay for itself." The basic premise of the payback method is that the more quickly the cost of an investment can be recovered, the more desirable is the investment.

The payback period is expressed in years. When the net annual cash inflow is the same every year, the following formula can be used to compute the payback period:

$$\text{Payback period} = \frac{\text{Investment required}}{\text{Net annual cash inflow}}$$

If new equipment is replacing old equipment, this becomes incremental net annual cash inflow.

Example G: York Company needs a new milling machine. The company is considering two machines:

machine A and machine B. Machine A costs $15,000 and will reduce operating costs by $5,000 per year. Machine B costs only $12,000 but will also reduce operating costs by $5,000 per year.

Required:

Which machine should be purchased according to the payback method?

Machine A payback period=$15000/$5000=3.0years

Machine B payback period=$12000/$5000=2.4years

According to the payback calculations, York Company should purchase machine B, since it has a shorter payback period than machine A.

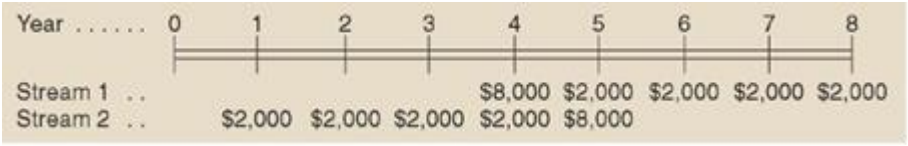
Evaluation of the Payback Method

The payback method is not a true measure of the profitability of an investment. Rather, it simply tells a manager how many years will be required to recover the original investment. Unfortunately, a shorter payback period does not always mean that one investment is more desirable than another.

To illustrate, consider again the two machines used in the example above. Since machine B has a shorter payback period than machine A, it appears that machine B is more desirable than machine A. But if we add one more piece of information, this illusion quickly disappears. Machine A has a projected 10-year life, and machine B has a projected 5-year life. It would take two purchases of machine B to provide the same length of service as would be provided by a single purchase of machine A. Under these circumstances, machine A would be a much better investment than machine B, even though machine B has a shorter payback period. Unfortunately, the payback method has no inherent mechanism for highlighting differences in useful life between investments. Such differences can be very important, and relying on payback alone may result in incorrect decisions.

A further criticism of the payback method is that it does not consider the time value of money. A cash inflow to be received several years in the future is weighed equally with a cash inflow to be received right now. To illustrate,

assume that for an investment of $8,000 you can purchase either of the two following streams of cash inflows:



Which stream of cash inflows would you prefer to receive in return for your $8,000 investment? Each stream has a payback period of 4.0 years. Therefore, if payback alone were relied on in making the decision, the streams would be viewed as equally desirable. However, from the point of view of the time value of money, stream 2 is much more desirable than stream 1.

On the other hand, under certain conditions the payback method can be very useful. For one thing, it can help identify which investment proposals are in the “ballpark.” That is, it can be used as a screening tool to help answer the question, “Should I consider this proposal further?” If a proposal doesn’t provide a payback within some specified period, then there may be no need to consider it

further. In addition, the payback period is often of great importance to new companies that are “cash poor.” When a company is cash poor, a project with a short payback period but a low rate of return might be preferred over another project with a high rate of return but a long payback period. The reason is that the company may simply need a faster return of its cash investment. And finally, the payback method is sometimes used in industries where products become obsolete very rapidly—such as consumer electronics. Since products may last only a year or two, the payback period on investments must be very short.

An Extended Example of Payback

As shown earlier, the payback period is computed by dividing the investment in a project by the net annual cash inflows that the project will generate. If new equipment is replacing old equipment, then any salvage value to be received on disposal of the old equipment should be deducted from the cost of the new equipment, and only the incremental investment should be used in the payback

computation. In addition, any depreciation deducted in arriving at the project's net operating income must be added back to obtain the project's expected net annual cash inflow. To illustrate, consider the following data:

Example H: Goodtime Fun Centers, Inc., operates amusement parks. Some of the vending machines in one of its parks provide very little revenue, so the company is considering removing the machines and installing equipment to dispense soft ice cream. The equipment would cost $80,000 and have an eight-year useful life. Incremental annual revenues and costs associated with the sale of ice cream would be as follows:

Sales	$150,000
Less cost of ingredients	90,000
Contribution margin	60,000
Less fixed expenses:	
Salaries	27,000
Maintenance	3,000

Depreciation	10,000
Total fixed expenses	40,000
Net operating income	$ 20,000

The vending machines can be sold for a $5,000 scrap value. The company will not purchase equipment unless it has a payback period of three years or less. Does the equipment to dispense ice cream pass this hurdle?

An analysis of the payback period for the proposed equipment is given below.

Step 1: *Compute the net annual cash inflow.* Since the net annual cash inflow is not given, it must be computed before the payback period can be determined:

Net operating income (given above)	$20,000
Add: Noncash deduction for depreciation	10,000
Net annual cash inflow	$30,000

Step 2: Compute the payback period. Using the net annual cash inflow figure from above, the payback period can be determined as follows:

Cost of the new equipment	$80,000
Less salvage value of old equipment	5,000
Investment required	$75,000

Payback period= Investment required/ Net annual cash inflow

=$75000/$30000=2.5years

Several things should be noted. First, depreciation is added back to net operating income to obtain the net annual cash inflow from the new equipment. Depreciation is not a cash outlay; thus, it must be added back to adjust net operating income to a cash basis. Second, the payback computation deducts the salvage value of the old machines from the cost of the new equipment so that only the incremental investment is used in computing the payback period.

Since the proposed equipment has a payback period of less than three years, the company's payback requirement has been met.

Payback and Uneven Cash Flows

When the cash flows associated with an investment project change from year to year, the simple payback formula that we outlined earlier cannot be used. Consider the following data:

Year	Investment	Cash inflow
1	$4000	$1000
2		0
3		2000
4	$2000	1000
5		500
6		3000
7		2000

What is the payback period on this investment? The answer is 5.5 years, but to obtain this figure it is necessary to track the unrecovered investment year by year. The steps involved in this process are shown below. By the middle of the sixth year, sufficient cash inflows will have been realized to recover the entire investment of $6,000 ($4,000 + $2,000).

Year	Investment	Cash Inflow	Unrecovered Investment
1	$4,000	$1,000	$3,000
2		$0	$3,000
3		$2,000	$1,000
4	$2,000	$1,000	$2,000
5		$500	$1,500
6		$3,000	$0
7		$2,000	$0

The Simple Rate of Return Method

The simple rate of return method is another capital budgeting technique that does not involve discounting cash flows. The simple rate of return is also known as the accounting rate of return or the unadjusted rate of return.

