

Chapter 10

Capital Budgeting Techniques



Global Edition

Principles of Managerial Finance

Thirteenth Edition

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PEARSON

Learning Goals



- LG1 Understand the key elements of the capital budgeting process.
- LG2 Calculate, interpret, and evaluate the payback period.
- LG3 Calculate, interpret, and evaluate the net present value (NPV) and economic value added (EVA)

Learning Goals (cont.)



- LG4 Calculate, interpret, and evaluate the internal rate of return (IRR).
- LG5 Use net present value profiles to compare NPV and IRR techniques.
- LG6 Discuss NPV and IRR in terms of conflicting rankings and the theoretical and practical strengths of each approach.

Overview of Capital Budgeting



- **Capital budgeting** is the process of evaluating and selecting long-term investments that are consistent with the firm's goal of maximizing owner wealth.
- A **capital expenditure** is an outlay of funds by the firm that is expected to produce benefits over a period of time *greater than 1 year*.
- An **operating expenditure** is an outlay of funds by the firm resulting in benefits received *within 1 year*.

Overview of Capital Budgeting: Steps in the Process



The **capital budgeting process** consists of five steps:

1. *Proposal generation.* Proposals for new investment projects are made at all levels within a business organization and are reviewed by finance personnel.
2. *Review and analysis.* Financial managers perform formal review and analysis to assess the merits of investment proposals
3. *Decision making.* Firms typically delegate capital expenditure decision making on the basis of dollar limits.
4. *Implementation.* Following approval, expenditures are made and projects implemented. Expenditures for a large project often occur in phases.
5. *Follow-up.* Results are monitored and actual costs and benefits are compared with those that were expected. Action may be required if actual outcomes differ from projected ones.

Overview of Capital Budgeting: Basic Terminology



Independent versus Mutually Exclusive Projects

- **Independent projects** are projects whose cash flows are unrelated to (or independent of) one another; the acceptance of one *does not eliminate* the others from further consideration.
- **Mutually exclusive projects** are projects that compete with one another, so that the acceptance of one *eliminates* from further consideration all other projects that serve a similar function.

Overview of Capital Budgeting: Basic Terminology (cont.)



Unlimited Funds versus Capital Rationing

- **Unlimited funds** is the financial situation in which a firm is able to accept all independent projects that provide an acceptable return.
- **Capital rationing** is the financial situation in which a firm has only a fixed number of dollars available for capital expenditures, and numerous projects compete for these dollars.

Overview of Capital Budgeting: Basic Terminology (cont.)



Accept-Reject versus Ranking Approaches

- An **accept–reject approach** is the evaluation of capital expenditure proposals to determine whether they meet the firm's minimum acceptance criterion.
- A **ranking approach** is the ranking of capital expenditure projects on the basis of some predetermined measure, such as the rate of return.

In more depth

Capital Budgeting Techniques



Bennett Company is a medium sized metal fabricator that is currently contemplating two projects: Project A requires an initial investment of \$42,000, project B an initial investment of \$45,000. The relevant operating cash flows for the two projects are presented in Table 10.1 and depicted on the time lines in Figure 10.1.

Table 10.1 Capital Expenditure Data for Bennett Company



TABLE 10.1 Capital Expenditure Data for Bennett Company

	Project A	Project B
Initial investment	\$42,000	\$45,000
Year	Operating cash inflows	
1	\$14,000	\$28,000
2	14,000	12,000
3	14,000	10,000
4	14,000	10,000
5	14,000	10,000

Figure 10.1 Bennett Company's Projects A and B



FIGURE 10.1

Bennett Company's Projects A and B
Time lines depicting the conventional cash flows of projects A and B



Payback Period



The **payback method** is the amount of time required for a firm to recover its initial investment in a project, as calculated from cash inflows.

Decision criteria:

- The length of the maximum acceptable payback period is determined by management.
- If the payback period is *less than* the maximum acceptable payback period, *accept* the project.
- If the payback period is *greater than* the maximum acceptable payback period, *reject* the project.

Payback Period (cont.)



We can calculate the payback period for Bennett Company's projects A and B using the data in Table 10.1.

