Fundamentals of Corporate Finance, 2/e

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Chapter 10: The Fundamentals of Capital Budgeting

Learning Objectives

1. DISCUSS WHY CAPITAL BUDGETING DECISIONS ARE THE MOST IMPORTANT INVESTMENT DECISIONS MADE BY A FIRM'S MANAGEMENT.
2. EXPLAIN THE BENEFITS OF USING THE NET PRESENT VALUE (NPV) METHOD TO ANALYZE CAPITAL EXPENDITURE DECISIONS AND CALCULATE THE NPV FOR A CAPITAL PROJECT.

Learning Objectives

3. DESCRIBE THE STRENGTHS AND WEAKNESSES OF THE PAYBACK PERIOD AS A CAPITAL EXPENDITURE DECISION-MAKING TOOL AND COMPUTE THE PAYBACK PERIOD FOR A CAPITAL PROJECT.
4. EXPLAIN WHY THE ACCOUNTING RATE OF RETURN (ARR) IS NOT RECOMMENDED FOR USE AS A CAPITAL EXPENDITURE DECISION-MAKING TOOL.

Learning Objectives

5. COMPUTE THE INTERNAL RATE OF RETURN (IRR) FOR A CAPITAL PROJECT AND DISCUSS THE CONDITIONS UNDER WHICH THE IRR TECHNIQUE AND THE NPV TECHNIQUE PRODUCE DIFFERENT RESULTS.
6. EXPLAIN THE BENEFITS OF POST-AUDIT AND ONGOING REVIEWS OF CAPITAL PROJECTS.

Introduction to Capital Budgeting

- THE IMPORTANCE OF CAPITAL BUDGETING
  - **Capital-budgeting decisions are the most important investment decisions made by management.**

    These decisions determine the long-term productive assets that will create wealth for a firm's owner(s).

Exhibit 10.1: Key Reasons for Making Capital Expenditures

Reason	Description
Renewal:	Over time, equipment must be repaired, overhauled, rebuilt, or retrofitted with new technology to keep the firm's manufacturing or service operations going. For example, a company that has a fleet of delivery trucks may decide to overhaul the trucks and their engines rather than purchase new trucks. Renewal decisions typically do not require an elaborate analysis and are made on a routine basis.
Replacement:	At some point, an asset will have to be replaced rather than repaired or overhauled. The major decision is whether to replace the asset with a similar piece of equipment or purchase equipment that would require a change in the production process. Sometimes, replacement decisions involve equipment that is operating satisfactorily but has become obsolete. The new or retrofitted equipment may provide cost savings with respect to labor or material usage and/or may improve product quality. These decisions typically originate at the plant level.
Expansion:	Strategically, the most important motive for capital expenditures is to expand the level of operating output. One type of expansion decision involves increasing the output of existing products. This may mean new equipment to produce more products or expansion of the firm's distribution system. These types of decisions typically require a more complex analysis than a renewal or replacement decision. Another type of expansion decision involves producing a new product or entering a new market. This type of expansion often involves large dollar amounts and significant business risk and requires the approval of the firm's board of directors.
Regulatory:	Some capital expenditures are required by federal and state regulations. These mandatory expenditures usually involve meeting workplace safety standards and environmental standards.
Other:	This category includes items such as parking facilities, office buildings, and executive aircraft. Many of these capital expenditures are hard to analyze because it is difficult to estimate their cash inflows. Ultimately, the decisions can be more subjective than analytical.

Introduction to Capital Budgeting

- THE IMPORTANCE OF CAPITAL BUDGETING
  - **Capital investments are large cash outlays, long-term commitments, not easily reversed, and primary factors in a firm's long-run performance**
  - **Capital-budgeting techniques help management systematically analyze potential opportunities in order to decide which are worth undertaking.**

Introduction to Capital Budgeting

- SOURCES OF INFORMATION
  - **Most of the information needed to make capital-budgeting decisions is generated internally, often beginning with the sales force.**
  - **Next the production team gets involved, followed by accountants.**
  - **All the information is reviewed by financial managers who evaluate the feasibility of the project.**

Introduction to Capital Budgeting

- CLASSIFICATION OF INVESTMENT PROJECTS
  - **Capital budgeting projects can be classified as**
    1. Independent projects
    2. Mutually exclusive projects
    3. Contingent projects

Introduction to Capital Budgeting

- CLASSIFICATION OF INVESTMENT PROJECTS

  1. **Independent projects**

     Projects for which the decision to accept or reject is not influenced by decisions about other projects being considered by the firm.

Introduction to Capital Budgeting

- CLASSIFICATION OF INVESTMENT PROJECTS

  2. Mutually exclusive projects

  Projects for which the decision to accept one project is simultaneously a decision to reject another project.

  These projects typically perform the same function.