Unlike the other capital budgeting methods that we have discussed, the simple rate of return method does not focus on cash flows. Rather, it focuses on accounting net operating income. The approach is to estimate the revenues that will be generated by a proposed investment and then to deduct from these revenues all of the projected

operating expenses associated with the project. The net operating income is then related to the initial investment in the project, as shown in the following formula:

$$\text{Simple rate of return} = \frac{\text{Annual incremental revenues} - \text{annual incremental expensesm including dep.}}{\text{initial investment}}$$

$$= \frac{\text{Annual incremental net operating income}}{\text{initial investment}}$$

Or, if a cost reduction project is involved, formula becomes:

$$\text{Simple rate of return} = \frac{\text{Annual cost saving} - \text{Annual depreciation on new equipment}}{\text{initial investment}}$$

Note: The initial investment should be reduced by any salvage value from the sale of old equipment

Example I: Brigham Tea, Inc., is a processor of low-acid tea. The company is contemplating purchasing equipment for an additional processing line. The additional

processing line would increase revenues by $90,000 per year. Incremental cash operating expenses would be $40,000 per year. The equipment would cost $180,000 and have a nine-year life. No salvage value is projected.

Simple rate of return

=

$$\frac{\text{Annual incremental revenues} - \text{annual incremental expensesm including dep.}}{\text{initial investment}}$$

Simple rate of return= annual incremental revenues-(annual cash operating expenses + annual depreciation)/initial investment

=$30000/$180000

=16.7%

Example J: Midwest Farms, Inc., hires people on a part-time basis to sort eggs. The cost of this hand-sorting process is $30,000 per year. The company is investigating an egg-sorting machine that would cost $90,000 and have a 15-year useful life. The machine would have negligible salvage value, and it would cost $10,000 per year to

operate and maintain. The egg-sorting equipment currently being used could be sold now for a scrap value of $2,500.

A cost reduction project is involved in this situation. By applying last equation, we can compute the simple rate of return as follows:

Cost savings=30000-10000=$20000

Depreciation=90000/15years=$6000

Simple rate of return=annual cost savings- annual depreciation on new equipment/initial investment

=20000-6000 / (90000-2500)

=16.0%

Criticisms of the Simple Rate of Return

The most damaging criticism of the simple rate of return method is that it does not consider the time value of money. The simple rate of return method considers a dollar received 10 years from now to be as valuable as a dollar received today. Thus, the simple rate of return

method can be misleading if the alternatives being considered have different cash flow patterns. Additionally, many projects do not have constant incremental revenues and expenses over their useful lives. As a result, the simple rate of return will fluctuate from year to year, with the possibility that a project may appear to be desirable in some years and undesirable in others. In contrast, the net present value method provides a single number that summarizes all of the cash flows over the entire useful life of the project.

Postaudit of Investment Projects

After an investment project has been approved and implemented, a postaudit should be conducted. A postaudit involves checking whether or not expected results are actually realized. This is a key part of the capital budgeting process. It helps to keep managers honest in their investment proposals. Any tendency to inflate the benefits or downplay the costs in a proposal should become evident after a few postaudits have been conducted. The postaudit also provides an opportunity to

reinforce and possibly expand successful projects and to cut losses on floundering projects.

The same technique should be used in the postaudit as was used in the original approval process. That is, if a project was approved on the basis of a net present value analysis, then the same procedure should be used in performing the postaudit. However, the data used in the postaudit analysis should be actual observed data rather than estimated data. This gives management an opportunity to make a side-by-side comparison to see how well the project has succeeded. It also helps assure that estimated data received on future proposals will be carefully prepared, since the persons submitting the data will know that their estimates will be given careful scrutiny in the postaudit process. Actual results that are far out of line with original estimates should be carefully reviewed.

General example 1:

Each of the following situations is independent. Work out your own solution to each situation, and then check it against the solution provided.

1.In 12 years, John plans to retire. Upon retiring, he would like to take an extended vacation, which he expects will cost at least $40,000. What lump-sum amount must he invest now to have the needed $40,000 at the end of 12 years if the rate of return is:

a. Eight percent?

b. Twelve percent?

2. The Morgans would like to send their daughter to a music camp at the end of each of the next five years. The camp costs $1,000 a year. What lump-sum amount would have to be invested now to have the $1,000 at the end of each year if the rate of return is:

a. Eight percent?

b.Twelve percent?

3.You have just received an inheritance from a relative. You can invest the money and either receive a $200,000 lump-sum amount at the end of 10 years or receive $14,000 at the end of each year for the next 10 years. If

your minimum desired rate of return is 12%, which alternative would you prefer?

Solution:

1. a. The amount that must be invested now would be the present value of the $40,000, using a discount rate of 8%. From Table, the factor for a discount rate of 8% for 12 periods is 0.397. Multiplying this discount factor by the $40,000 needed in 12 years will give the amount of the present investment required: $40,000 X 0.397 = $15,880. b. We will proceed as we did in (a) above, but this time we will use a discount rate of 12%. From Table, the factor for a discount rate of 12% for 12 periods is 0.257. Multiplying this discount factor by the $40,000 needed in 12 years will give the amount of the present investment required: $40,000 X 0.257 = $10,280. Notice that as the discount rate (desired rate of return) increases, the present value decreases.

2. This part differs from (1) above in that we are now dealing with an annuity rather than with a single future sum. The amount that must be invested now will be the

present value of the $1,000 needed at the end of each year for five years. Since we are dealing with an annuity, or

a series of annual cash flows, we must refer to Table for the appropriate discount factor.

a. From Table, the discount factor for 8% for five periods is 3.993. Therefore, the amount that must be invested now to have $1,000 available at the end of

each year for five years is $1,000 X 3.993 = $3,993.

b. From Table, the discount factor for 12% for five periods is 3.605. Therefore, the amount that must be invested now to have $1,000 available at the end of each year for five years is $1,000 X 3.605 = $3,605.

Again, notice that as the discount rate (desired rate of return) increases, the present value decreases. At a higher rate of return we can invest less than would have been needed if a lower rate of return were being earned.

3. For this part we will need to refer to the Tables . we will need to find the discount factor for 12% for 10 periods, then apply it to the $200,000 lump sum to be received in

10 years. From Table, we will need to find the discount factor for 12% for 10 periods, then apply it to the series of $14,000 payments to be received over the 10-year period. Whichever alternative has the higher present value is the one that should be selected.

$200,000 X 0.322 = $64,400

$14,000 X 5.650 = $79,100

Thus, you should prefer to receive the $14,000 per year for 10 years rather than the $200,000 lump sum.

General example 2:

Lamar Company is studying a project that would have an eight-year life and require a $2,400,000 investment in equipment. At the end of eight years, the project would terminate and the equipment would have no salvage value. The project would provide net operating income each year as follows:

sales		$3000000
Less variable expenses		1800000
Contribution margin		1200000
Less fixed expenses:		
Advertising, salaries, and other fixed out-of-pocket costs	700000	
Depreciation	300000	
Total fixed expenses		1000000
Net operating income		$200000

The company's discount rate is 12%.