- For project A, which is an annuity, the payback period is 3.0 years ($\$42,000$ initial investment \div $\$14,000$ annual cash inflow).
- Because project B generates a mixed stream of cash inflows, the calculation of its payback period is not as clear-cut.
 - In year 1, the firm will recover $\$28,000$ of its $\$45,000$ initial investment.
 - By the end of year 2, $\$40,000$ ($\$28,000$ from year 1 + $\$12,000$ from year 2) will have been recovered.
 - At the end of year 3, $\$50,000$ will have been recovered.
 - Only 50% of the year-3 cash inflow of $\$10,000$ is needed to complete the payback of the initial $\$45,000$.
- The payback period for project B is therefore 2.5 years (2 years + 50% of year 3).

Payback Period: Pros and Cons of Payback Analysis



- The payback method is widely used by large firms to evaluate small projects and by small firms to evaluate most projects.
- Its popularity results from its computational simplicity and intuitive appeal.
- By measuring how quickly the firm recovers its initial investment, the payback period also gives implicit consideration to the timing of cash flows and therefore to the time value of money.
- Because it can be viewed as a measure of risk exposure, many firms use the payback period as a decision criterion or as a supplement to other decision techniques.

Payback Period: Pros and Cons of Payback Analysis (cont.)



- The major weakness of the payback period is that the appropriate payback period is merely a subjectively determined number.
 - It cannot be specified in light of the wealth maximization goal because it is not based on discounting cash flows to determine whether they add to the firm's value.
- A second weakness is that this approach fails to take fully into account the time factor in the value of money.
- A third weakness of payback is its failure to recognize cash flows that occur after the payback period.

Focus on Practice



Limits on Payback Analysis

- While easy to compute and easy to understand, the payback period simplicity brings with it some drawbacks.
- Whatever the weaknesses of the payback period method of evaluating capital projects, the simplicity of the method does allow it to be used in conjunction with other, more sophisticated measures.
- In your view, if the payback period method is used in conjunction with the NPV method, should it be used before or after the NPV evaluation?

Personal Finance Example



Seema Mehdi is considering investing \$20,000 to obtain a 5% interest in a rental property. Seema is in the 25% tax bracket.

- Her real estate agent conservatively estimates that Seema should receive between \$4,000 and \$6,000 per year in cash from her 5% interest in the property.
- Seema's calculation of the payback period on this deal begins with calculation of the range of annual after-tax cash flow:
- After-tax cash flow = $(1 - \text{tax rate}) \times \text{Pre-tax cash flow}$
 - = $(1 - 0.25) \times \$4,000 = \$3,000$
 - = $(1 - 0.25) \times \$6,000 = \$4,500$

Personal Finance Example (cont.)



Seema Mehdi is considering investing \$20,000 to obtain a 5% interest in a rental property. Seema is in the 25% tax bracket.

- Dividing the \$20,000 initial investment by each of the estimated after-tax cash flows, we get the payback period:
- Payback period = Initial investment \div After-tax cash flow
= \$20,000 \div \$3,000 = 6.67 years
= \$20,000 \div \$4,500 = 4.44 years

Table 10.2 Relevant Cash Flows and Payback Periods for DeYarman Enterprises' Projects



TABLE 10.2

Relevant Cash Flows and Payback Periods for DeYarman Enterprises' Projects

	Project gold	Project silver
Initial investment	\$50,000	\$50,000
Year	Operating cash inflows	
1	\$ 5,000	\$40,000
2	5,000	2,000
3	40,000	8,000
4	10,000	10,000
5	10,000	10,000
Payback period	3 years	3 years

Table 10.3 Calculation of the Payback Period for Rashid Company's Two Alternative Investment Projects



TABLE 10.3

Calculation of the Payback Period for Rashid Company's Two Alternative Investment Projects

	Project X	Project Y
Initial investment	\$10,000	\$10,000
Year	Operating cash inflows	
1	\$5,000	\$3,000
2	5,000	4,000
3	1,000	3,000
4	100	4,000
5	100	3,000
Payback period	2 years	3 years

Net Present Value (NPV)



Net present value (NPV) is a sophisticated capital budgeting technique; found by subtracting a project's initial investment from the present value of its cash inflows discounted at a rate equal to the firm's cost of capital.

NPV = Present value of cash inflows – Initial investment

$$NPV = \sum_{t=1}^n \frac{CF_t}{(1+r)^t} - CF_0$$

Net Present Value (NPV) (cont.)



Decision criteria:

- If the NPV is *greater than* \$0, *accept* the project.
- If the NPV is *less than* \$0, *reject* the project.

