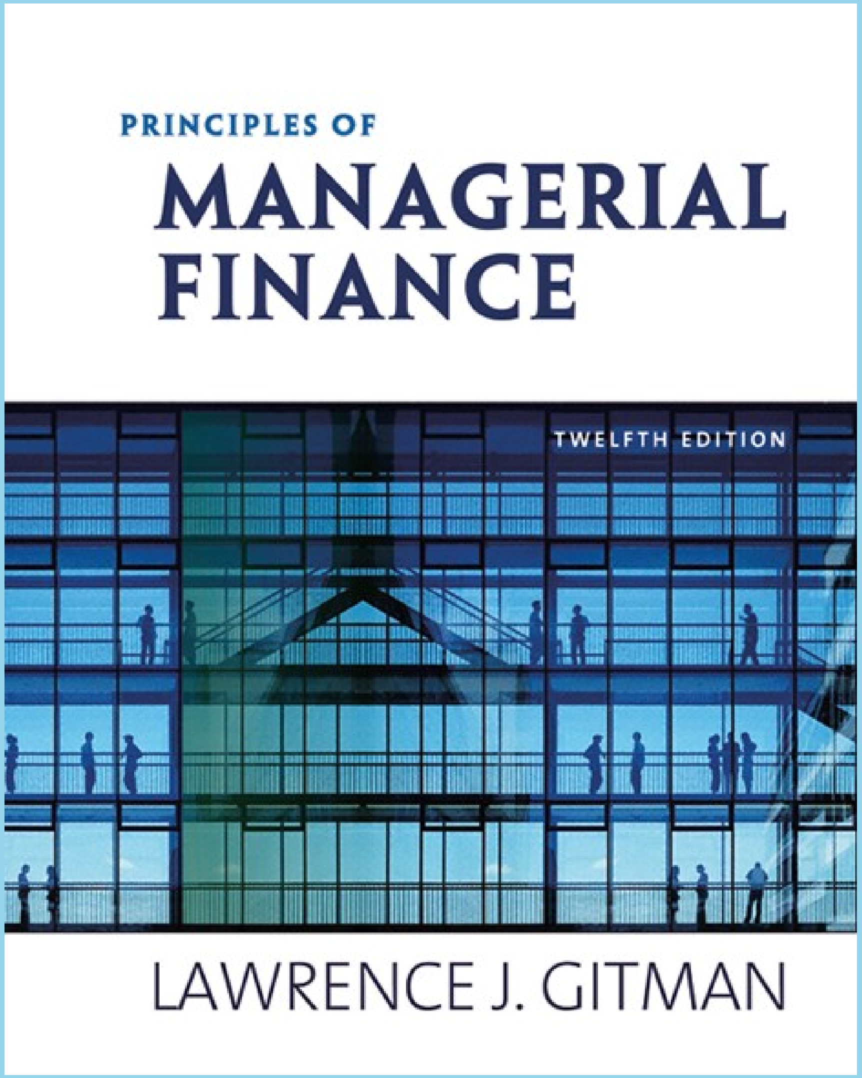
Chapter 9

Capital Budgeting Techniques

Week 10



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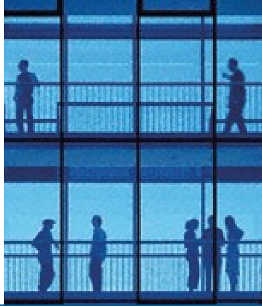
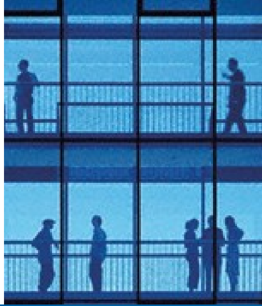


Learning Goals

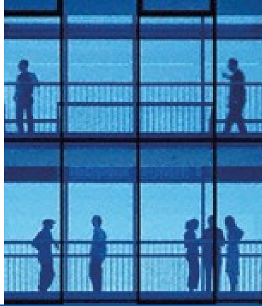
1. Understand the role of capital budgeting techniques in the capital budgeting process.
2. Calculate, interpret, and evaluate the payback period.
3. Calculate, interpret, and evaluate the net present value (NPV).