Required:

1. Compute the net annual cash inflow from the project.

2. Compute the project's net present value. Is the project acceptable?

3. Find the project's internal rate of return to the nearest whole percent.

4. Compute the project's payback period.

5. Compute the project's simple rate of return.

Solution:

1. The net annual cash inflow can be computed by deducting the cash expenses from sales:

Sales	$3,000,000
Less variable expenses	1,800,000
Contribution margin	1,200,000
Less advertising, salaries, and other fixed out-of-pocket costs	700,000
Net annual cash inflow	$ 500,000

Or it can be computed by adding depreciation back to net operating income:

Net operating income	$200,000
Add: Noncash deduction for depreciation	300000
Net annual cash inflow	$500,000

2. The net present value can be computed as follows:

item	Year/s	Amount of cash flow	14% factor	Present value of cash flows
Cost of new equipment	Now	($2400000)	1.000	$(2400000)
Net annual cash inflow	1-8	$500000	4.968	2484000
Net present value				$84000

Yes, the project is acceptable since it has a positive net present value.

3. The formula for computing the factor of the internal rate of return is:

Factor of the internal rate of return

=investment required/ net annual cash inflow

=2400000/500000=4.800

Looking in Table and scanning along the 8-period line, we find that a factor of 4.800 represents a rate of return of about 13%.

The formula for the payback period is:

Payback period=investment required/net annual cash inflow

=$2400000/$500000=4.8years

5. The formula for the simple rate of return is:

Simple rate of return=annual incremental revenues-annual incremental expenses, including depreciation=annual incremental net operating income/ initial investment

=$200000/$2400000

=8.3%

Questions:

EX1- Wendell's Donut Shoppe is investigating the purchase of a new $18,600 donut-making machine. The new machine would permit the company to reduce the amount of part-time help needed, at a cost savings of $3,800 per year. In addition, the new machine would allow the company to produce one new style of donut, resulting in the sale of at least 1,000 dozen more donuts each year. The company realizes a contribution margin of $1.20 per dozen donuts sold. The new machine would have a six-year useful life.

Required:

(Ignore income taxes.)

1. What would be the total annual cash inflows associated with the new machine for capital budgeting purposes?

2. Find the internal rate of return promised by the new machine to the nearest whole percent.

EX2- Solve each of the following present value exercises independently:

Required:

(Ignore income taxes.)

1. The Cambro Foundation, a nonprofit organization, is planning to invest $104,950 in a project that will last for three years. The project will provide cash inflows as follows:

Year 1	$30000
Year 2	$40000
Year 3	?

Assuming that the project will yield exactly a 12% rate of return, what is the expected cash inflow for Year 3?

2. Lukow Products is investigating the purchase of a piece of automated equipment that will save $400,000 each year in direct labor and inventory carrying costs. This equipment costs $2,500,000 and is expected to have a 15-year useful life with no salvage value. The company's required rate of return is 20% on all equipment purchases.

Management anticipates that this equipment will provide intangible benefits such as greater flexibility and higher quality output. What dollar value per year would these intangible benefits have to have to make the equipment an acceptable investment?

3. The Matchless Dating Service has made an investment in video and recording equipment that costs $106,700. The equipment is expected to generate cash inflows of $20,000 per year. How many years will the equipment have to be used to provide the company with a 10% rate of return on its investment?

EX3- A piece of laborsaving equipment has just come onto the market that Mitsui Electronics, Ltd., could use to reduce costs in one of its plants in Japan. Relevant data relating to the equipment follow (currency is in thousands of yen, denoted by ¥):

Purchase cost of the equipment	¥432,000
Annual cost savings that will be provided by the equipment	¥90,000

Life of the equipment 12 years

Required:

(Ignore income taxes.)

1. Compute the payback period for the equipment. If the company requires a payback period of four years or less, would the equipment be purchased?

2. Compute the simple rate of return on the equipment. Use straight-line depreciation based on the equipment's useful life. Would the equipment be purchased if the company's required rate of return is 14%?

EX4- Consider each part below independently. Ignore income taxes.

1. Preston Company's required rate of return is 14% on all investments. The company can purchase a new machine at a cost of $84,900. The new machine would generate cash inflows of $15,000 per year and have a 12-year useful life with no salvage value. Compute the machine's net present value. Is the machine an acceptable investment? Explain.

2. The Walton Daily News is investigating the purchase of a new auxiliary press that has a projected life of 18 years. It is estimated that the new press will save $30,000 per year in cash operating costs. If the new press costs $217,500, what is its internal rate of return? Is the press an acceptable investment if the company's required rate of return is 16%? Explain.

3. Refer to the data above for the Walton Daily News. How much would the annual cash inflows (cost savings) have to be for the new press to provide the required 16% rate of return? Round your answer to the nearest whole dollar.

EX5- Labeau Products, Ltd., of Perth, Australia, has $35,000 to invest. The company is trying to decide between two alternative uses for the funds as follows:

	Invest in project x	Invest in project y
Investment required	$35000	$35000
Annual cash inflows	$9000	
Single cash inflow at the end of 10 years		$150000
Life of the project	10years	10years

The company's discount rate is 18%.

Required:

(Ignore income taxes.) Which alternative would you recommend that the company accept? Show all computations using the net present value approach. Prepare separate computations for each project.

EX6- Henrie's Drapery Service is investigating the purchase of a new machine for cleaning and blocking drapes. The machine would cost $130,400, including freight and installation. Henrie's has estimated that the new machine would increase the company's cash inflows, net of expenses, by $25,000 per year. The machine would have a 10-year useful life and no salvage value.

Required:

(Ignore income taxes.)

1. Compute the machine's internal rate of return to the nearest whole percent.

2. Compute the machine's net present value. Use a discount rate of 14%. Why do you have a zero net present value?

3. Suppose that the new machine would increase the company's annual cash inflows, net of expenses, by only $22,500 per year. Under these conditions, compute the internal rate of return to the nearest whole percent.

EX7- Paul Swanson has an opportunity to acquire a franchise from The Yogurt Place, Inc., to dispense frozen yogurt products under The Yogurt Place name. Mr. Swanson has assembled the following information relating to the franchise:

a. A suitable location in a large shopping mall can be rented for $3,500 per month.

b. Remodeling and necessary equipment would cost $270,000. The equipment would have a 15-year life and an

$18,000 salvage value. Straight-line depreciation would be used, and the salvage value would be considered in computing depreciation.

c. Based on similar outlets elsewhere, Mr. Swanson estimates that sales would total $300,000 per year. Ingredients would cost 20% of sales.

d. Operating costs would include $70,000 per year for salaries, $3,500 per year for insurance, and $27,000 per year for utilities. In addition, Mr. Swanson would have to pay a commission to The Yogurt Place, Inc., of 12.5% of sales.

Required:

(Ignore income taxes.)

1. Prepare a contribution format income statement that shows the expected net operating income each year from the franchise outlet.

2. Compute the simple rate of return promised by the outlet. If Mr. Swanson requires a simple rate of return of at least 12%, should he acquire the franchise?

3. Compute the payback period on the outlet. If Mr. Swanson wants a payback of four years or less, will he acquire the franchise?

EX8- Oxford Company has limited funds available for investment and must ration the funds among five competing projects. Selected information on the five projects follows:

project	Investment Required	Net Present Value	Life of the Project (years)	Internal Rate of Return (percent)
A	$160,000	$44,323	7	18%
B	$135,000	$42,000	12	16%
C	$100,000	$35,035	7	20%
D	$175,000	$38,136	3	22%
E	$150,000	$(8,696)	6	8%

The net present values above have been computed using a 10% discount rate. The company wants your assistance in determining which project to accept first, second, and so forth.