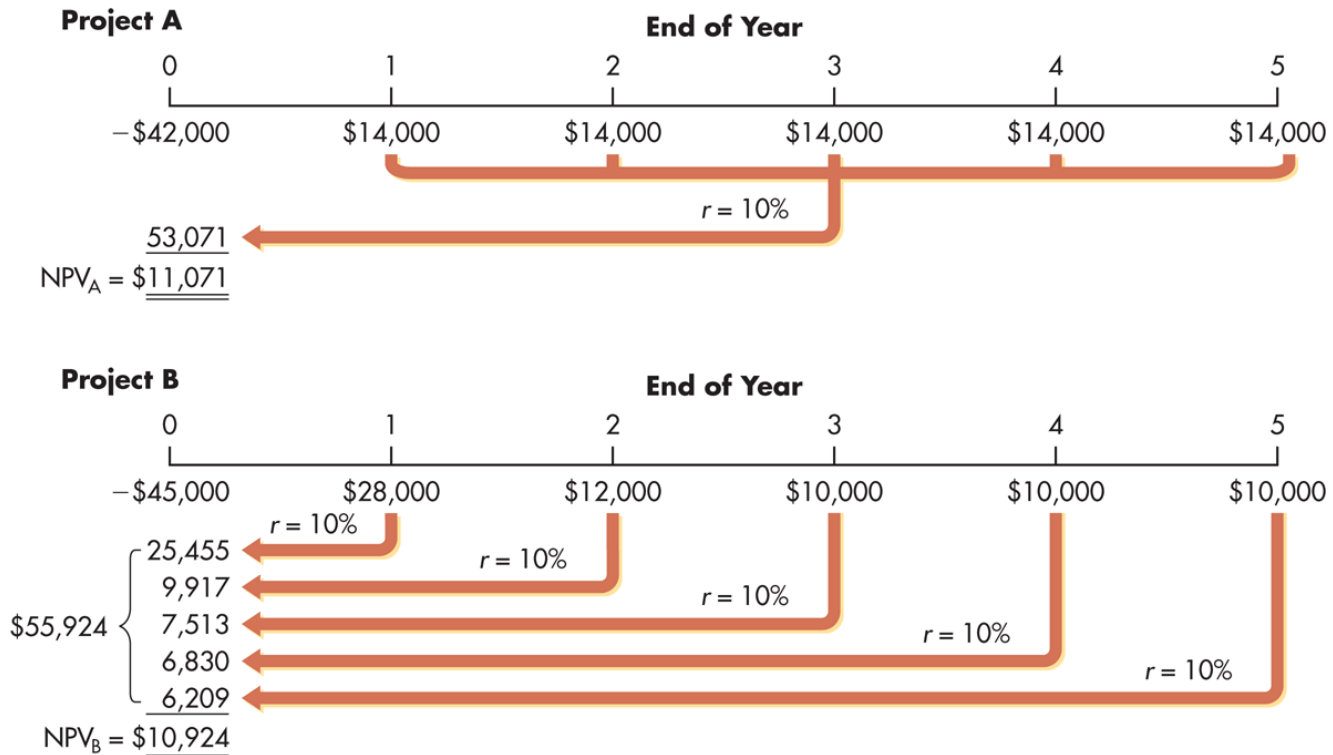
If the NPV is greater than \$0, the firm will earn a return greater than its cost of capital. Such action should increase the market value of the firm, and therefore the wealth of its owners by an amount equal to the NPV.

Figure 10.2 Calculation of NPVs for Bennett Company's Capital Expenditure Alternatives



FIGURE 10.2

Calculation of NPVs for Bennett Company's Capital Expenditure Alternatives
 Time lines depicting the cash flows and NPV calculations for projects A and B



Net Present Value (NPV) (cont.)



Project A

Input	Function
-42000	CF ₀
14000	CF ₁
5	N
10	I
	NPV
Solution	
11,071.01	

Project B

Input	Function
-45000	CF ₀
28000	CF ₁
12000	CF ₂
10000	CF ₃
3	N
10	I
	NPV
Solution	
10,924.40	

Net Present Value (NPV) (cont.)