Learning Goals (cont.)



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

Capital Budgeting Techniques



- Chapter Problem

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 9.1 and depicted on the time lines in Figure 9.1.

Capital Budgeting Techniques (cont.)

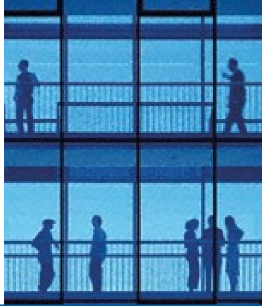


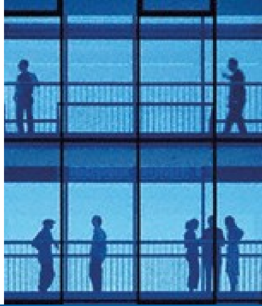
Table 9.1 Capital Expenditure Data for Bennett Company

	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

Capital Budgeting Techniques (cont.)

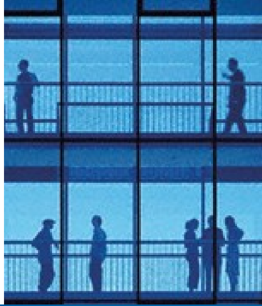
Figure 9.1 Bennett Company's Projects A and B

Payback Period



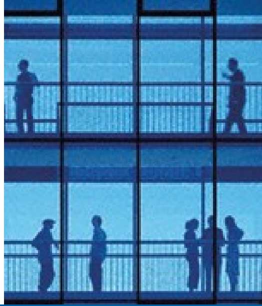
- The **payback method** simply measures **how long** (in years and/or months) it takes to recover the initial investment.
- The **maximum** acceptable payback period is determined by management.
- If the payback period is **less than** the maximum acceptable payback period, **accept** the project.
- If the payback period is **greater than** the maximum acceptable payback period, **reject** the project.

Pros and Cons of Payback Periods



- The **payback method** is widely used by large firms to evaluate small projects and by small firms to evaluate most projects.
- It is simple, intuitive, and considers cash flows rather than accounting profits.
- It also gives implicit consideration to the timing of cash flows and is widely used as a supplement to other methods such as Net Present Value and Internal Rate of Return.

Pros and Cons of Payback Periods (cont.)



- One **major weakness** of the payback method is that the appropriate payback period is a subjectively determined number.
- It also fails to consider the principle of **wealth maximization** because it is not based on **discounted cash flows** and thus provides no indication as to whether a project adds to firm value.
- Thus, payback fails to fully consider the **time value of money**.

Pros and Cons of Payback Periods (cont.)

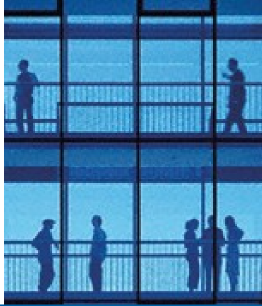


Table 9.2 Relevant Cash Flows and Payback Periods for DeYarman Enterprises' Projects

	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

Pros and Cons of Payback Periods (cont.)

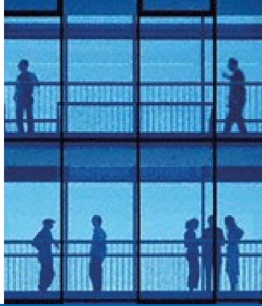


Table 9.3 Calculation of the Payback Period for Rashid Company's Two Alternative Investment Projects

	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

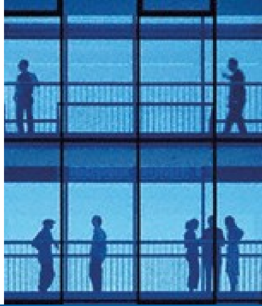
Net Present Value (NPV)

- Net Present Value (NPV): Net Present Value is found by subtracting the present value of the after-tax outflows from the present value of the after-tax inflows.

