CHAPTER 5

NET PRESENT VALUE AND OTHER INVESTMENT CRITERIA

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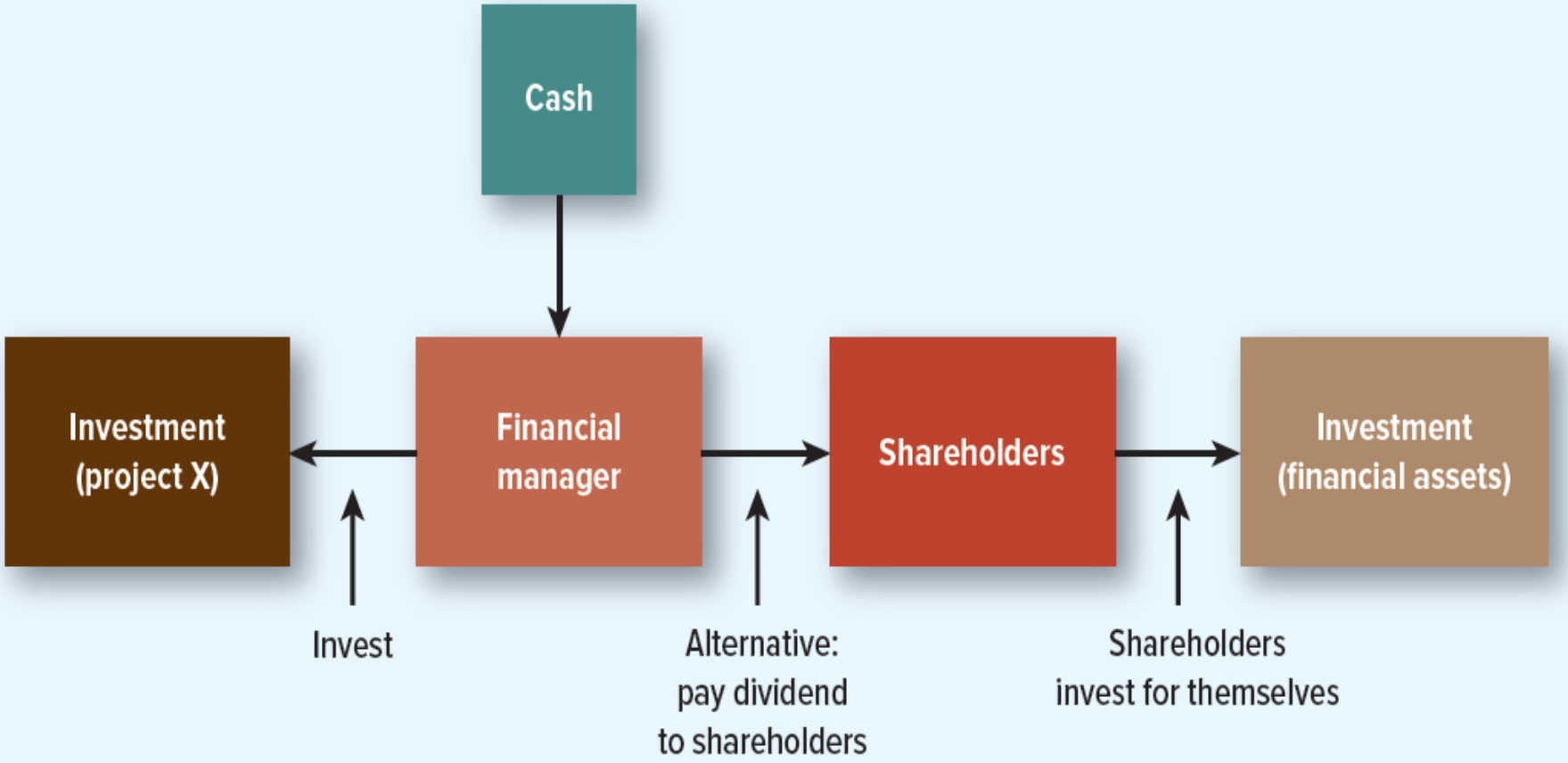
Topics Covered

- A Review of The Basics
- Book Rate of Return and Payback
- Internal (or Discounted Cash Flow) Rate of Return
- Choosing Capital Investments When Resources Are Limited