	A	B	C
1	DETERMINING THE NET PRESENT VALUE		
2	Firm's cost of capital		10%
3		Year-End Cash Flow	
4	Year	Project A	Project B
5	0	\$ (42,000)	\$ (45,000)
6	1	\$ 14,000	\$ 28,000
7	2	\$ 14,000	\$ 12,000
8	3	\$ 14,000	\$ 10,000
9	4	\$ 14,000	\$ 10,000
10	5	\$ 14,000	\$ 10,000
11	NPV	\$ 11,071	\$ 10,924
12	Choice of project		Project A
<p>Entry in Cell B11 is $=NPV(\\$C\\$2,B6:B10)+B5$ Copy the entry in Cell B11 to Cell C11. Entry in Cell C12 is $=IF(B11>C11,B4,C4)$.</p>			

Net Present Value (NPV): NPV and the Profitability Index



For a project that has an initial cash outflow followed by cash inflows, the profitability index (PI) is simply equal to the present value of cash inflows divided by the initial cash outflow:

$$PI = \frac{\sum_{t=1}^n \frac{CF_t}{(1+r)^t}}{CF_0}$$

When companies evaluate investment opportunities using the PI, the decision rule they follow is to invest in the project when the index is greater than 1.0.

Net Present Value (NPV): NPV and the Profitability Index (cont.)



We can refer back to Figure 10.2, which shows the present value of cash inflows for projects A and B, to calculate the PI for each of Bennett's investment options:

$$PI_A = \$53,071 \div \$42,000 = 1.26$$

$$PI_B = \$55,924 \div \$45,000 = 1.24$$

Net Present Value (NPV): NPV and Economic Value Added



- Economic Value Added (or EVA), a registered trademark of the consulting firm, Stern Stewart & Co., is another close cousin of the NPV method.
- The EVA method begins the same way that NPV does—by calculating a project's net cash flows.
- However, the EVA approach subtracts from those cash flows a charge that is designed to capture the return that the firm's investors demand on the project.
- EVA determines whether a project earns a **pure economic profit**—a profit above and beyond the normal competitive rate of return in a line of business.

Net Present Value (NPV): NPV and Economic Value Added



Suppose a certain project costs \$1,000,000 up front, but after that it will generate net cash inflows each year (in perpetuity) of \$120,000. If the firm's cost of capital is 10%, then the project's NPV and EVA are:

$$\text{NPV} = -\$1,000,000 + (\$120,000 \div 0.10) = \$200,000$$

$$\text{EVA} = \$120,000 - \$100,000 = \$20,000$$

Internal Rate of Return (IRR)



The **Internal Rate of Return (IRR)** is a sophisticated capital budgeting technique; the discount rate that equates the NPV of an investment opportunity with \$0 (because the present value of cash inflows equals the initial investment); it is the rate of return that the firm will earn if it invests in the project and receives the given cash inflows.

$$\$0 = \sum_{t=1}^n \frac{CF_t}{(1 + IRR)^t} - CF_0$$

$$\sum_{t=1}^n \frac{CF_t}{(1 + IRR)^t} = CF_0$$

Internal Rate of Return (IRR)



Decision criteria:

- If the IRR is *greater than* the cost of capital, *accept* the project.
- If the IRR is *less than* the cost of capital, *reject* the project.

These criteria guarantee that the firm will earn at least its required return. Such an outcome should increase the market value of the firm and, therefore, the wealth of its owners.

Figure 10.3a Calculation of IRRs for Bennett Company's Capital Expenditure Alternatives