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

$$= \sum_{t=1}^{n} (CF_t \times PVIF_{r,t}) - CF_0$$

Net Present Value (NPV) (cont.)



- Net Present Value (NPV): Net Present Value is found by subtracting the present value of the after-tax outflows from the present value of the after-tax inflows.

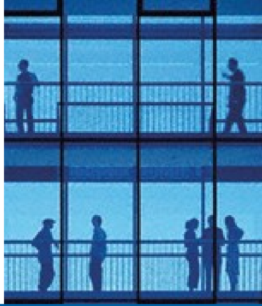
Decision Criteria

If NPV > 0, accept the project

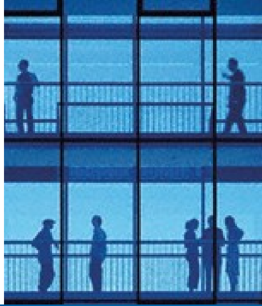
If NPV < 0, reject the project

If NPV = 0, technically indifferent

Net Present Value (NPV) (cont.)

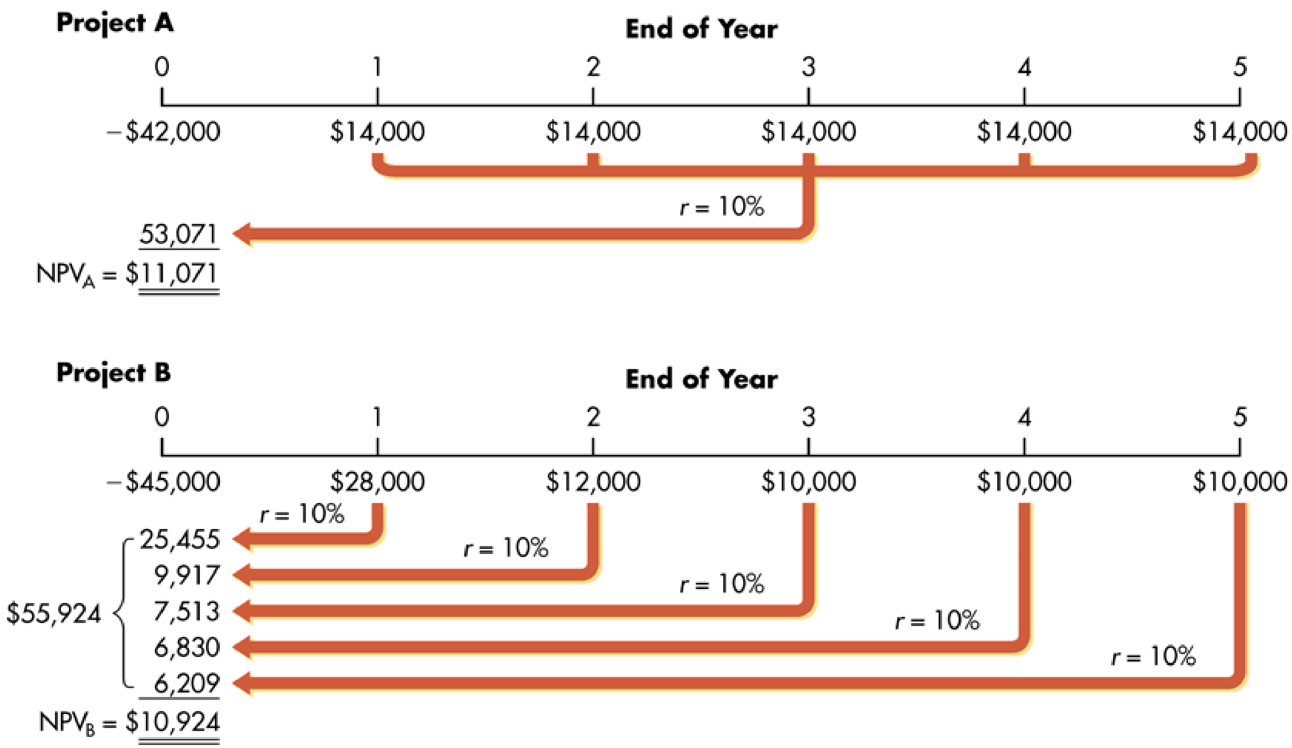


Using the Bennett Company data from Table 9.1, assume the firm has a 10% cost of capital. Based on the given cash flows and cost of capital (required return), the NPV can be calculated as shown in Figure 9.2