Figure 5.1 A Review of the Basics

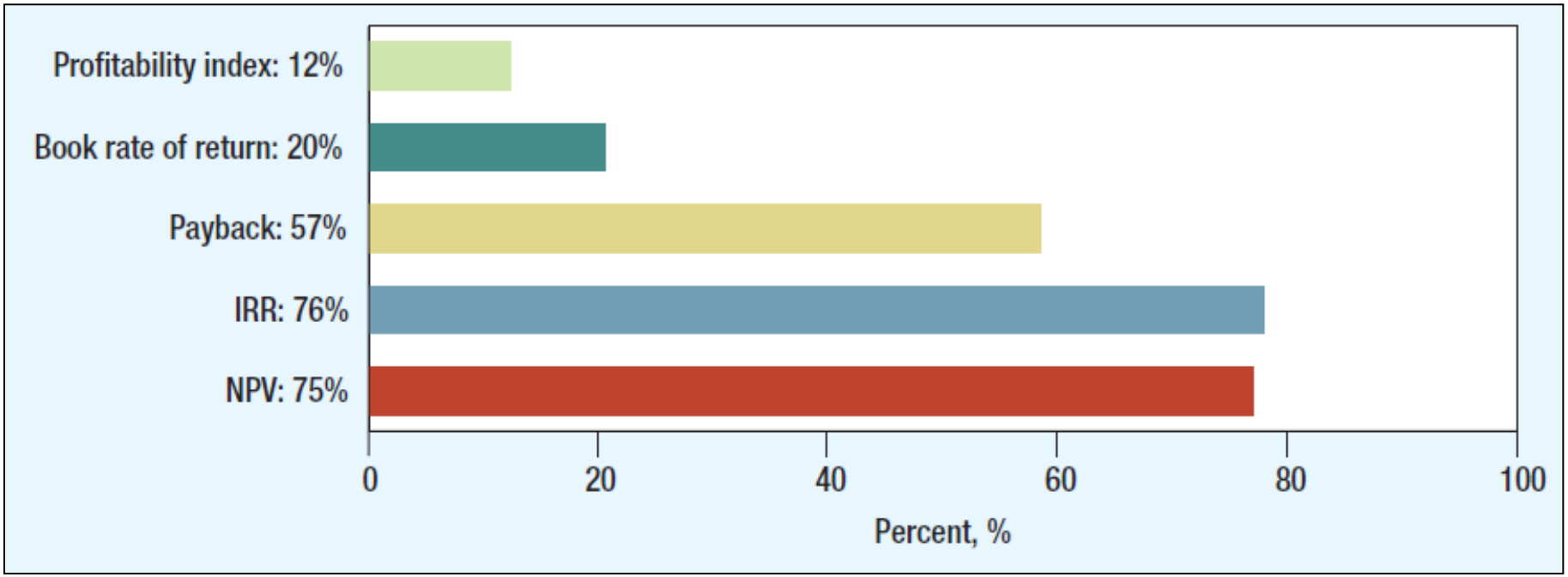


Three Points to Remember about NPV

1. A dollar today is worth more than a dollar tomorrow
2. Net present value depends solely on the *forecasted cash flows* from the project and the *opportunity cost of capital*
3. Because present values are all measured in today's dollars, you can add them up

$$NPV(A + B) = NPV(A) + NPV(B)$$

Figure 5.2 Survey Data on CFOs' Use of Investment Evaluation Techniques



Book Rate of Return and Payback

- **Book Rate of Return**
  - Average income divided by average book value over project life. Also called accounting rate of return.

$$\text{Book rate of return} = \frac{\text{book income}}{\text{book assets}}$$

- Managers rarely use this measurement to make decisions.
  - The components reflect tax and accounting figures, not market values or cash flows.

Book Rate of Return and Payback Continued

- The payback period of a project is the number of years it takes before the cumulative forecasted cash flow equals the initial outlay.
- The payback rule says to only accept projects that "pay back" in the desired time frame.
- This method is flawed, primarily because it ignores later-year cash flows and the present value of future cash flows.

Book Rate of Return and Payback Continued 2

Example

Examine the three projects and note the mistake we would make if we insisted on only taking projects with a payback period of two years or less.