FIGURE 10.3

Calculation of IRRs for Bennett Company's Capital Expenditure Alternatives

Time lines depicting the cash flows and IRR calculations for projects A and B

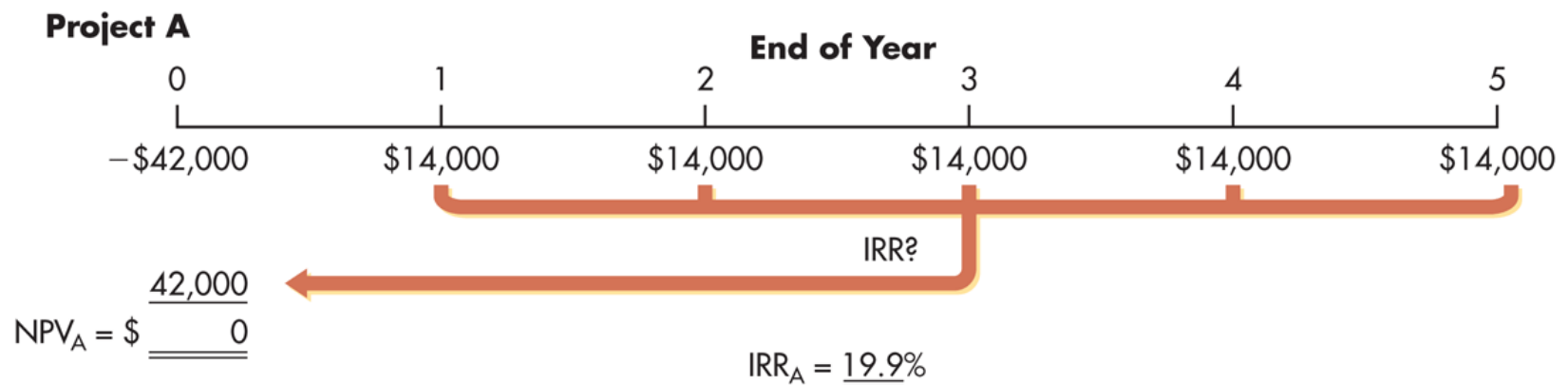
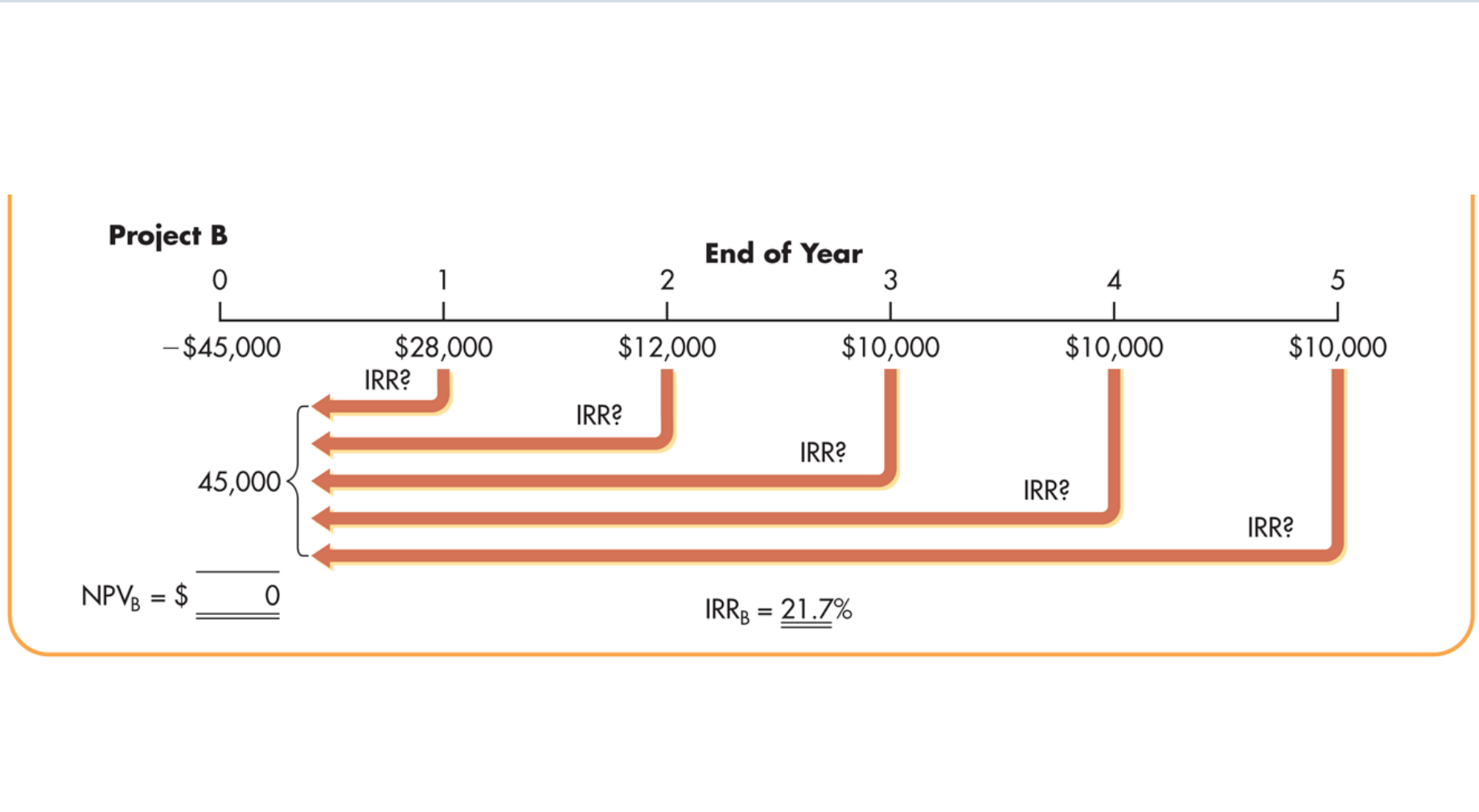


Figure 10.3 Calculation of IRRs for Bennett Company's Capital Expenditure Alternatives



Internal Rate of Return (IRR): Calculating the IRR (cont.)