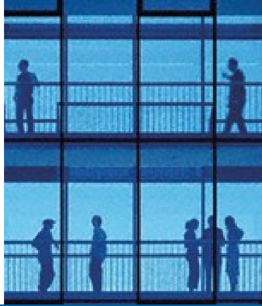


Net Present Value (NPV) (cont.)

Figure 9.2 Calculation of NPVs for Bennett Company's Capital Expenditure Alternatives



Net Present Value (NPV) (cont.)



Project A

Input	Function
−42000	CF_0
14000	CF_1
5	N
10	I
	NPV

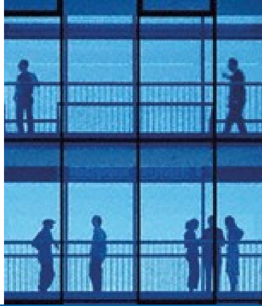
Solution: 11,071.01

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

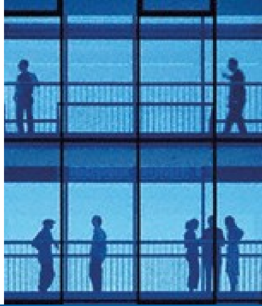
Net Present Value (NPV) (cont.)



	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

Entry in Cell B11 is
=NPV(C2,B6:B10)+B5
Copy the entry in Cell B11 to Cell C11.
Entry in Cell C12 is =IF(B11>C11,B4,C4).

Internal Rate of Return (IRR)

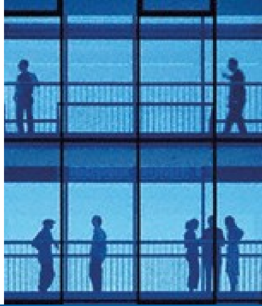


- The **Internal Rate of Return (IRR)** is the discount rate that will equate the present value of the outflows with the present value of the inflows.
- The IRR is the project's intrinsic rate of return.

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

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

Internal Rate of Return (IRR) (cont.)



- The **Internal Rate of Return (IRR)** is the discount rate that will equate the present value of the outflows with the present value of the inflows.
- The IRR is the project's intrinsic rate of return.