Required:

1. Compute the project profitability index for each project.

2. In order of preference, rank the five projects in terms of:

a. Net present value.

b. Project profitability index.

c. Internal rate of return.

3. Which ranking do you prefer? Why?

EX9- Sharkey's Fun Center contains a number of electronic games as well as a miniature golf course and various rides located outside the building. Paul Sharkey, the owner, would like to construct a water slide on one portion of his property. Mr. Sharkey has gathered the following information about the slide:

a. Water slide equipment could be purchased and installed at a cost of $330,000. According to the

manufacturer, the slide would be usable for 12 years after which it would have no salvage value.

b. Mr. Sharkey would use straight-line depreciation on the slide equipment.

c. To make room for the water slide, several rides would be dismantled and sold. These rides are fully depreciated, but they could be sold for $60,000 to an amusement park in a nearby city.

d. Mr. Sharkey has concluded that about 50,000 more people would use the water slide each year than have been using the rides. The admission price would be $3.60 per person (the same price that the Fun Center has been charging for the old rides).

e. Based on experience at other water slides, Mr. Sharkey estimates that annual incremental operating expenses for the slide would be: salaries, $85,000; insurance, $4,200; utilities, $13,000; and maintenance, $9,800.

Required:

(Ignore income taxes.)

1. Prepare an income statement showing the expected net operating income each year from the water slide.

2. Compute the simple rate of return expected from the water slide. Based on this computation, would the water slide be constructed if Mr. Sharkey requires a simple rate of return of at least 14% on all investments?

3. Compute the payback period for the water slide. If Mr. Sharkey accepts any project with a payback period of five years or less, would the water slide be constructed?

EX10- The Elberta Fruit Farm of Ontario has always hired transient workers to pick its annual cherry crop. Francie Wright, the farm manager, has just received information on a cherry picking machine that is being purchased by many fruit farms. The machine is a motorized device that shakes the cherry tree, causing the cherries to fall onto plastic tarps that funnel the cherries into bins. Ms. Wright has gathered the following information to decide whether

a cherry picker would be a profitable investment for the Elberta Fruit Farm:

a. Currently, the farm is paying an average of $40,000 per year to transient workers to pick the cherries.

b. The cherry picker would cost $94,500, and it would have an estimated 12-year useful life. The farm uses straight-line depreciation on all assets and considers salvage value in computing depreciation deductions. The estimated salvage value of the cherry picker is $4,500.

c. Annual out-of-pocket costs associated with the cherry picker would be: cost of an operator and an assistant, $14,000; insurance, $200; fuel, $1,800; and a maintenance contract, $3,000.

Required:

(Ignore income taxes.)

1. Determine the annual savings in cash operating costs that would be realized if the cherry picker were purchased.

2. Compute the simple rate of return expected from the cherry picker. (Hint: Note that this is a cost reduction project.) Would the cherry picker be purchased if Elberta Fruit Farm's required rate of return is 16%?

3. Compute the payback period on the cherry picker. The Elberta Fruit Farm will not purchase equipment unless it has a payback period of five years or less. Would the cherry picker be purchased?

4. Compute (to the nearest whole percent) the internal rate of return promised by the cherry picker. Based on this computation, does it appear that the simple rate of return is an accurate guide in investment decisions?

True/False Questions

1. An investment project with a project profitability index of -0.02 has an internal rate of return that is larger than the discount rate.

2. Both the net present value method and the internal rate of return method can be used as a screening tool in capital budgeting decisions.

3. When considering a number of investment projects, the project that has the best payback period will also always have the highest net present value.

4. When discounted cash flow methods of capital budgeting are used, the working capital required for a project is ordinarily counted as a cash outflow at the beginning of the project and as a cash inflow at the end of the project.

5. Discounted cash flow techniques automatically provide for recovery of initial investment.

6. The salvage value of new equipment should not be considered when using the internal rate of return method to evaluate a project.

7. Because of the uncertainty and large cost involved in investments in automated equipment, any intangible benefits from these projects should be ignored.

8. When the internal rate of return method is used to rank investment proposals, the lower the internal rate of return, the more desirable the investment.

9. When computing the project profitability index of an investment project, the investment required will include any investment made in working capital at the beginning of the project.

10. If investment funds are limited, the net present value of one project should not be compared directly to the net present value of another project unless the initial

investments in these projects are equal.

11. In calculating payback where new equipment is replacing old equipment, any salvage value to be received on disposal of the old equipment should be deducted from the cost of the new equipment.

12. In the payback method, depreciation is added back to net operating income when computing the net annual cash flow.

13. The simple rate of return method is desirable because of its simplicity and the fact that it takes the time value of money into account.

14. The present value of a cash flow will never be greater than the future dollar amount of the cash flow.

15. If salvage value is ignored in depreciating an asset for tax purposes, any sales proceeds received at the end of the life of the asset are fully taxable as income.

Multiple Choice Questions

16. If a company has computed a project profitability index of -0.015 for an investment project, then:

A)the project's internal rate of return is less than the discount rate.

B)the project's internal rate of return is greater than the discount rate.

C)the project's internal rate of return is equal to the discount rate.

D)the relationship of the internal rate of return and the discount rate is impossible to determine from the data given.

17. If the project profitability index of an investment project is zero, then:

A)the project's internal rate of return is less than the discount rate.

B)the project's internal rate of return is greater than the discount rate.

C)the project's internal rate of return is equal to the discount rate.

D) the relationship of the rate of return and the discount rate is impossible to determine from the data given.

18. If the internal rate of return of an investment in equipment is equal to the discount rate:

A) the net present value of the investment will be zero.

B) the payback period of the investment will be equal to the useful life of the equipment.

C) neither A nor B above will be true.

D) both A and B above will be true.

19. Neu Company is considering the purchase of an investment that has a positive net present value based on a discount rate of 12%. The internal rate of return would be:

A) zero.

B) 12%.

C) greater than 12%.

D) less than 12%.

20. The assumption that the cash flows from an investment project are reinvested at the company's discount rate applies to:

A) both the internal rate of return and the net present value methods.

B) only the internal rate of return method.

C) only the net present value method.

D) neither the internal rate of return nor net present value methods.

21. The net present value of a proposed investment is negative. Therefore, the discount rate used must be:

A) greater than the project's internal rate of return.

B) less than the project's internal rate of return.

C) greater than the minimum required rate of return.

D) less than the minimum required rate of return.

22. Some investment projects require that a company increase its working capital. Under the net present value method, the investment and eventual recovery of working capital should be treated as:

A) an initial cash outflow.

B) a future cash inflow.

C) both an initial cash outflow and a future cash inflow.

D) irrelevant to the net present value analysis.

23. The net present value (NPV) method of investment project analysis assumes that the project's cash flows are reinvested at the:

A) internal rate of return.

B) discount rate used in the NPV calculation.

C) firm's simple rate of return.

D) firm's average ROI.

24. If taxes are ignored, all of the following items are included in a discounted cash flow analysis except:

A) future operating cash savings.

B) depreciation expense.

C) future salvage value.