Introduction to Capital Budgeting

- CLASSIFICATION OF INVESTMENT PROJECTS

  3. Contingent projects

  Projects for which the decision to accept one project depends on acceptance of another project.

  – *Types of contingent projects*

  »mandatory projects

  »optional projects

Introduction to Capital Budgeting

- BASIC CAPITAL BUDGETING TERMS
  - **Capital rationing: a firm with limited funds chooses the best projects to undertake**
  - **Capital asset: a long-term asset**

Net Present Value

- NET PRESENT VALUE (NPV)
  - **Is the best capital-budgeting technique. It is consistent with goal of maximizing shareholder wealth.**
  - **The method compares the present value of expected benefits and cash flows from a project to the present value of the expected costs. If the benefits are larger, the project is feasible.**

Exhibit 10.2: Sample Worksheet for Net Present Value Analysis

EXHIBIT 10.2

Sample Worksheet for Net Present Value Analysis

In addition to following the five-step framework for solving NPV analysis problems, we recommend that you use a worksheet with a time line like the one shown here to help you determine the proper cash flows for each period.

Time line	0	1	2	3	4	5 Year
Cash Flows:						
Initial cost	$-CF_0$					
Cash inflows (CIF)		CIF_1	CIF_2	CIF_3	CIF_4	CIF_5
Cash outflows (COF)		$-COF_1$	$-COF_2$	$-COF_3$	$-COF_4$	$-COF_5$
Salvage value						SV
Net cash flow	$-NCF_0$	NCF_1	NCF_2	NCF_3	NCF_4	NCF_5

$$NPV = -NCF_0 + \sum_{t=1}^{5} \frac{NCF_t}{(1+k)^t}$$

Net Present Value

- VALUATION OF REAL ASSETS
  - **Valuing real assets requires the same steps as in valuing financial assets**
    - estimate future cash flows
    - estimate cost of capital/required rate-of-return
    - calculate present value of future cash flows

Net Present Value

- VALUATION OF REAL ASSETS
  - **Practical difficulties in valuing real assets**

    Cash-flow estimates must be prepared in-house and are not as readily available as those for financial assets with legal contracts.

    Estimating required rates-of-return for real assets is more difficult than estimating required returns for financial assets because no market data is available for real assets.

Net Present Value

- NPV – THE BASIC CONCEPT
  - **The net present value of a project is the difference between the present values of its expected cash inflows and expected cash outflows**
  - **Positive NPV projects increase shareholder wealth and negative NPV projects decrease shareholder wealth**
  - **In theory, managers should be indifferent about accepting or rejecting zero NPV projects**

Net Present Value

- FRAMEWORK FOR CALCULATING NPV
  - **The NPV calculation uses the discounted cash flow technique**

    Compute the expected net cash flow (NCF_t) associated with a project for each time period t, where

    $$NCF_t = (\text{Cash inflows} - \text{Cash outflows})$$

Net Present Value

NPV Equation

$$NPV = NCF_0 + \frac{NCF_1}{1+k} + \frac{NCF_2}{(1+k)^2} + \ldots + \frac{NCF_n}{(1+k)^n} \qquad (10.1)$$

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

Pocket Pizza Project Timeline and Cash Flows

EXHIBIT 10.3
Pocket Pizza Project Time Line and Cash Flows ($ thousands)

The worksheet approach introduced in Exhibit 10.2 is helpful in organizing the data given for the pocket pizza project.

Time line	0	1	2	3	4	5 Year
Cash Flows:						
Initial cost	−$300					
Cash inflows		$300	$300	$300	$300	$300
Cash outflows		−$220	−$220	−$220	−$220	−$220
Salvage						30
Net cash flow	−$300	$80	$80	$80	$80	$110

Self-Rising Pizza Dough Project Timeline and Cash Flows

Time line	0	1	2	3	4	5 Year
Cash Flows:						
Initial cost	−$300					
Cash inflows		$200	$300	$300	$500	$500
Cash outflows		−$250	−$200	−$200	−$200	−$200
Salvage						
Net cash flow	−$300	−$50	$100	$100	$300	$300

EXHIBIT 10.4

Self-Rising Pizza Dough Project Time Line and Cash Flows ($ thousands)

The worksheet shows the time line and cash flows for the self-rising pizza dough project in Learning by Doing Application 10.1. As always, it is important to assign each cash flow to the appropriate year and to give it the proper sign. Once you have computed the net cash flow for each time period, solving for NPV is just a matter of plugging the data into the NPV formula.

Net Present Value

- A FIVE-STEP APPROACH FOR CALCULATING NPV

1. **Estimate project cost**

   Identify and add the present value of expenses related to the project.

   There are projects whose entire cost occurs at the start of the project, but many projects have costs occurring beyond the first year.

   The cash flow in year 0 (NCF_0) on the timeline is negative, indicating an outflow.