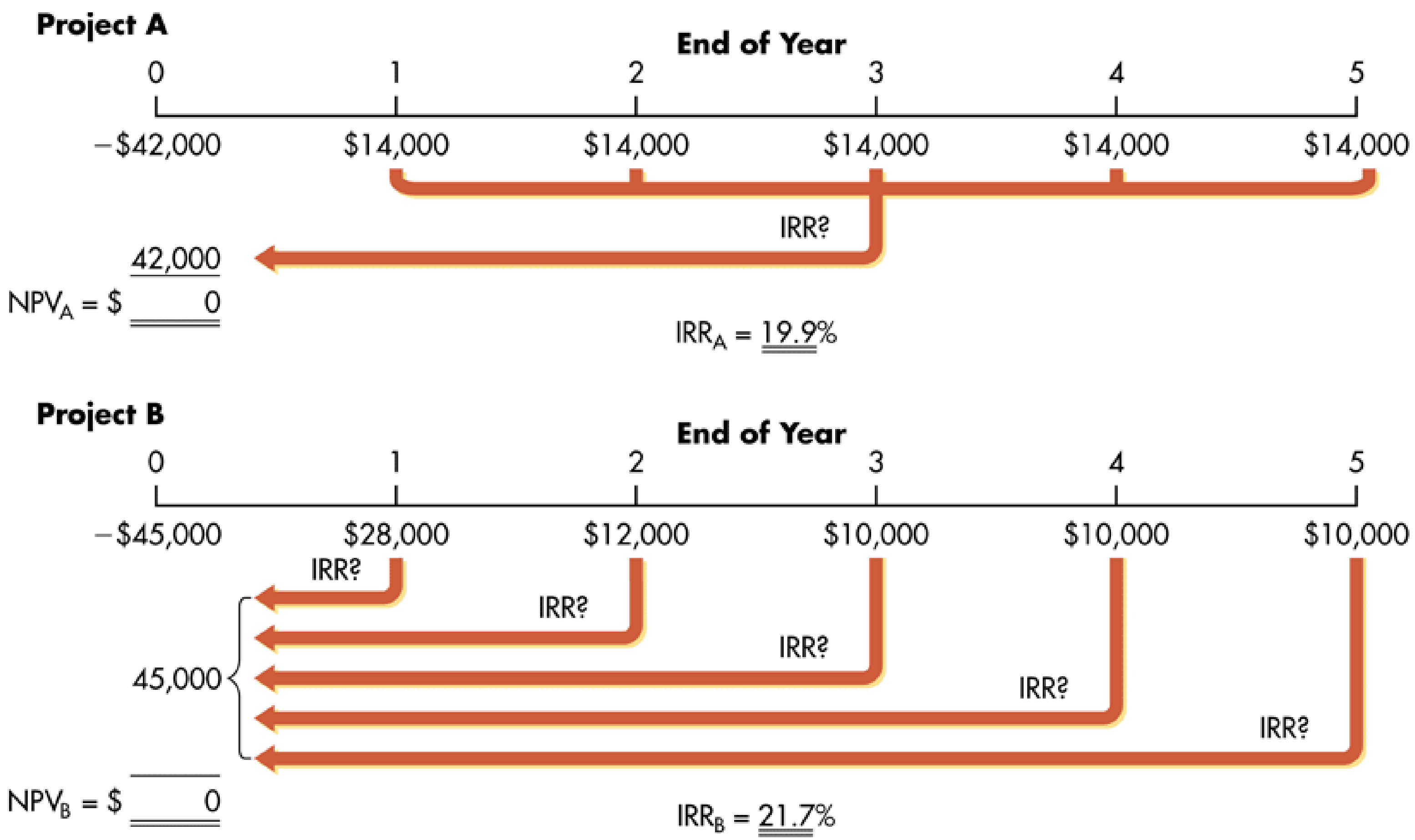
Decision Criteria

If IRR > k, accept the project

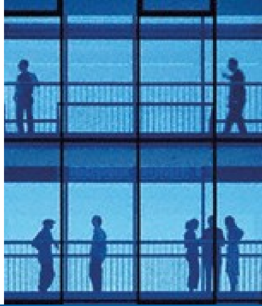
If IRR < k, reject the project

If IRR = k, technically indifferent

Figure 9.3 Calculation of IRRs for Bennett Company's Capital Expenditure Alternatives



Internal Rate of Return (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

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).

Net Present Value Profiles

- **NPV Profiles** are graphs that depict project NPVs for various discount rates and provide an excellent means of making comparisons between projects.

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.

Net Present Value Profiles (cont.)