D) investment in working capital.

25. In capital budgeting computations, discounted cash flow methods:

A) automatically provide for recovery of initial investment.

B) can't be used unless cash flows are uniform from year to year.

C) assume that all cash flows occur at the beginning of a period.

D) responses a, b, and c are all correct.

26. The internal rate of return for a project can be determined:

A) only if the project's cash flows are constant.

B) by finding the discount rate that yields a zero net present value for the project.

C) by subtracting the company's cost of capital from the project's profitability index.

D) only if the project profitability index is greater than zero.

27. The investment required for the project profitability index should:

A) be reduced by the amount of any salvage recovered from the sale of old equipment.

B) be reduced by the amount of any salvage recovered from the sale of the new equipment at the end of its useful life.

C) be reduced by the amount of any salvage recovered from the sale of both the old and new equipment.

D) none of the above is correct.

28. Which of the following represents the correct treatment of a loss on the sale of an old asset in a net present value analysis under the total cost approach?

A) Multiply the amount of the loss times one minus the tax rate prior to discounting.

B) Multiply the amount of the loss times the tax rate prior to discounting.

C) Make no adjustment to the amount of the loss prior to discounting.

D) None of the above.

29. In net present value analysis, the release of working capital at the end of a project

should be:

A) ignored.

B) included as a cash outflow.

C) included as a cash inflow.

D) included as a tax deduction.

30. Buret Corporation is contemplating a plant expansion capital budgeting decision. The plant expansion will require an $80,000 increase in working capital. This amount will be released at the end of the useful life of this project. Which of the following will increase the present value of the cash flows associated with the increase and release of the $80,000 of working capital?

A) an increase in the cost of capital.

B) an increase in the tax rate.

C) an increase in the useful life of the project.

D) none of the above.

31. (Ignore income taxes in this problem.) Ataxia Fitness Center is considering an investment in some additional weight training equipment. The equipment has an estimated useful life of 10 years with no salvage value at the end of the 10 years. Ataxia expects net annual cash inflows of $54,000 from this equipment. Ataxia's internal rate of return on this equipment is 14%. Ataxia's discount

rate is also 14%.What is the payback period on this equipment?

A) 1.92 years

B) 2.70 years

C) 3.70 years

D) 5.22 years

32. (Ignore income taxes in this problem.) Ludington, Inc. purchased a new machine on January 1 for $350,000. The machine is expected to have a useful life of 8 years and no salvage value. Straight-line depreciation is to be used. The internal rate of return on the project is 14%. The present value of the annual cash inflows generated by the machine was calculated to be $371,120 using the internal rate of return of 14%. What was the annual cash inflow that was used in the calculation of the present value?

A) $350,000 x 0.351

B) $350,000 ÷ 4.639

C) $371,120 x 0.351

D) $371,120 ÷ 4.639

33. (Ignore income taxes in this problem.) An investment project has the following characteristics:

Cost of equipment $22,820

Annual cash inflows $5,000

Internal rate of return 12%

The life of the equipment would be:

A) It is impossible to determine from the data given.

B) 7 years

C) 12 years

D) 4.56 years.

34. (Ignore income taxes in this problem.) The Allen Company is planning an investment with the following characteristics:

Useful life 7 years

Yearly net cash inflow $40,000

Salvage value $0

Internal rate of return 20%

Discount rate 16%

The initial cost of the equipment is:

A) $240,080

B) $152,480

C) $144,200

D) Cannot be determined from the given information.

35. (Ignore income taxes in this problem.) Highpoint, Inc., is considering investing in automated equipment with a ten-year useful life. Managers at Highpoint have estimated the cash flows associated with the tangible costs and benefits of automation, but have been unable to estimate the cash flows associated with the intangible

benefits. Using the company's 12% required rate of return, the net present value of the cash flows associated with just the tangible costs and benefits is a negative $282,500.

How large would the annual net cash inflows from the intangible benefits have to be to make this a financially acceptable investment?

A) $20,000

B) $28,250

C) $35,000

D) $50,000

36. (Ignore income taxes in this problem.) A company wants to have $40,000 at the end of a five-year period through investment of a single sum now. How much needs to be invested in order to have the desired sum in five years, if the money can be invested at 10%:

A) $10,551

B) $8,000

C) $24,840

D) $12,882

37. (Ignore income taxes in this problem.) The following data on a proposed investment project have been provided:

Cost of equipment	$50,000
Working capital required	$30,000
Salvage value of equipment	$0
Annual cash inflows from the project	$20,000
Required rate of return	20%
Life of the project	8 years

The net present value of the project would be:

A) $3,730

B) $0

C) $32,450

D) $88,370

38. (Ignore income taxes in this problem.) Stratford Company purchased a machine with an estimated useful life of seven years. The machine will generate cash

inflows of $9,000 each year over the next seven years. If the machine has no salvage value at the end of seven years, and assuming the company's discount rate is 10%, what is the purchase price of the machine if the net present value of the investment is $17,000?

A) $43,812

B) $26,812

C) $17,000

D) $22,195

39. (Ignore income taxes in this problem.) Anthony operates a part time auto repair service. He estimates that a new diagnostic computer system will result in increased cash inflows of $1,500 in Year 1, $2,100 in Year 2, and $3,200 in Year 3. If Anthony's required rate of return is 10%, then the most he would be willing to pay for the new computer system would be:

A) $4,599

B) $5,501

C) $5,638

D) $5,107

40. (Ignore income taxes in this problem.) Fossa Road Paving Company is considering an investment in a curb-forming machine. The machine will cost $240,000, will last 10 years, and will have a $40,000 salvage value at the end of 10 years. The machine is expected to generate net cash inflows of $60,000 per year in each of the 10 years.

Fossa's discount rate is 18%. What is the net present value of this machine?

A) $5,840

B) $37,280

C) $(48,780)

D) $69,640

40. (Ignore income taxes in this problem.) Apnea Video Rental Store is considering the purchase of an almost new minivan to use as a vehicle to deliver and pick up video

tapes for customers. The minivan will cost $18,000 and is expected to last 8 years but only if the engine is overhauled at a cost of $3,000 at the end of year 3. The minivan is expected to have a $1,000 salvage value at the end of 8 years. This delivery service is expected to generate net cash inflows of $6,000 per year in each of the 8 years. Apnea's discount rate is 14%. What is the net present value of this investment opportunity?

A) $(2,826)

B) $(3,801)

C) $7,185

D) $8,160

41. (Ignore income taxes in this problem.) Naomi Corporation has a capital budgeting project that has a negative net present value of $36,000. The life of this project is 6 years. Naomi's discount rate is 20%. By how much would the annual cash inflows from this project have to increase in order to have a positive net present value?