Net Present Value

- A FIVE-STEP APPROACH FOR CALCULATING NPV

2. **Estimate project net cash flows**

   Both cash inflows (CIF) and cash outflows (COF) are likely in each year of the project. Estimate the net cash flow (NCF_n) = CIF_n – COF_n for each year.

   Include salvage value of the project in its terminal year.

Net Present Value

- A FIVE-STEP APPROACH FOR CALCULATING NPV

3. **Determine project risk and estimate cost of capital**

   The cost of capital is the discount rate used to determine the present value of expected net cash flows.

   The riskier a project, the higher its cost of capital.

Net Present Value

- A FIVE-STEP APPROACH FOR CALCULATING NPV

4. **Compute the project's NPV**

   Determine the difference between the present values of the expected net cash flows from the project and the expected cost of the project.

5. **Make a decision**

   Accept a project if it has a positive NPV, reject it if the NPV is negative.

Net Present Value

- NPV EXAMPLE
  - **Find the net present value of the example in Exhibit 10.3**

$$P_B = -\$300 + \frac{\$80}{(1.15)^1} + \frac{\$80}{(1.15)^2} + \frac{\$80}{(1.15)^3} + \frac{\$80}{(1.15)^4} + \frac{\$80 + \$30}{(1.15)^5}$$

$$= -\$300 + \$69.57 + \$60.49 + \$52.60 + \$45.74 + 54.69$$

$$= -\$16.91$$

Net Present Value

- NPV EXAMPLE
  - Calculator Solution

Enter	5	15		80	30
	N	i	PV	PMT	FV
Answer			-283.09		

$$NPV = \$283.09 - \$300 = -\$16.91$$

NPV Example – Excel Solution

USING EXCEL

NET PRESENT VALUE

Net present value problems are most commonly solved using a spreadsheet program. The program's design is good for keeping track of all the cash flows and the periods in which they occur. The following spreadsheet setup for Learning by Doing Application 10.1 shows how to calculate the NPV for the self-rising pizza dough machine:

Notice that the NPV formula does not take into account the cash flow in year zero. Therefore, you only enter into the NPV formula the cash flows in years 1 through 5, along with the discount rate. You then add the cash flow in year zero to the total from the NPV formula calculation to get the NPV for the investment.

◇	A	B	C	D	E
1					
2		**Net Present Value Calculations**			
3					
4		**Year**		**Cash Flow**	
5		0		-$300,000	
6		1		-50,000	
7		2		100,000	
8		3		100,000	
9		4		300,000	
10		5		300,000	
11					
12		Cost of capital		0.15	
13					
14		**NPV**		**$118,567**	
15		Formula used		=NPV(D12, D6:D10)+D5	
16					

Net Present Value

Summary of Net Present Value (NPV) Method

Decision Rule: NPV $>$ 0 ➪ Accept the project.
NPV $<$ 0 ➪ Reject the project.

Key Advantages

1. Uses the discounted cash flow valuation technique to adjust for the time value of money.
2. Provides a direct (dollar) measure of how much a capital project will increase the value of the firm.
3. Consistent with the goal of maximizing stockholder value.

Key Disadvantage

1. Can be difficult to understand without an accounting and finance background.

Payback Period

- THE PAYBACK PERIOD
  - **Is the amount of time it takes for the sum of the net cash flows from a project to equal the project's initial investment**
  - **Says an acceptable project has a payback period shorter than a certain amount of time**
  - **Can serve as a risk indicator – the quicker a project' s cost is recovered, the less risky the project**
  - **Is one of the most widely used tools for evaluating capital projects**

Payback Period

- COMPUTING THE PAYBACK PERIOD
  - **To compute the payback period, estimate a project's cost and its future net cash flows**

    Equation 10.2 shows how to compute the payback period.

$$PB = \text{Years before cost recovery} + \frac{\text{Remaining cost to recover}}{\text{Cash flow during the year}} \quad (10.2)$$

Payback Period Cash Flows and Calculations

Time line	0	1	2	3	4 Year
Net cash flow (NCF)	−$70,000	$30,000	$30,000	$20,000	$15,000
Cumulative NCF	−$70,000	−$40,000	−$10,000	$10,000	$25,000

EXHIBIT 10.5

Payback Period Cash Flows and Calculations

The exhibit shows the net and cumulative net cash flows for a proposed capital project with an initial cost of $70,000. The cash flow data are used to compute the payback period, which is 2.5 years.