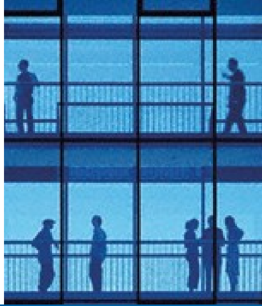
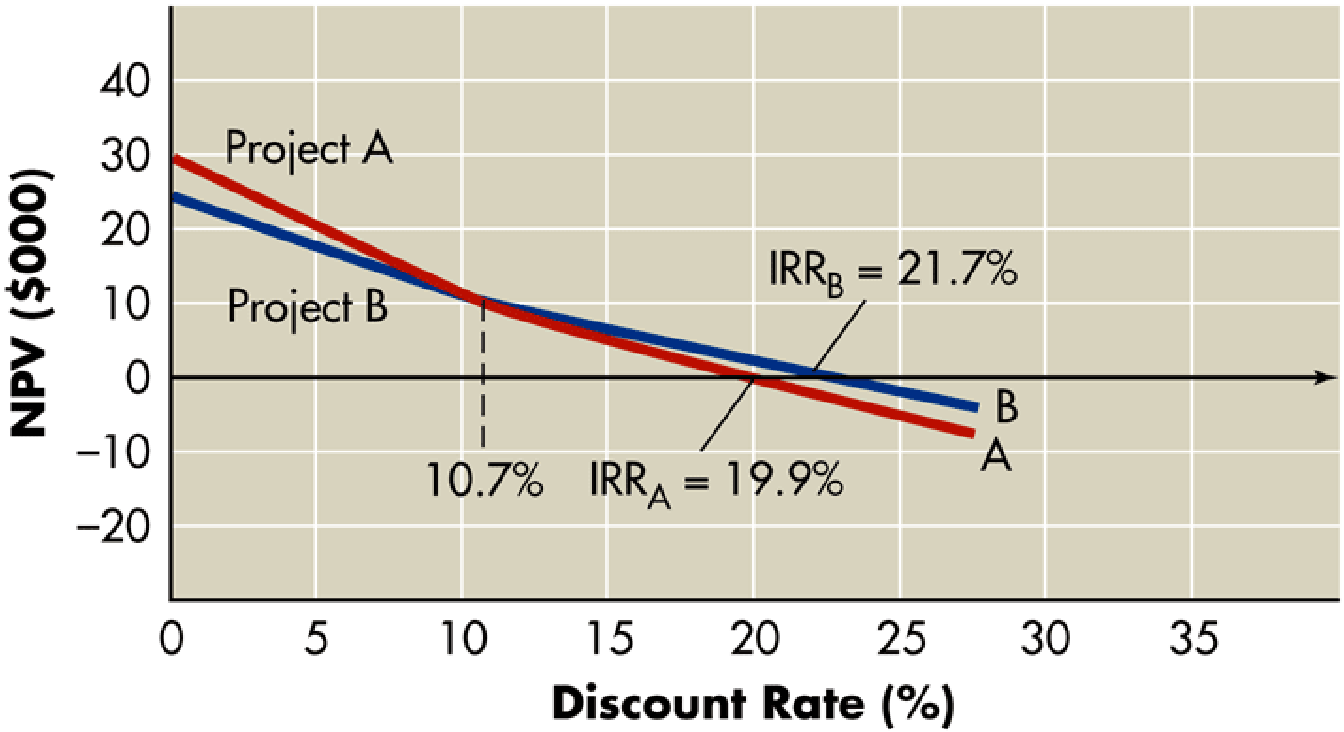


Table 9.4 Discount Rate–NPV Coordinates for Projects A and B

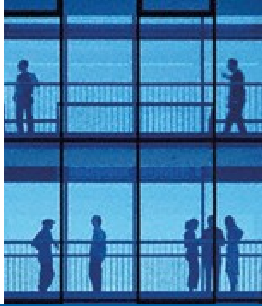
	Net present value	
Discount rate	Project A	Project B
0 %	$28,000	$25,000
10	11,071	10,924
19.9	0	—
21.7	—	0

Net Present Value Profiles (cont.)

Figure 9.4 NPV Profiles

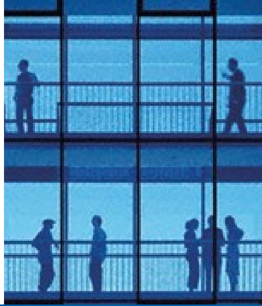


Conflicting Rankings



- **Conflicting rankings** between two or more projects using NPV and IRR sometimes occurs because of differences in the timing and magnitude of cash flows.
- This 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.

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 it’s IRR is 15%. Table 9.5 on the following slide demonstrates the calculation of the project’s future value at the end of it’s 3-year life, assuming both a 10% (cost of capital) and 15% (IRR) interest rate.

Conflicting Rankings (cont.)