A) $1,200 or more

B) $2,412 or more

C) $6,000 or more

D) $10,824 or more

42. (Ignore income taxes in this problem.) The following data pertain to an investment project:

Investment required $34,055

Annual savings $5,000

Life of the project 15 years

The internal rate of return is:

A) 12%

B) 14%

C) 10%

D) 8%

43. (Ignore income taxes in this problem.) The Laws company has decided to buy a machine costing $16,000. Estimated cash savings from using the new machine

amount to $4,120 per year. The machine will have no salvage value at the end of its useful life of six years. If the required rate of return for Laws Company is 12%, the machine's internal rate of return is closest to:

A) 12%

B) 14%

C) 16%

D) 18%

44. (Ignore income taxes in this problem.) James Company is considering buying a new machine costing $30,000. James estimates that the machine will save $6,900 per year in cash operating expenses for the next six years. If the machine has no salvage value at the end of six years and the discount rate used by James is 8%, then the machine's internal rate of return is closest to:

A) 8%

B) 10%

C) 12%

D) 14%

45. A project requires an initial investment of $70,000 and has a project profitability index of 0.932. The present value of the future cash inflows from this investment is:

A) $70,000

B) $36,231

C) $135,240

D) Cannot be determined from the data provided.

46. (Ignore income taxes in this problem.) Major Corporation is considering the purchase of a new machine for $5,000. The machine has an estimated useful life of 5 years and no salvage value. The machine will increase Major's cash flows by $2,000 annually for 5 years. Major uses straight-line depreciation. The company's required rate of return is 10%. What is the payback period for the machine?

A) 5.00 years

B) 2.50 years

C) 7.58 years

D) 8.34 years

47. (Ignore income taxes in this problem.) An investment project requires an initial investment of $100,000. The project is expected to generate net cash inflows of $28,000 per year for the next five years. Assuming a 12% discount rate, the project'spayback period is:

A) 0.28 years

B) 3.36 years

C) 3.57 years

D) 1.40 years

48. (Ignore income taxes in this problem.) Mercer Corporation is considering replacing a technologically obsolete machine with a new state-of-the-art numerically controlled machine. The new machine would cost $250,000 and would have a ten-year useful life. Unfortunately, the new machine would have no salvage value. The new machine would cost $12,000 per year to

operate and maintain, but would save $55,000 per year in labor and other costs. The old machine can be sold now for scrap for $10,000. The simple rate of return on the new machine is closest to:

A) 17.9%

B) 7.5%

C) 22.0%

D) 7.2%

49. A company needs an increase in working capital of $30,000 in a project that will last 4 years. The company's tax rate is 30% and its discount rate is 8%. The present value of the release of the working capital at the end of the project is closest to:

A) $22,051

B) $21,000

C) $9,000

D) $15,436

Use the following to answer questions 50-53:

(Ignore income taxes in this problem.) Overland Company has gathered the following data on a proposed investment project:

Investment in depreciable equipment	$150,000
Annual cash flows	$40,000
Salvage value of equipment	$0
Life of the equipment	10 years
Required rate of return	10%

The company uses straight-line depreciation on all equipment.

50. The payback period for the investment is:

A) 0.27 years

B) 3.75 years

C) 10.00 years

D) 2.13 years

51. The simple rate of return on the investment is:

A) 26.67%

B) 16.67%

C) 36.67%

D) 10.00%

52. The net present value of this investment is:

A) $40,000

B) $3,625

C) $57,831

D) $95,800

53. The internal rate of return on the investment is closest to:

A) 23%

B) 25%

C) 24%

D) 21%

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TABLE 6A–6 Present Value of an Annuity Due of $1

$$PVAD = \left[\frac{1 - \frac{1}{(1+i)^n}}{i}\right] \times (1+i)$$

n/i	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%	5.5%	6.0%	7.0%	8.0%	9.0%	10.0%	11.0%	12.0%	20.0%
1	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
2	1.99010	1.98522	1.98039	1.97561	1.97087	1.96618	1.96154	1.95694	1.95238	1.94787	1.94340	1.93458	1.92593	1.91743	1.90909	1.90090	1.89286	1.83333
3	2.97040	2.95588	2.94156	2.92742	2.91347	2.89969	2.88609	2.87267	2.85941	2.84632	2.83339	2.80802	2.78326	2.75911	2.73554	2.71252	2.69005	2.52778
4	3.94099	3.91220	3.88388	3.85602	3.82861	3.80164	3.77509	3.74896	3.72325	3.69793	3.67301	3.62432	3.57710	3.53129	3.48685	3.44371	3.40183	3.10648
5	4.90197	4.85438	4.80773	4.76197	4.71710	4.67308	4.62990	4.58753	4.54595	4.50515	4.46511	4.38721	4.31213	4.23972	4.16987	4.10245	4.03735	3.58873
6	5.85343	5.78264	5.71346	5.64583	5.57971	5.51505	5.45182	5.38998	5.32948	5.27028	5.21236	5.10020	4.99271	4.88965	4.79079	4.69590	4.60478	3.99061
7	6.79548	6.69719	6.60143	6.50813	6.41719	6.32855	6.24214	6.15787	6.07569	5.99553	5.91732	5.76654	5.62288	5.48592	5.35526	5.23054	5.11141	4.32551
8	7.72819	7.59821	7.47199	7.34939	7.23028	7.11454	7.00205	6.89270	6.78637	6.68297	6.58238	6.38929	6.20637	6.03295	5.86842	5.71220	5.56376	4.60459
9	8.65168	8.48593	8.32548	8.17014	8.01969	7.87396	7.73274	7.59589	7.46321	7.33457	7.20979	6.97130	6.74664	6.53482	6.33493	6.14612	5.96764	4.83716
10	9.56602	9.36052	9.16224	8.97087	8.78611	8.60769	8.43533	8.26879	8.10782	7.95220	7.80169	7.51523	7.24689	6.99525	6.75902	6.53705	6.32825	5.03097
11	10.47130	10.22218	9.98259	9.75206	9.53020	9.31661	9.11090	8.91272	8.72173	8.53763	8.36009	8.02358	7.71008	7.41766	7.14457	6.88923	6.65022	5.19247
12	11.36763	11.07112	10.78685	10.51421	10.25262	10.00155	9.76048	9.52892	9.30641	9.09254	8.88687	8.49867	8.13896	7.80519	7.49506	7.20652	6.93770	5.32706
13	12.25508	11.90751	11.57534	11.25776	10.95400	10.66333	10.38507	10.11858	9.86325	9.61852	9.38384	8.94269	8.53608	8.16073	7.81369	7.49236	7.19437	5.43922
14	13.13374	12.73153	12.34837	11.98318	11.63496	11.30274	10.98565	10.68285	10.39357	10.11708	9.85268	9.35765	8.90378	8.48690	8.10336	7.74987	7.42355	5.53268
15	14.00370	13.54338	13.10625	12.69091	12.29607	11.92052	11.56312	11.22283	10.89864	10.58965	10.29198	9.74547	9.24424	8.78615	8.36669	7.98187	7.62817	5.61057
16	14.86505	14.34323	13.84926	13.38138	12.93794	12.51741	12.11839	11.73955	11.37966	11.03758	10.71225	10.10791	9.55948	9.06069	8.60608	8.19087	7.81086	5.67547
17	15.71787	15.13126	14.57771	14.05500	13.56110	13.09412	12.65230	12.23402	11.83777	11.46216	11.10590	10.44665	9.85137	9.31256	8.82371	8.37916	7.97399	5.72956
18	16.56225	15.90765	15.29187	14.71220	14.16612	13.65132	13.16567	12.70719	12.27407	11.86461	11.47726	10.76322	10.12164	9.54363	9.02155	8.54879	8.11963	5.77463
19	17.39827	16.67256	15.99203	15.35336	14.75351	14.18968	13.65930	13.15999	12.68959	12.24607	11.82760	11.05909	10.37189	9.75563	9.20141	8.70162	8.24967	5.81219
20	18.22601	17.42617	16.67846	15.97889	15.32380	14.70984	14.13394	13.59329	13.08532	12.60765	12.15812	11.33560	10.60360	9.95011	9.36492	8.83929	8.36578	5.84350
21	19.04555	18.16864	17.35143	16.58916	15.87747	15.21240	14.59033	14.00794	13.46221	12.95038	12.46992	11.59401	10.81815	10.12855	9.51356	8.96333	8.46944	5.86958
25	22.24339	21.03041	19.91393	18.88499	17.93554	17.05837	16.24696	15.49548	14.79864	14.15170	13.55036	12.46933	11.52876	10.70661	9.98474	9.34814	8.78432	5.93710
30	26.06579	24.37608	22.84438	21.45355	20.18845	19.03577	17.98371	17.02189	16.14107	15.33310	14.59072	13.27767	12.15841	11.19828	10.36961	9.65011	9.02181	5.97472
40	33.16303	30.36458	27.90259	25.73034	23.80822	22.10250	20.58448	19.22966	18.01704	16.92866	15.94907	14.26493	12.87858	11.72552	10.75696	9.93567	9.23303	5.99592