Payback Period

- PAYBACK PERIOD EXAMPLE
  - **Calculate Payback Period**

$$PB = 2 \text{ years} + \frac{\$70{,}000 - \$60{,}000}{\$20{,}000}$$

$$= 2 \text{ years} + \frac{\$10{,}000}{\$20{,}000}$$

$$= 2 \text{ years} + 0.5$$

$$= 2.5 \text{ years}$$

Payback Period

- COMPUTING THE PAYBACK PERIOD
  - **Projects with shorter payback periods are more desirable. Cash flows occurring after the payback period are not considered.**
  - **There is no economic rationale that makes the payback method consistent with shareholder wealth maximization.**

Payback Period with Various Cash Flow Patterns

EXHIBIT 10.6 **Payback Period with Various Cash Flow Patterns**

Each of the five capital budgeting projects shown in the exhibit calls for an initial investment of $500, but all have different cash flow patterns. The bottom part of the exhibit shows each project's payback period, along with its net present value for comparison.

Year	A	B	C	D	E
0	−$500	−$500	−$500	−$500	−$500
1	200	300	250	500	200
2	300	100	250	0	200
3	400	50	−250	0	200
4	500	0	250	−5,000	5,000
Payback (years)	2.0	∞	2.0/4.0	1.0/∞	2.5
NPV	$450	−$131	−$115	−$2,924	$2,815

Cost of capital = 15%

Payback Period

- DISCOUNTED PAYBACK PERIOD
  - **Future cash flows are discounted by the firm's cost of capital**
  - **The major advantage of the discounted payback is that it tells management how long it takes a project to reach a positive NPV**

Discounted Payback Period Cash Flows and Calculations

EXHIBIT 10.7
Discounted Payback Period Cash Flows and Calculations

The exhibit shows the net and cumulative net cash flows for a proposed capital project with an initial cost of $40,000. The cash flow data are used to compute the discounted payback period for a 10 percent cost of capital, which is 2.35 years.

Time line	0	1	2	3 Year
Net cash flow (NCF)	−$40,000	$20,000	$20,000	$20,000
Cumulative NCF	−$40,000	−$20,000	$0	$20,000
Discounted NCF (at 10%)	−$40,000	$18,182	$16,529	$15,026
Cumulative discounted NCF	−$40,000	−$21,818	−$5,289	$9,737

Payback period = 2 years + $0/$20,000 = 2 years
Discounted payback period = 2 years + $5,289/$15,026 = 2.35 years
NPV = $49,737 − $40,000 = $9,737
Cost of capital = 10%

Payback Period

- EVALUATING THE PAYBACK RULE
  - **The ordinary payback period is widely used in business**

    It provides a simple measure of an investment's liquidity risk.

It provides a simple measure of an investment's liquidity risk.

    It ignores the time value of money.

Payback Period

- EVALUATING THE PAYBACK RULE
  - **Payback period does not account for differences in the overall risk of projects**
  - **The biggest weakness of the ordinary and discounted payback methods is their failure to consider cash flows after the payback period**

Payback Period

Summary of Payback Method

Decision Rule:

Payback period ≤ Payback cutoff point ⇨ Accept the project.
Payback period > Payback cutoff point ⇨ Reject the project.

Key Advantages	Key Disadvantages
1. Easy to calculate and understand for people without a strong finance background.	1. Most common version does not account for time value of money.
2. A simple measure of a project's liquidity.	2. Does not consider cash flows past the payback period.
	3. Bias against long-term projects such as research and development and new product launches.
	4. Arbitrary cutoff point.

The Accounting Rate of Return

- THE ACCOUNTING RATE OF RETURN
  - Is often called the book value rate-of-return
  - Uses accounting numbers to compute the return on a capital project - the project's net income (NI) and book value (BV), rather than cash flow data
  - The most common definition of AAR

$$AAR = \frac{Average\ Net\ Income}{Average\ Book\ Value} \qquad (10.3)$$

Accounting Rate of Return

- THE ACCOUNTING RATE OF RETURN
  - **Has major flaws as a tool for making capital expenditure decisions**

    The ARR is not a true rate of return. It is generated from numbers on the income statement and balance sheet.

    It ignores the time value of money.

    There is no economic rationale that makes it consistent with the goal of maximizing shareholders' wealth.

Internal Rate of Return

- INTERNAL RATE OF RETURN
  - **The IRR technique compares a firm's cost of capital to the rate-of-return that makes the net cash flows from a project equal to the project's cost**
  - **A project is acceptable if its IRR is greater than the firm's cost-of-capital**
  - **The IRR is the discount rate that makes a project have an NPV equal to zero**

Internal Rate of Return

- INTERNAL RATE OF RETURN
  - **The NPV and IRR techniques are similar in that both utilize discounted cash flows**
  - **The IRR is an important and legitimate alternative to the NPV method**

Internal Rate of Return

- INTERNAL RATE OF RETURN
  - **The IRR is much like the yield-to-maturity on a bond**

Time Line and Expected Net Cash Flows for the Ford Project

	0	1	2	3 Year
Time line				
Net cash flow	−$560	$240	$240	$240

Cost of capital = 12%
NPV = $576.44 − $560.00 = $16.44

EXHIBIT 10.8

Time Line and Expected Net Cash Flows for the Ford Project ($ thousands)

The cash flow data in the exhibit are used to compute the project's IRR. The project's NPV is a positive $16,440, which indicates that the IRR is greater than the cost of capital of 12 percent.