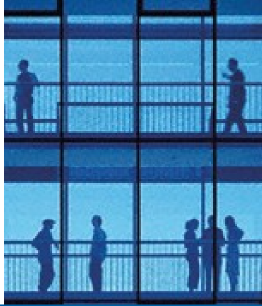


Table 9.5 Reinvestment Rate Comparisons for a Project [a]

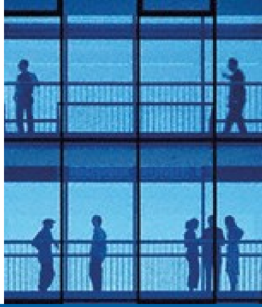
			Reinvestment rate			
			10%		15%	
Year (1)	Operating cash inflows (2)	Number of years earnings interest (t) [3 − (1)] (3)	$FVIF_{10\%,t}$ (4)	Future value [(2) × (4)] (5)	$FVIF_{15\%,t}$ (6)	Future value [(2) × (6)] (7)
1	$ 52,000	2	1.210	$ 62,920	1.323	$ 68,796
2	78,000	1	1.100	85,800	1.150	89,700
3	100,000	0	1.000	100,000	1.000	100,000
		Future value end of year 3		$248,720		$258,496

NPV @ 10% = $16,867

IRR = 15%

[a]Initial investment in this project is $170,000.

Conflicting Rankings (cont.)



If the future value in each case in Table 9.5 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 9.6 on the following slide.

Conflicting Rankings (cont.)

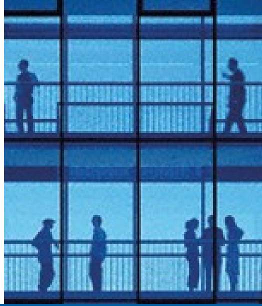
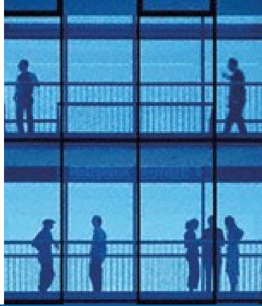


Table 9.6 Project Cash Flows After Reinvestment

	Reinvestment rate	
	10%	15%
Initial investment	$170,000	
Year	Operating cash inflows	
1	$ 0	$ 0
2	0	0
3	248,720	258,496
NPV @ 10%	$ 16,867	$ 24,213
IRR	13.5%	15.0%

Conflicting Rankings (cont.)



Bennett Company's projects A and B were found to have conflicting rankings at the firm's 10% cost of capital as depicted in Table 9.4. If we review the project's cash inflow pattern as presented in Table 9.1 and Figure 9.1, we see that although the projects require similar investments, they have dissimilar cash flow patterns. Table 9.7 on the following slide indicates that project B, which has higher early-year cash inflows than project A, would be preferred over project A at higher discount rates.

Conflicting Rankings (cont.)

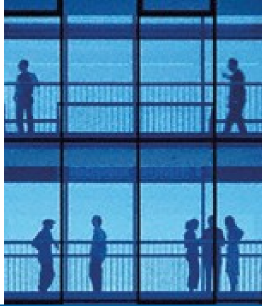
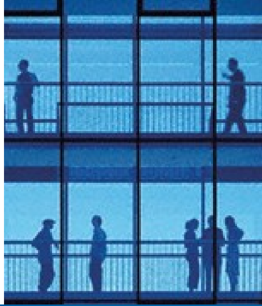


Table 9.7 Preferences Associated with Extreme Discount Rates and Dissimilar Cash Inflow Patterns

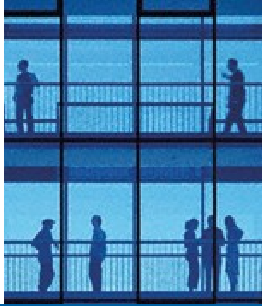
	Cash inflow pattern	
Discount rate	Lower early-year cash inflows	Higher early-year cash inflows
Low	Preferred, because higher late-year cash inflows are not greatly reduced and therefore dominate in terms of present value.	Not preferred
High	Not preferred	Preferred, because the higher early-year cash inflows are not greatly reduced and therefore dominate in terms of present value.