made at the *beginning* of each compounding period.

TABLE 6A–2 Present Value of $1

$$PV = \frac{\$1}{(1+i)^n}$$

n/i	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%	5.5%	6.0%	7.0%	8.0%	9.0%	10.0%	11.0%	12.0%	20.0%
1	0.99010	0.98522	0.98039	0.97561	0.97087	0.96618	0.96154	0.95694	0.95238	0.94787	0.94340	0.93458	0.92593	0.91743	0.90909	0.90090	0.89286	0.83333
2	0.98030	0.97066	0.96117	0.95181	0.94260	0.93351	0.92456	0.91573	0.90703	0.89845	0.89000	0.87344	0.85734	0.84168	0.82645	0.81162	0.79719	0.69444
3	0.97059	0.95632	0.94232	0.92860	0.91514	0.90194	0.88900	0.87630	0.86384	0.85161	0.83962	0.81630	0.79383	0.77218	0.75131	0.73119	0.71178	0.57870
4	0.96098	0.94218	0.92385	0.90595	0.88849	0.87144	0.85480	0.83856	0.82270	0.80722	0.79209	0.76290	0.73503	0.70843	0.68301	0.65873	0.63552	0.48225
5	0.95147	0.92826	0.90573	0.88385	0.86261	0.84197	0.82193	0.80245	0.78353	0.76513	0.74726	0.71299	0.68058	0.64993	0.62092	0.59345	0.56743	0.40188
6	0.94205	0.91454	0.88797	0.86230	0.83748	0.81350	0.79031	0.76790	0.74622	0.72525	0.70496	0.66634	0.63017	0.59627	0.56447	0.53464	0.50663	0.33490
7	0.93272	0.90103	0.87056	0.84127	0.81309	0.78599	0.75992	0.73483	0.71068	0.68744	0.66506	0.62275	0.58349	0.54703	0.51316	0.48166	0.45235	0.27908
8	0.92348	0.88771	0.85349	0.82075	0.78941	0.75941	0.73069	0.70319	0.67684	0.65160	0.62741	0.58201	0.54027	0.50187	0.46651	0.43393	0.40388	0.23257
9	0.91434	0.87459	0.83676	0.80073	0.76642	0.73373	0.70259	0.67290	0.64461	0.61763	0.59190	0.54393	0.50025	0.46043	0.42410	0.39092	0.36061	0.19381
10	0.90529	0.86167	0.82035	0.78120	0.74409	0.70892	0.67556	0.64393	0.61391	0.58543	0.55839	0.50835	0.46319	0.42241	0.38554	0.35218	0.32197	0.16151
11	0.89632	0.84893	0.80426	0.76214	0.72242	0.68495	0.64958	0.61620	0.58468	0.55491	0.52679	0.47509	0.42888	0.38753	0.35049	0.31728	0.28748	0.13459
12	0.88745	0.83639	0.78849	0.74356	0.70138	0.66178	0.62460	0.58966	0.55684	0.52598	0.49697	0.44401	0.39711	0.35553	0.31863	0.28584	0.25668	0.11216
13	0.87866	0.82403	0.77303	0.72542	0.68095	0.63940	0.60057	0.56427	0.53032	0.49856	0.46884	0.41496	0.36770	0.32618	0.28966	0.25751	0.22917	0.09346
14	0.86996	0.81185	0.75788	0.70773	0.66112	0.61778	0.57748	0.53997	0.50507	0.47257	0.44230	0.38782	0.34046	0.29925	0.26333	0.23199	0.20462	0.07789
15	0.86135	0.79985	0.74301	0.69047	0.64186	0.59689	0.55526	0.51672	0.48102	0.44793	0.41727	0.36245	0.31524	0.27454	0.23939	0.20900	0.18270	0.06491
16	0.85282	0.78803	0.72845	0.67362	0.62317	0.57671	0.53391	0.49447	0.45811	0.42458	0.39365	0.33873	0.29189	0.25187	0.21763	0.18829	0.16312	0.05409
17	0.84438	0.77639	0.71416	0.65720	0.60502	0.55720	0.51337	0.47318	0.43630	0.40245	0.37136	0.31657	0.27027	0.23107	0.19784	0.16963	0.14564	0.04507
18	0.83602	0.76491	0.70016	0.64117	0.58739	0.53836	0.49363	0.45280	0.41552	0.38147	0.35034	0.29586	0.25025	0.21199	0.17986	0.15282	0.13004	0.03756
19	0.82774	0.75361	0.68643	0.62553	0.57029	0.52016	0.47464	0.43330	0.39573	0.36158	0.33051	0.27651	0.23171	0.19449	0.16351	0.13768	0.11611	0.03130
20	0.81954	0.74247	0.67297	0.61027	0.55368	0.50257	0.45639	0.41464	0.37689	0.34273	0.31180	0.25842	0.21455	0.17843	0.14864	0.12403	0.10367	0.02608
21	0.81143	0.73150	0.65978	0.59539	0.53755	0.48557	0.43883	0.39679	0.35894	0.32486	0.29416	0.24151	0.19866	0.16370	0.13513	0.11174	0.09256	0.02174
24	0.78757	0.69954	0.62172	0.55288	0.49193	0.43796	0.39012	0.34770	0.31007	0.27666	0.24698	0.19715	0.15770	0.12640	0.10153	0.08170	0.06588	0.01258
25	0.77977	0.68921	0.60953	0.53939	0.47761	0.42315	0.37512	0.33273	0.29530	0.26223	0.23300	0.18425	0.14602	0.11597	0.09230	0.07361	0.05882	0.01048
28	0.75684	0.65910	0.57437	0.50088	0.43708	0.38165	0.33348	0.29157	0.25509	0.22332	0.19563	0.15040	0.11591	0.08955	0.06934	0.05382	0.04187	0.00607
29	0.74934	0.64936	0.56311	0.48866	0.42435	0.36875	0.32065	0.27902	0.24295	0.21168	0.18456	0.14056	0.10733	0.08215	0.06304	0.04849	0.03738	0.00506
30	0.74192	0.63976	0.55207	0.47674	0.41199	0.35628	0.30832	0.26700	0.23138	0.20064	0.17411	0.13137	0.09938	0.07537	0.05731	0.04368	0.03338	0.00421
31	0.73458	0.63031	0.54125	0.46511	0.39999	0.34423	0.29646	0.25550	0.22036	0.19018	0.16425	0.12277	0.09202	0.06915	0.05210	0.03935	0.02980	0.00351
40	0.67165	0.55126	0.45289	0.37243	0.30656	0.25257	0.20829	0.17193	0.14205	0.11746	0.09722	0.06678	0.04603	0.03184	0.02209	0.01538	0.01075	0.00068