Internal Rate of Return

- CALCULATING THE IRR
  - **Calculator Solution**

    Find the IRR of the cash flows in Exhibit 10.8 using a financial calculator.

Enter		3	-560	240	0
	N	i	PV	PMT	FV
Answer		13.7			

Using Excel - Internal Rate of Return

USING EXCEL

INTERNAL RATE OF RETURN

You know that calculating IRR by hand can be tedious. The trial-and-error method can take a long time and can be quite frustrating. Knowing all the cash flows and an approximate rate will allow you to use a spreadsheet formula to get an answer instantly.

The accompanying spreadsheet shows the setup for calculating the IRR for the low-cal yogurt machine at Larry's Ice Cream Parlor that is described in Learning by Doing Application 10.3.

Here are a couple of important points to note about IRR calculations using spreadsheet programs:

1. Unlike the NPV formula, the IRR formula accounts for all cash flows, including the initial investment in year 0, so there is no need to add this cash flow later.
2. The syntax of the IRR function requires that you first provide the project's cash flows in order beginning at time zero. To calculate the IRR, you will also need to provide a "guess" value, or a number you estimate is close to the IRR. A good value to start with is the cost of capital. To learn more about why this value is needed, you should go to your spreadsheet's help manual and search for "IRR."

◇	A	B	C	D	E
1					
2		**IRR Calculations**			
3					
4		**Year**		**Cash Flow**	
5		0		-$6,750	
6		1		2,000	
7		2		2,000	
8		3		2,000	
9		4		2,000	
10		5		2,000	
11		6		2,000	
12		7		2,000	
13		8		2,000	
14		9		2,000	
15		10		2,400	
16					
17		Cost of capital		0.15	
18					
19		**IRR**		**27.08%**	
20		Formula used		=IRR(E5:E15, E17)	
21					
22	Remember to keep track of signs - cash outflows are negative and cash inflows are positive.				
23					
24					

Internal Rate of Return

- WHEN IRR AND NPV METHODS AGREE
  - **The methods will always agree when projects are independent and the cash flows are conventional**

    A conventional project has an initial outflow to begin and net inflows each year thereafter.