- To find the IRR using the preprogrammed function in a financial calculator, the keystrokes for each project are the same as those for the NPV calculation, except that the last two NPV keystrokes (punching I and then NPV) are replaced by a single IRR keystroke.
- Comparing the IRRs of projects A and B given in Figure 10.3 to Bennett Company's 10% cost of capital, we can see that both projects are acceptable because
 - $IRR_A = 19.9\% > 10.0\%$ cost of capital
 - $IRR_B = 21.7\% > 10.0\%$ cost of capital
- Comparing the two projects' IRRs, we would prefer project B over project A because $IRR_B = 21.7\% > IRR_A = 19.9\%$.

Internal Rate of Return (IRR): Calculating the IRR (cont.)



	A	B	C
1	DETERMINING THE INTERNAL RATE OF RETURN		
2	Year-End Cash Flow		
3	Year	Project A	Project B
4	0	\$ (42,000)	\$ (45,000)
5	1	\$ 14,000	\$ 28,000
6	2	\$ 14,000	\$ 12,000
7	3	\$ 14,000	\$ 10,000
8	4	\$ 14,000	\$ 10,000
9	5	\$ 14,000	\$ 10,000
10	IRR	19.9%	21.7%
11	Choice of project		Project B
<p>Entry in Cell B10 is =IRR(B4:B9). Copy the entry in Cell B10 to Cell C10. Entry in Cell C11 is =IF(B10>C10,B3,C3).</p>			

Internal Rate of Return (IRR): Calculating the IRR (cont.)



- It is interesting to note in the preceding example that the IRR suggests that project B, which has an IRR of 21.7%, is preferable to project A, which has an IRR of 19.9%.
- This conflicts with the NPV rankings obtained in an earlier example.
- Such conflicts are not unusual.
- There is no guarantee that NPV and IRR will rank projects in the same order. However, both methods should reach the same conclusion about the acceptability or nonacceptability of projects.

Personal Finance Example



Tony DiLorenzo is evaluating an investment opportunity. He feels that this investment must earn a minimum compound annual after-tax return of 9% in order to be acceptable. Tony's initial investment would be \$7,500, and he expects to receive annual after-tax cash flows of \$500 per year in each of the first 4 years, followed by \$700 per year at the end of years 5 through 8. He plans to sell the investment at the end of year 8 and net \$9,000, after taxes.

- Tony finds the investment's IRR of 9.54%.
- Given that the expected IRR of 9.54% exceeds Tony's required minimum IRR of 9%, the investment is acceptable.

Comparing NPV and IRR Techniques: Net Present Value Profiles



Net present value profiles are graphs that depict a project's NPVs for various discount rates.

To prepare NPV profiles for Bennett Company's projects A and B, the first step is to develop a number of discount rate-NPV coordinates and then graph them as shown in the following table and figure.

Table 10.4 Discount Rate–NPV Coordinates for Projects A and B



TABLE 10.4

Discount Rate–NPV Coordinates for Projects A and B

Discount rate	Net present value	
	Project A	Project B
0%	\$28,000	\$25,000
10	11,071	10,924
19.9	0	—
21.7	—	0