TABLE 6A–4 Present Value of an Ordinary Annuity of $1

$$PVA = \frac{1 - \frac{1}{(1+i)^n}}{i}$$

n/i	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%	5.5%	6.0%	7.0%	8.0%	9.0%	10.0%	11.0%	12.0%	20.0%
1	0.99010	0.98522	0.98039	0.97561	0.97087	0.96618	0.96154	0.95694	0.95238	0.94787	0.94340	0.93458	0.92583	0.91743	0.90909	0.90090	0.89286	0.83333
2	1.97040	1.95588	1.94156	1.92742	1.91347	1.89969	1.88609	1.87267	1.85941	1.84632	1.83339	1.80802	1.78326	1.75911	1.73554	1.71252	1.69005	1.52778
3	2.94099	2.91220	2.88388	2.85602	2.82861	2.80164	2.77509	2.74896	2.72325	2.69793	2.67301	2.62432	2.57710	2.53129	2.48685	2.44371	2.40183	2.10648
4	3.90197	3.85438	3.80773	3.76197	3.71710	3.67308	3.62990	3.58753	3.54595	3.50515	3.46511	3.38721	3.31213	3.23972	3.16987	3.10245	3.03735	2.58873
5	4.85343	4.78264	4.71346	4.64583	4.57971	4.51505	4.45182	4.38998	4.32948	4.27028	4.21236	4.10020	3.99271	3.88965	3.79079	3.69590	3.60478	2.99061
6	5.79548	5.69719	5.60143	5.50813	5.41719	5.32855	5.24214	5.15787	5.07569	4.99553	4.91732	4.76654	4.62288	4.48592	4.35526	4.23054	4.11141	3.32551
7	6.72819	6.59821	6.47199	6.34939	6.23028	6.11454	6.00205	5.89270	5.78637	5.68297	5.58238	5.38929	5.20637	5.03295	4.86842	4.71220	4.56376	3.60459
8	7.65168	7.48593	7.32548	7.17014	7.01969	6.87396	6.73274	6.59589	6.46321	6.33457	6.20979	5.97130	5.74664	5.53482	5.33493	5.14612	4.96764	3.83716
9	8.56602	8.36052	8.16224	7.97087	7.78611	7.60769	7.43533	7.26879	7.10782	6.95220	6.80169	6.51523	6.24689	5.99525	5.75902	5.53705	5.32825	4.03097
10	9.47130	9.22218	8.98259	8.75206	8.53020	8.31661	8.11090	7.91272	7.72173	7.53763	7.36009	7.02358	6.71008	6.41766	6.14457	5.88923	5.65022	4.19247
11	10.36763	10.07112	9.78685	9.51421	9.25262	9.00155	8.76048	8.52892	8.30641	8.09254	7.88687	7.49867	7.13896	6.80519	6.49506	6.20652	5.93770	4.32706
12	11.25508	10.90751	10.57534	10.25776	9.95400	9.66333	9.38507	9.11858	8.86325	8.61852	8.38384	7.94269	7.53608	7.16073	6.81369	6.49236	6.19437	4.43922
13	12.13374	11.73153	11.34837	10.98319	10.63496	10.30274	9.98565	9.68285	9.39357	9.11708	8.85268	8.35765	7.90378	7.48690	7.10336	6.74987	6.42355	4.53268
14	13.00370	12.54338	12.10625	11.69091	11.29607	10.92052	10.56312	10.22283	9.89864	9.58965	9.29498	8.74547	8.24424	7.78615	7.36669	6.98187	6.62817	4.61057
15	13.86505	13.34323	12.84926	12.38138	11.93794	11.51741	11.11839	10.73955	10.37966	10.03758	9.71225	9.10791	8.55948	8.06069	7.60608	7.19087	6.81086	4.67547
16	14.71787	14.13126	13.57771	13.05500	12.56110	12.09412	11.65230	11.23402	10.83777	10.46216	10.10590	9.44665	8.85137	8.31256	7.82371	7.37916	6.97399	4.72956
17	15.56225	14.90765	14.29187	13.71220	13.16612	12.65132	12.16567	11.70719	11.27407	10.86461	10.47726	9.76322	9.12164	8.54363	8.02155	7.54879	7.11963	4.77463
18	16.39827	15.67256	14.99203	14.35336	13.75351	13.18968	12.65930	12.15999	11.68959	11.24607	10.82760	10.05909	9.37189	8.75563	8.20141	7.70162	7.24967	4.81219
19	17.22601	16.42617	15.67846	14.97889	14.32380	13.70984	13.13394	12.59329	12.08532	11.60765	11.15812	10.33560	9.60360	8.95011	8.36492	7.83929	7.36578	4.84350
20	18.04555	17.16864	16.35143	15.58916	14.87747	14.21240	13.59033	13.00794	12.46221	11.95038	11.46992	10.59401	9.81815	9.12855	8.51356	7.96333	7.46944	4.86958
21	18.85698	17.90014	17.01121	16.18455	15.41502	14.69797	14.02916	13.40472	12.82115	12.27524	11.76408	10.83553	10.01680	9.29224	8.64869	8.07507	7.56200	4.89132
25	22.02316	20.71961	19.52346	18.42438	17.41315	16.48151	15.62208	14.82821	14.09394	13.41393	12.78336	11.65358	10.67478	9.82258	9.07704	8.42174	7.84314	4.94759
30	25.80771	24.01584	22.39646	20.93029	19.60044	18.39205	17.29203	16.28889	15.37245	14.53375	13.76483	12.40904	11.25778	10.27365	9.42691	8.69379	8.05518	4.97894
40	32.83469	29.91585	27.35548	25.10278	23.11477	21.35507	19.79277	18.40158	17.15909	16.04612	15.04630	13.33171	11.92461	10.75736	9.77905	8.95105	8.24378	4.99660

This table shows the present value of an ordinary annuity of $1 at various interest rates (*i*) and time periods (*n*). It is used to calculate the present value of any series of equal payments made at the *end* of each compounding period.