NPV Profile for the Ford Project

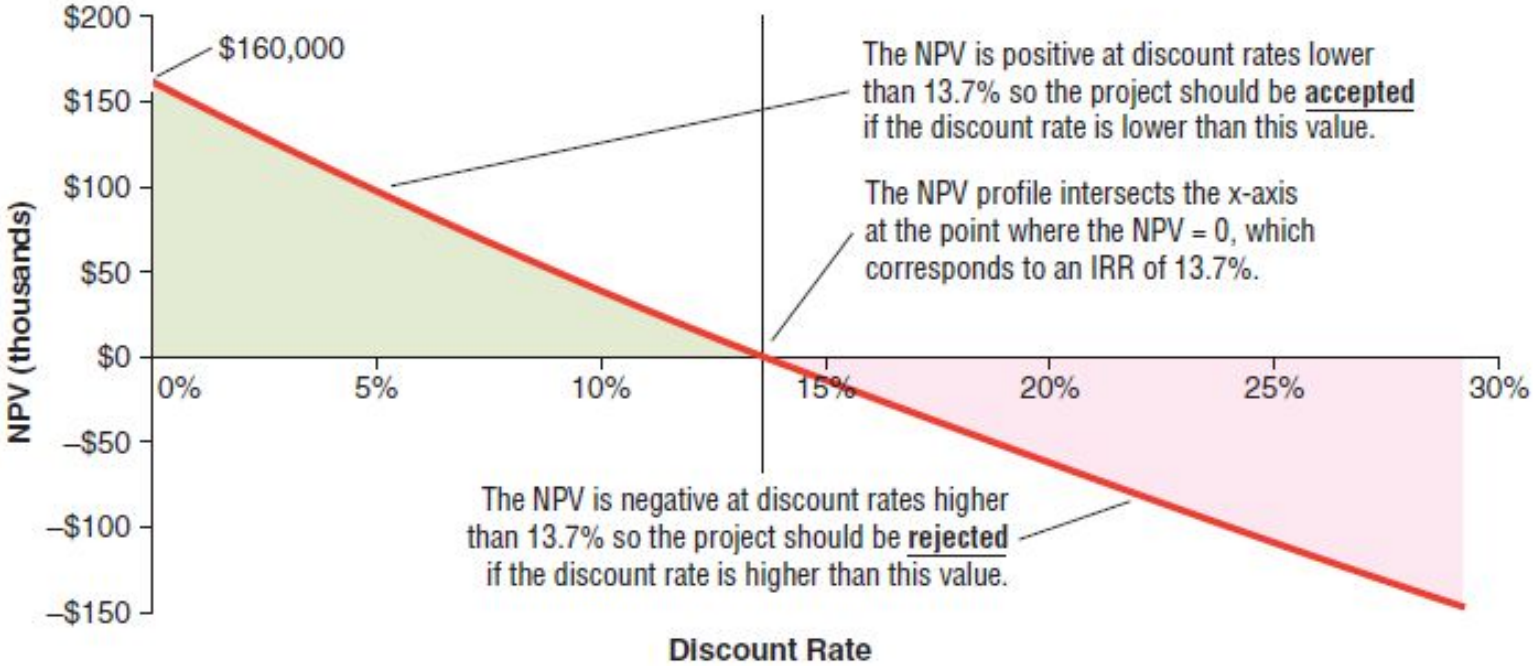

EXHIBIT 10.9
NPV Profile for the Ford Project

In the NPV profile for the Ford project, the NPV value is on the vertical (y) axis and the discount rate is on the horizontal (x) axis. You can see that as the discount rate increases, the NPV profile curve declines smoothly and intersects the x-axis at precisely the point where the NPV is 0 and the IRR is 13.7 percent—the point at which the NPV changes from a positive to a negative value. Thus, the NPV and IRR methods lead to identical accept-or-reject decisions for the Ford project.

Internal Rate of Return

- WHEN IRR AND NPV METHODS DISAGREE
  - **The IRR and NPV methods can produce different accept/reject decisions if a project has unconventional cash flows or projects are mutually exclusive**

Internal Rate of Return

- UNCONVENTIONAL CASH FLOWS
  - **Unconventional cash flows may exhibit many patterns**
    - Positive initial cash flow followed by negative net cash flows.
    - Positive and negative net cash flows.
    - Conventional except for a negative net cash flow at the end of a project's life.

Internal Rate of Return

- UNCONVENTIONAL CASH FLOWS
  - **With unconventional cash flows, the IRR technique may provide more than one rate of return. This makes the calculation unreliable and it should not be used to determine whether a project should be accepted or rejected**

NPV Profile for Gold-Mining Operation

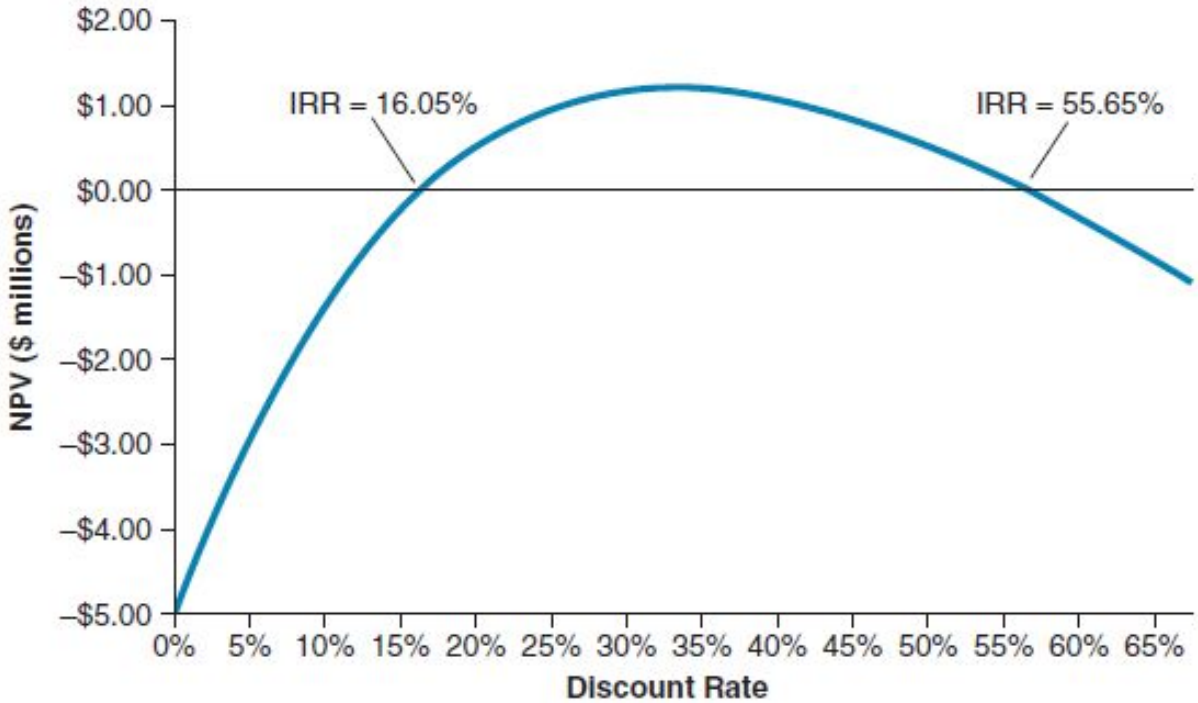

EXHIBIT 10.10
NPV Profile for Gold-Mining Operation Showing Multiple IRR Solutions