Discounted Cash Flows ($)				
Project	C_0	C_1	C_2	C_3
A	–2,000	500/1.10 = 455	$500/1.10^2$ = 413	$5,000/1.10^3$ = 3,757
B	–2,000	500/1.10 = 455	$1,800/1.10^2$ = 1,488	
C	–2,000	1,800/1.10 = 1,636	$500/1.10^2$ = 413	

Book Rate of Return and Payback Concluded

Example

Examine the three projects and note the mistake we would make if we insisted on only taking projects with a payback period of two years or less.

Discounted Cash Flows ($)						
Project	C_0	C_1	C_2	C_3	Discounted Payback Period (years)	NPV at 20%
A	–2,000	500/1.10 = 455	$500/1.10^2$ = 413	$5,000/1.10^3$ = 3,757	3	+2,624
B	–2,000	500/1.10 = 455	$1,800/1.10^2$ = 1,488		—	–58
C	–2,000	1,800/1.10 = 1,636	$500/1.10^2$ = 413		2	+50

Internal (or Discounted Cash Flow) Rate of Return

- **Internal Rate of Return (IRR)**
  - Discount rate at which NPV = 0

- **Internal Rate of Return Rule**
  - Invest in any project offering a rate of return that is higher than the opportunity cost of capital

$$\text{Rate of return} = \frac{\text{payoff}}{\text{investment}} - 1$$

Internal (or Discounted Cash Flow) Rate of Return Continued

Example

You can purchase a turbo-powered machine tool gadget for $4,000. The investment will generate $2,000 and $4,000 in cash flows for two years, respectively. What is the IRR on this investment?