Which Approach is Better?



- On a purely theoretical basis, NPV is the better approach because:
  - NPV assumes that intermediate cash flows are reinvested at the cost of capital whereas IRR assumes they are reinvested at the IRR,
  - Certain mathematical properties may cause a project with non-conventional cash flows to have zero or more than one real IRR.
- Despite its theoretical superiority, however, financial managers prefer to use the IRR because of the preference for rates of return.

Other techniques



- Profitability Index (PI) – example
- Using the data from the earlier example on projects A & B (slides 28):

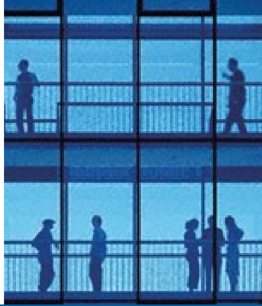
$$PI = \frac{\text{PV of net cash inflows}}{\text{Initial Investment}}$$

$$PI_A = \frac{\$300/1.1}{\$200} = 1.36 \text{ Accept (NPV = \$72.73)}$$

$$PI_B = \frac{\$1{,}900/1.1}{\$1{,}500} = 1.15 \text{ Accept (NPV = \$227.30)}$$

<u>Conflict</u>: $PI_A > PI_B$, but $NPV_B > NPV_A$

Other techniques

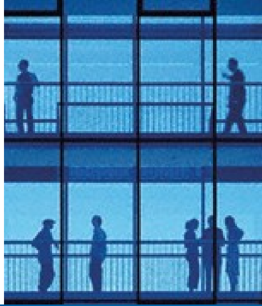


- Discounted Payback Period (DPP) uses exact amount of time required for a project to recover its initial investment

- Decision criterion:
  → *accept* if DPP < maximum acceptable period
  → *reject* if DPP > maximum acceptable period

- Weakness: ignores cash flows after payback period & therefore ranking conflict with NPV possible

Table 9.8 Summary of Key Formulas/Definitions and Decision Criteria for Capital Budgeting Techniques

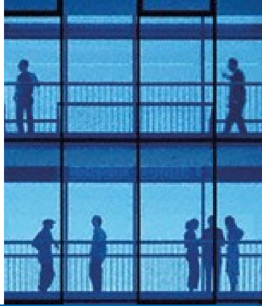


Technique	Formula/definition	Decision criteria
Payback period[a]	*For annuity:* $\frac{\text{Initial investment}}{\text{Annual cash inflow}}$ *For mixed stream:* Calculate cumulative cash inflows on year-to-year basis until the initial investment is recovered.	*Accept* if < maximum acceptable payback period. *Reject* if > maximum acceptable payback period.
Net present value (NPV)[b]	Present value of cash inflows − Initial investment.	*Accept* if > \$0. *Reject* if < \$0.
Internal rate of return (IRR)[b]	The discount rate that causes $NPV = \$0$ (present value of cash inflows equals the initial investment).	*Accept* if > the cost of capital. *Reject* if < the cost of capital.

[a] Unsophisticated technique, because it does not give explicit consideration to the time value of money.

[b] Sophisticated technique, because it gives explicit consideration to the time value of money.

Practice quiz



- Kaufman Chemical is evaluating the purchase of a new multi-stage centrifugal compressor for its wastewater treatment operation that costs $750,000 and requires $57,000 to install. This outlay would be partially offset by the sale of an existing compressor originally purchased five years ago for $490,000. It is being depreciated using a five-year recovery schedule under line method and can currently be sold for $150,000. The existing compressor's maintenance costs are increasing, and the new compressor could reduce operating costs before depreciation and taxes by $280,000 annually for the next five years. The new equipment will be depreciated under a five-year recovery schedule using straight line method. The firm has an 18% cost of capital and a 40% tax of ordinary and capital gain income.
- Evaluate whether Kaufman Chemical should replace its existing wastewater treatment equipment with the new compressor. (Do not consider the terminal value of the new compressor in your analysis.)