The gold-mining operation has unconventional cash flows. Because there are two cash flow sign reversals, we end up with two IRRs—16.05 percent and 55.65 percent—neither of them correct. In situations like this, the IRR provides a solution that is meaningless, and therefore, the results should not be used for capital budgeting decisions.

Internal Rate of Return

- MUTUALLY EXCLUSIVE PROJECTS
  - **There is a discount rate at which the NPVS of two mutually exclusive projects will be equal. That rate is the crossover point.**
  - **Depending on whether the required rate of return is higher or lower than the crossover rate, the ranking of the projects will be different.**
  - **It is easy to identify the superior project based on NPV, but it cannot be done using IRR. Thus, ranking conflicts can arise.**

Internal Rate of Return

- MUTUALLY EXCLUSIVE PROJECTS
  - **When projects differ in scale, the IRR technique may suggest choosing a small project that generates a net cash flow of $10,000 over a larger one that has $50,000 in net cash flow.**
  - **The larger cash flow project should be chosen because of its greater contribution to shareholder wealth. Using NPV would lead to its selection.**

NPV Profiles for Two Mutually Exclusive Projects

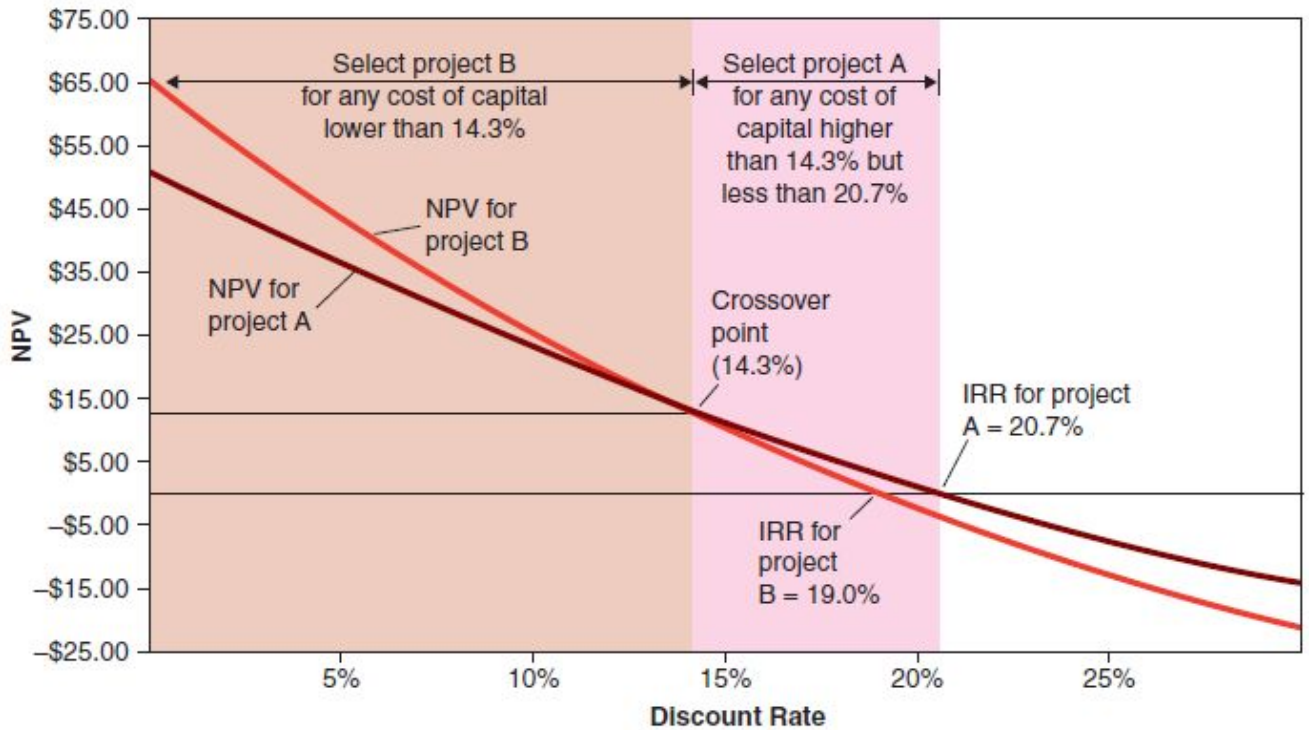

EXHIBIT 10.11
NPV Profiles for Two Mutually Exclusive Projects

The NPV profiles for two projects often cross over each other. When evaluating mutually exclusive projects, it is helpful to know where this crossover point is. For projects A and B in the exhibit, the crossover point is at 14.3 percent. For any cost of capital above 14.3 percent but below 20.7 percent the NPV for project A is higher than that for project B and is positive; thus, project A should be selected. For any cost of capital below the crossover point, the NPV of project B is higher, and project B should be selected.