Internal (or Discounted Cash Flow) Rate of Return Concluded

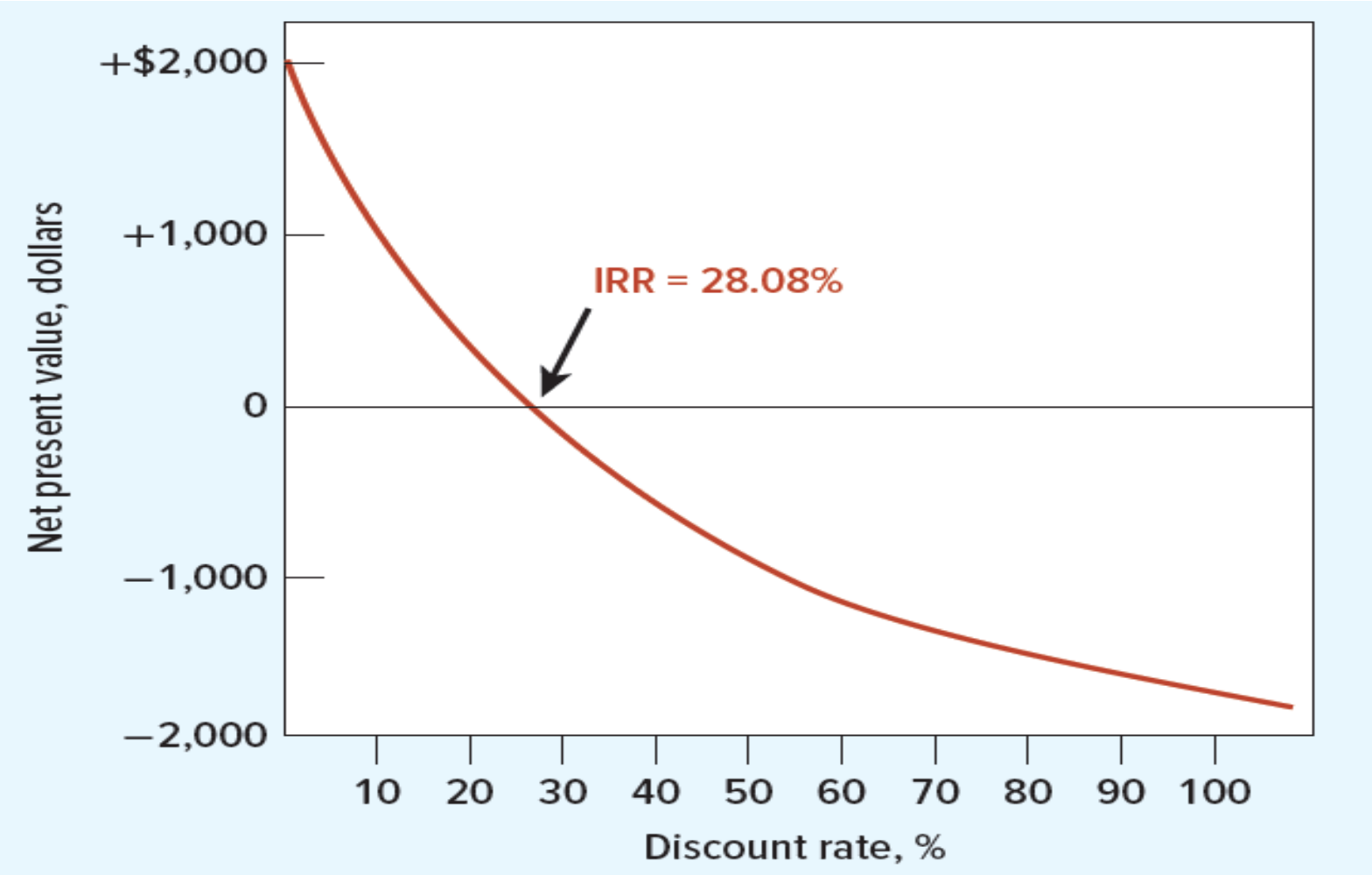
Example

You can purchase a turbo-powered machine tool gadget for $4,000. The investment will generate $2,000 and $4,000 in cash flows for two years, respectively. What is the IRR on this investment?

$$\text{NPV} = -4{,}000 + \frac{2{,}000}{(1+\text{IRR})^1} + \frac{4{,}000}{(1+\text{IRR})^2} = 0$$

$$\text{IRR} = 28.08\%$$

Figure 5.3 Internal Rate of Return



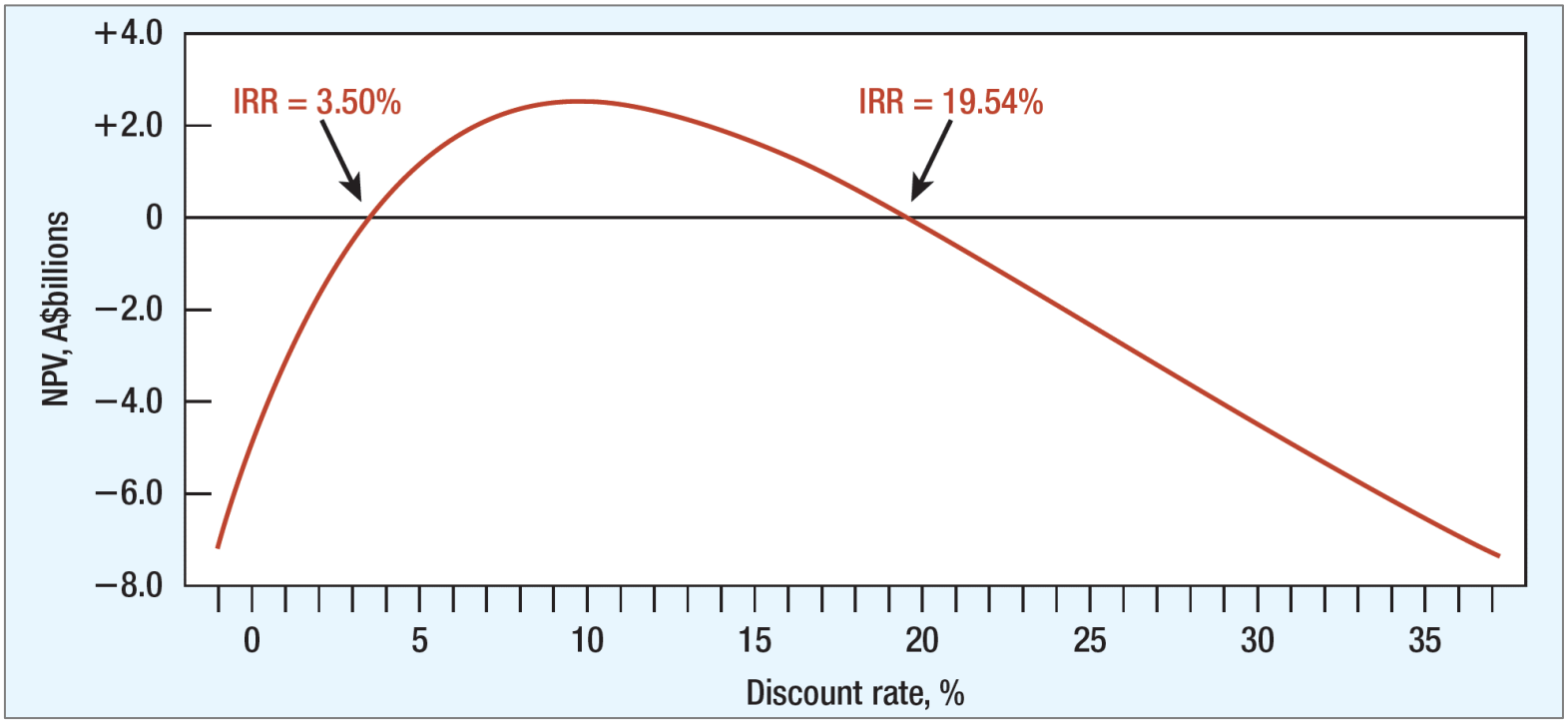
Pitfall 1—Lending or Borrowing?