Figure 10.4

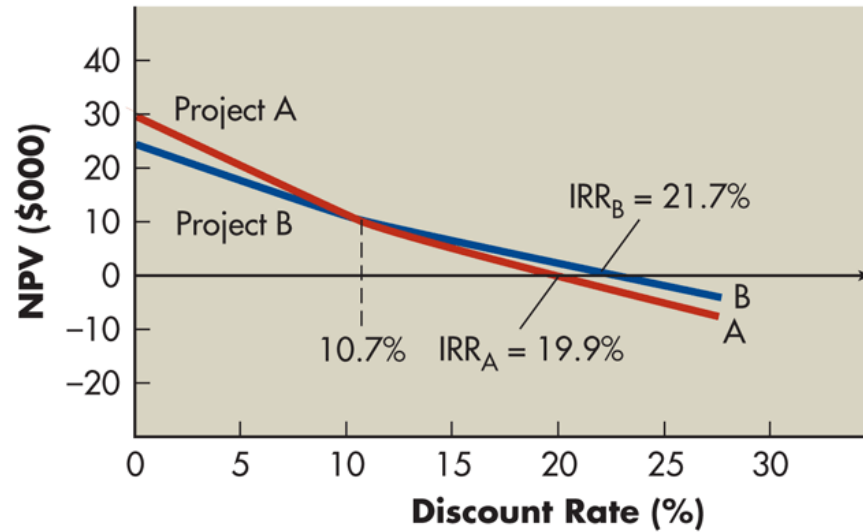
NPV Profiles



FIGURE 10.4

NPV Profiles

Net present value profiles for Bennett Company's projects A and B



Comparing NPV and IRR

Techniques: Conflicting Rankings



- **Conflicting rankings** are conflicts in the ranking given a project by NPV and IRR, resulting from differences in the magnitude and timing of cash flows.
- One underlying cause of conflicting rankings is the implicit assumption concerning the reinvestment of **intermediate cash inflows**—cash inflows received prior to the termination of the project.
- NPV assumes intermediate cash flows are reinvested at the cost of capital, while IRR assumes that they are reinvested at the IRR.

In more depth

Comparing NPV and IRR Techniques: Conflicting Rankings (cont.)



A project requiring a \$170,000 initial investment is expected to provide cash inflows of \$52,000, \$78,000 and \$100,000. The NPV of the project at 10% is \$16,867 and its IRR is 15%. Table 10.5 on the following slide demonstrates the calculation of the project's future value at the end of its 3-year life, assuming both a 10% (cost of capital) and 15% (IRR) interest rate.

Table 10.5 Reinvestment Rate Comparisons for a Project



TABLE 10.5 Reinvestment Rate Comparisons for a Project^a

Year	Operating cash inflows	Number of years earnings interest (<i>t</i>)	Reinvestment rate	
			10%	15%
			Future value	Future value
1	\$ 52,000	2	\$ 62,920	\$ 68,770
2	78,000	1	85,800	89,700
3	100,000	0	<u>100,000</u>	<u>100,000</u>
		Future value end of year 3	<u>\$248,720</u>	<u>\$258,470</u>

NPV @ 10% = \$16,867

IRR = 15%

^aInitial investment in this project is \$170,000.

Comparing NPV and IRR Techniques: Conflicting Rankings (cont.)



If the future value in each case in Table 10.5 were viewed as the return received 3 years from today from the \$170,000 investment, then the cash flows would be those given in Table 10.6 on the following slide.

Table 10.6 Project Cash Flows After Reinvestment



TABLE 10.6 Project Cash Flows after Reinvestment

	Reinvestment rate	
	10%	15%
Initial investment	\$170,000	
Year	Operating cash inflows	
1	\$ 0	\$ 0
2	0	0
3	248,720	258,470
NPV @ 10%	\$ 16,867	\$ 24,418
IRR	13.5%	15.0%

Comparing NPV and IRR Techniques: Timing of the Cash Flow



Another reason why the IRR and NPV methods may provide different rankings for investment options has to do with differences in the timing of cash flows.

- When much of a project's cash flows arrive early in its life, the project's NPV will not be particularly sensitive to the discount rate.
- On the other hand, the NPV of projects with cash flows that arrive later will fluctuate more as the discount rate changes.
- The differences in the timing of cash flows between the two projects does not affect the ranking provided by the IRR method.

Table 10.7 Ranking Projects A and B Using IRR and NPV Methods



TABLE 10.7 Ranking Projects A and B Using IRR and NPV Methods

Method	Project A	Project B
IRR		✓
NPV		
if $r < 10.7\%$	✓	
if $r > 10.7\%$		✓

Comparing NPV and IRR Techniques: Magnitude of the Initial Investment



The scale problem occurs when two projects are very different in terms of how much money is required to invest in each project.

- In these cases, the IRR and NPV methods may rank projects differently.
- The IRR approach (and the PI method) may favor small projects with high returns (like the \$2 loan that turns into \$3).
- The NPV approach favors the investment that makes the investor the most money (like the \$1,000 investment that yields \$1,100 in one day).

Comparing NPV and IRR Techniques: Which Approach is Better?



On a purely theoretical basis, NPV is the better approach because:

- NPV measures how much wealth a project creates (or destroys if the NPV is negative) for shareholders.
- Certain mathematical properties may cause a project to have **multiple IRRs**—more than one IRR resulting from a capital budgeting project with a *nonconventional cash flow pattern*; the maximum number of IRRs for a project is equal to the number of sign changes in its cash flows.

Despite its theoretical superiority, however, financial managers prefer to use the IRR approach just as often as the NPV method because of the preference for rates of return.