Modified Internal Rate of Return

- MODIFIED INTERNAL RATE OF RETURN (MIRR)
  - **A major weakness of the IRR compared to the NPV method is the reinvestment rate assumption**

    IRR assumes that cash flows from a project are reinvested to earn the IRR while NPV assumes that they are reinvested and earn the firm's cost of capital.

    This optimistic assumption in the IRR method leads to some projects being accepted when they should not.

    – *The reinvested cash flows cannot earn the IRR.*

Modified Internal Rate of Return

- MODIFIED INTERNAL RATE OF RETURN (MIRR)
  - **In the modified internal rate of return (MIRR) technique, cash flow is assumed to be reinvested at the firm's cost of capital**
  - **The compounded values are summed to get a project's terminal value (TV) at the end of its life**
  - **The MIRR is the rate which equates a project's cost to its terminal value**

Modified Internal Rate of Return

- MIRR EQUATION

$$PV_{Project\,Cost} = \frac{TV}{(1+MIRR)^n} \qquad (10.5)$$

Modified Internal Rate of Return

- MIRR EXAMPLE
  - **A project costs $1,200.00 and will generate net cash inflows of $400 for four years. Calculate the MIRR of the project.**

continued on next slide

Modified Internal Rate of Return

- MIRR EXAMPLE

$$TV_n = \$400(1.08)^3 + \$400(1.08)^2 + \$400(1.08)^1 + \$400(1.08)^0$$

$$= \$1{,}802.44$$

$$\$1{,}200.00 = \frac{\$1{,}802.44}{(1+MIRR)^4}$$

$$\frac{\$1{,}802.44}{\$1{,}200.00} = (1+MIRR)^4$$

$$\sqrt[4]{1.5020} = 1 + MIRR = 1.1071$$

$$MIRR = 0.1071 \, or \, 10.71\%$$

IRR versus NPV: A Final Comment

Review of Internal Rate of Return (IRR)

Decision Rule: IRR > Cost of capital ➪ Accept the project.
IRR < Cost of capital ➪ Reject the project.

Key Advantages

1. Intuitively easy to understand.
2. Based on discounted cash flow technique.

Key Disadvantages

1. With nonconventional cash flows, IRR approach can yield no usable answer or multiple answers.
2. A lower IRR can be better if a cash inflow is followed by cash outflows.
3. With mutually exclusive projects, IRR can lead to incorrect investment decisions.
4. IRR calculation assumes cash flows are reinvested at the IRR.

Capital-Budgeting Techniques Used by Business Firms

EXHIBIT 10.12 **Capital Budgeting Techniques Used by Business Firms**

The exhibit summarizes evidence from two studies that examined the use of capital budgeting techniques by businesses. As you can see, over time more firms have come to use the NPV and IRR techniques. Surprisingly, though, even in 1999, 20.3 percent still computed the accounting rate of return.

Capital Budgeting Tool	Percent of Surveyed Firms That Use the Technique Frequently	
	1981	1999
Payback period	5.0	56.7
Accounting rate of return (ARR)	10.7	20.3
Internal rate of return (IRR)	65.3	75.7
Net persent value (NPV)	16.5	74.9

Sources: Stanley, Marjorie T. and Stanley B. Block, "A Survey of Multinational Capital Budgeting" *The Financial Review,* March 1984. Graham, John R. and Campbell R. Harvey, "The Theory and Practice of Corporate Finance," *Journal of Financial Economics,* May/June 2001.

Capital Budgeting in Practice

- PRACTITIONERS' METHODS OF CHOICE
  - **Many financial managers use multiple capital budgeting tools.**
  - **there is better alignment between practitioners and the academic community.**

Capital Budgeting in Practice

- ONGOING AND POST-AUDIT REVIEWS
  - **Management should systematically review the status of all ongoing capital projects and perform post-audits on completed capital projects.**

    In a post-audit review, management compares the actual results of a project with what was projected in the capital-budgeting proposal.

    A post-audit examination may reveal why a project was successful or failed to achieve its financial goals.

Capital Budgeting in Practice

- ONGOING AND POST-AUDIT REVIEWS
  - **Managers should conduct ongoing reviews of capital projects in progress.**

    A review should challenge the business plan, including cash flow projections and cost assumptions.

    Management must also evaluate the performance of people responsible for implementing a capital project.