- With some cash flows (as noted below), the NPV of the project increases as the discount rate increases
- This is contrary to the normal relationship between NPV and discount rates

	Cash Flows ($)			
Project	C_0	C_1	IRR	NPV at 10%
A	−1,000	+1,500	+50%	+364
B	+1,000	−1,500	+50%	−364

Pitfall 2—Multiple Rates of Return

- Certain cash flows can generate NPV = 0 at two different discount rates
- The following cash flow in Figure 5.4 generates NPV = $A 253 million at both IRR% of +3.50% and +19.54%.



Pitfall 2—Multiple Rates of Return

		FACTOR
0	−1000	
1	200	$1/1+r$
2	200	$1/(1+r)^2$
3	−500	$1/(1+r)^3$
4	25	$1/(1+r)^4$
5	25	$1/(1+r)^5$
6	−10	$1/(1+r)^6$

nonlinear
polynomial
Descrates Rule

Pitfall 2—Multiple Rates of Return Continued

- It is possible to have a zero IRR and a positive NPV

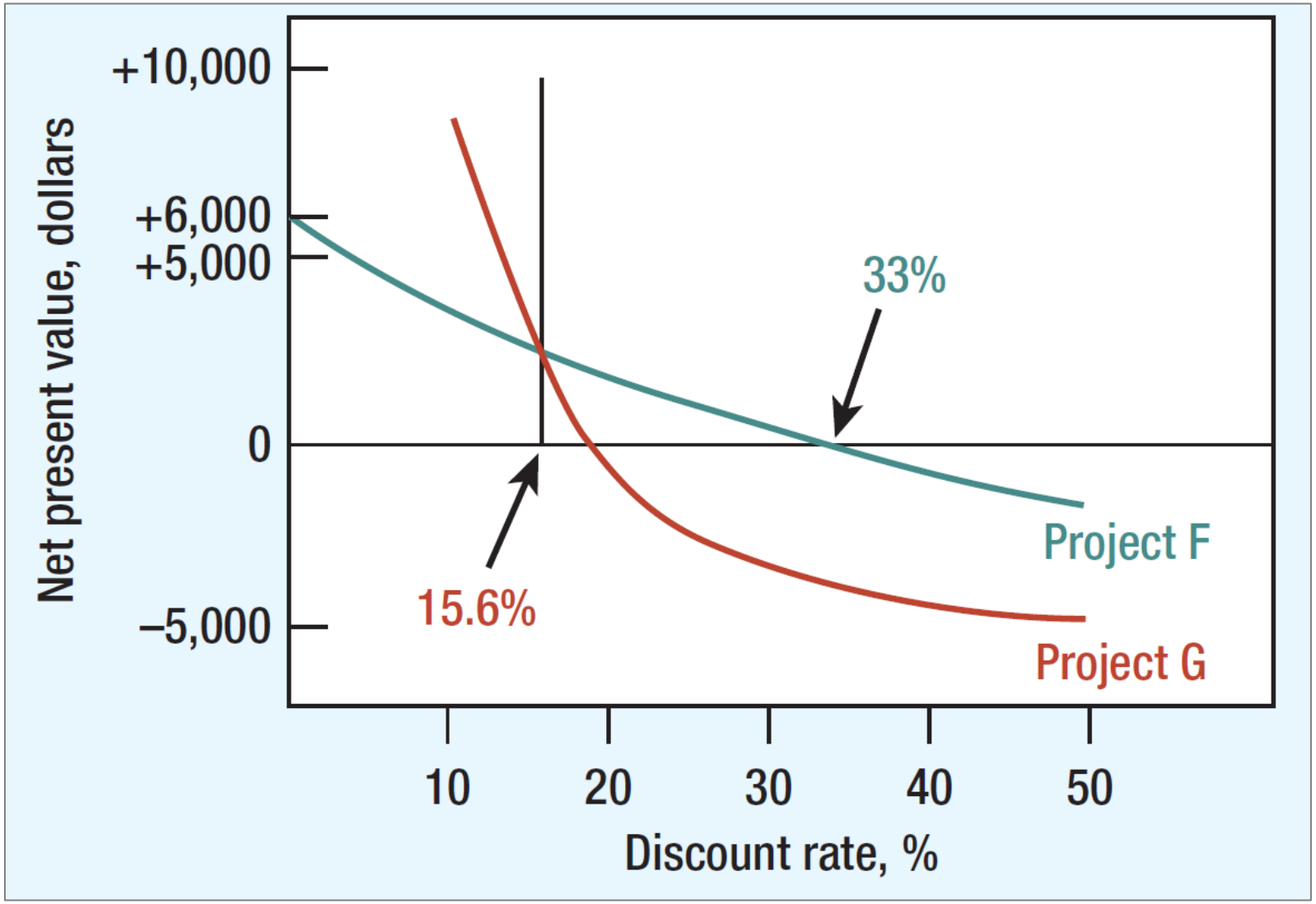
	Cash Flows ($)				
Project	C_0	C_1	C_2	IRR (%)	NPV at 10%
C	+1,000	−3,000	+2,500	None	+339