Matter of Fact



Which Methods Do Companies Actually Use?

- A recent survey asked Chief Financial Officers (CFOs) what methods they used to evaluate capital investment projects.
- The most popular approaches by far were IRR and NPV, used by 76% and 75% (respectively) of the CFOs responding to the survey.
- These techniques enjoy wider use in larger firms, with the payback approach being more common in smaller firms.

Focus on Ethics



Nonfinancial Considerations in Project Selection

- For most companies ethical considerations are primarily concerned with the reduction of potential risks associated with a project.
- However, The Kuwait Fund was established as the first institution in the Middle East that took an active role in international development efforts. The fund finances development projects and their feasibility studies in developing countries.
- One of the major objectives of the Kuwait Fund is to build a solid bridge of friendship and solidarity between the state of Kuwait and the developing nations.
- The success of the Kuwait Fund in achieving this objective helped the state of Kuwait to get the necessary votes in the United Nations and the U.N. Security Council for the war against Iraq to liberate Kuwait in 1991.
- The Kuwait Fund offers many forms of assistance, including direct loans or the provision of guarantees, and grants-in-aid to finance technical, economic, and financial studies.
- *What are the potential benefits to the state of Kuwait of the ethical behavior of the Kuwait Fund?*

Review of Learning Goals



- LG1 Understand the key elements of the capital budgeting process.
- Capital budgeting techniques are the tools used to assess project acceptability and ranking. Applied to each project's relevant cash flows, they indicate which capital expenditures are consistent with the firm's goal of maximizing owners' wealth.

Review of Learning Goals (cont.)



LG2 Calculate, interpret, and evaluate the payback period.

- The payback period is the amount of time required for the firm to recover its initial investment, as calculated from cash inflows. Shorter payback periods are preferred. The payback period is relatively easy to calculate, has simple intuitive appeal, considers cash flows, and measures risk exposure. Its weaknesses include lack of linkage to the wealth maximization goal, failure to consider time value explicitly, and the fact that it ignores cash flows that occur after the payback period.

Review of Learning Goals (cont.)



- LG3 Calculate, interpret, and evaluate the net present value (NPV) and economic value added (EVA).
- NPV measures the amount of value created by a given project; only positive NPV projects are acceptable. The rate at which cash flows are discounted in calculating NPV is called the discount rate, required return, cost of capital, or opportunity cost. By whatever name, this rate represents the minimum return that must be earned on a project to leave the firm's market value unchanged.
 - The EVA method begins the same way that NPV does—by calculating a project's net cash flows. However, the EVA approach subtracts from those cash flows a charge that is designed to capture the return that the firm's investors demand on the project. That is, the EVA calculation asks whether a project generates positive cash flows above and beyond what investors demand. If so, then the project is worth undertaking.

Review of Learning Goals (cont.)



- LG4 Calculate, interpret, and evaluate the internal rate of return (IRR).
- Like NPV, IRR is a sophisticated capital budgeting technique. IRR is the compound annual rate of return that the firm will earn by investing in a project and receiving the given cash inflows. By accepting only those projects with IRRs in excess of the firm's cost of capital, the firm should enhance its market value and the wealth of its owners.

Review of Learning Goals (cont.)



LG5 Use net present value profiles to compare NPV and IRR techniques.

- A net present value profile is a graph that depicts projects' NPVs for various discount rates. The NPV profile is prepared by developing a number of "discount rate–net present value" coordinates (including discount rates of 0 percent, the cost of capital, and the IRR for each project) and then plotting them on the same set of discount rate–NPV axes.

Review of Learning Goals (cont.)



- LG6 Discuss NPV and IRR in terms of conflicting rankings and the theoretical and practical strengths of each approach.
- Conflicting rankings of projects frequently emerge from NPV and IRR as a result of differences in the reinvestment rate assumption, as well as the magnitude and timing of cash flows. NPV assumes reinvestment of intermediate cash inflows at the more conservative cost of capital; IRR assumes reinvestment at the project's IRR. On a purely theoretical basis, NPV is preferred over IRR because NPV assumes the more conservative reinvestment rate and does not exhibit the mathematical problem of multiple IRRs that often occurs when IRRs are calculated for nonconventional cash flows. In practice, the IRR is more commonly used because it is consistent with the general preference of business professionals for rates of return, and corporate financial analysts can identify and resolve problems with the IRR before decision makers use it.

Chapter Resources on MyFinanceLab



- Chapter Cases
- Group Exercises
- Critical Thinking Problems