Pitfall 3—Mutually Exclusive Projects

- IRR sometimes ignores the magnitude of the project
- The following two projects illustrate that problem

	Cash Flows ($)			
Project	C_0	C_1	IRR (%)	NPV at 10%
D	−10,000	+20,000	100	+8,182
E	−20,000	+35,000	75	+11,818

Figure 5.5 Pitfall 3—Mutually Exclusive Projects



Pitfall 4—What Happens When There Is More than One Opportunity Cost of Capital

- Term structure assumption
- We assume that discount rates are stable during the term of the project
- This assumption implies that all funds are reinvested at the IRR
- This is a false assumption

Choosing Capital Investments When Resources Are Limited

- Capital Rationing
  - Limit set on the amount of funds available for investment
- Soft Rationing
  - Limits on available funds imposed by management
- Hard Rationing
  - Limits on available funds imposed by the unavailability of funds in the capital market

An Easy Problem in Capital Rationing

- When resources are limited, the profitability index (PI) provides a tool for selecting among various project combinations and alternatives
- A set of limited resources and projects can yield various combinations
- The highest weighted average PI can indicate which projects to select

An Easy Problem in Capital Rationing Continued

Project	Investment ($ millions)	NPV ($ millions)	Profitability Index
A	10	21	2.1
B	5	16	3.2
C	5	12	2.4

$$\text{Profitability index} = \frac{\text{NPV}}{\text{investment}}$$

An Easy Problem in Capital Rationing Concluded

Cash Flows ($ millions)				
Project	C_0	C_1	C_2	NPV at 10%
A	−10	+30	+5	21
B	−5	+5	+20	16
C	−5	+5	+15	12

Example: Profitability Index

Example

We only have $300,000 to invest. Which do we select?

Project	NPV	Investment	PI
A	230,000	200,000	1.15
B	141,250	125,000	1.13
C	194,250	175,000	1.11
D	162,000	150,000	1.08

Example: Profitability Index Continued

Example continued

Project	NPV	Investment	PI
A	230,000	200,000	1.15
B	141,250	125,000	1.13
C	194,250	175,000	1.11
D	162,000	150,000	1.08

Select projects with the highest weighted average PI

$$\text{Weighted average PI (BD)} = \left(1.13 \times \frac{125}{300}\right) + \left(1.08 \times \frac{150}{300}\right) + \left(0.0 \times \frac{25}{30}\right) = 1.01$$

Example: Profitability Index Concluded

Example concluded

Project	NPV	Investment	PI
A	230,000	200,000	1.15
B	141,250	125,000	1.13
C	194,250	175,000	1.11
D	162,000	150,000	1.08

Select projects with highest weighted average PI

WAPI (BD) = 1.01

WAPI (A) = 0.77

WAPI (BC) = 1.12