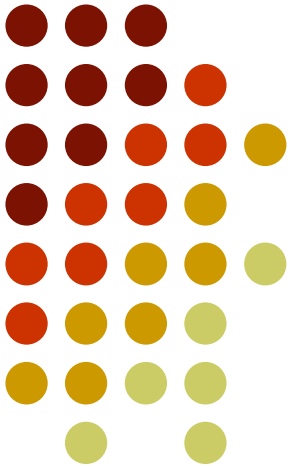
Capital Budgeting

Chapter 13



Outline

- What is capital budgeting?
- Net present value method
- Internal rate of return method
- Ranking investment alternatives
- Risk adjustments in capital budgeting
- Reference: BF Chap 22; PF Chap 13

Capital Budgeting

- The process of selecting long-term investments, primarily plant and equipment
- Conceptually no different than an investment in a stock or bond

Importance of Capital Budgeting

- Long-term impact
- Timing
- Substantial expenditures for which funds must be raised (either internally, externally, or both)

Project Classifications

- Replacement decisions
  - Determine whether to purchase assets to take the place of existing assets to maintain existing operations
- Expansion decisions
  - Determine whether to purchase assets/projects and add them to existing assets to increase existing operations

Project Classifications

- Independent projects
  - Projects whose cash flows are not affected by the acceptance or rejection of other projects; all good independent projects can be purchased
- Mutually exclusive projects
  - A set of projects where the acceptance of one project means the others cannot be accepted; only one mutually exclusive project can be purchased

Importance of Cash Flows

- The cash outflow to make the investment
- The cash inflow generated by the investment

Net Present Value (NPV)

- Present value of cash inflows minus cash outflows
- Discounts the cash inflows at the cost of capital and subtracts the present value of the cash outflows (i.e., the cost of the investment)

Net Present Value (NPV)

- NPV= $CF_1/(1+k) + \ldots + CF_n/(1+k)^n - C$
  - $CF_1, \ldots, CF_n$: cash inflows generated by the investment in years 1, …, n
  - n: number of years in which the investment generates cash inflows
  - C: the investment's cost (initial cash outflow)
  - k: firm's cost of capital
- Decision criterion
  - If NPV > 0, accept the investment
  - If NPV < 0, reject the investment

Example: NPV

- A firm is considering an investment that costs $1,000 and has the following cash inflows

Year	Investment A Cash Inflow
1	$400
2	400
3	400
4	400

  - The cost of capital is 8%. Should management make this investment?

Example: NPV (Cont'd)

- Present value of this investment:

Year	Cash Inflow × Interest Factor = Present Value		
1	$400	0.926	$370.40
2	400	0.857	342.80
3	400	0.794	317.60
4	400	0.735	294.00
			Σ = 1,324.80

- NPV = 1,324.80 – 1000 = $324.80
- Since the NPV > 0, the investment more than covers all the cost of the funds. The additional NPV increases the value of the firm. So the investment should be made.

Example: NPV (Cont'd)

- Suppose the firm is considering the following investments in addition to the one previously discussed:

	Cash Inflows Investment		
Year	B	C	D
1	$295	$250	$357
2	295	150	357
3	295	330	357
4	295	450	357

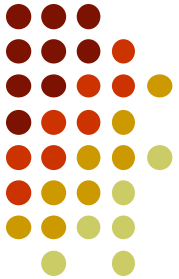
Should management make all these investments?

Example: NPV (Cont'd)

Investment	Net Present Value
A	$325
D	182
B	(23)
C	(47)

The firm should make investments A and D, but reject investments B and C.

Internal Rate of Return (IRR)



- The rate which equates the present value of cash inflows and the cash outflows, i.e.,
  - $C = CF_1/(1+r) + \ldots + CF_n/(1+r)^n$

- Decision criterion: compare the IRR to the cost of capital (k)
  - If IRR > k, accept the investment
  - If IRR < k, reject the investment

Example: IRR

- Consider investment A

$$1{,}000 = \frac{400}{(1+r)^1} + \frac{400}{(1+r)^2} + \frac{400}{(1+r)^3} + \frac{400}{(1+r)^4}$$

  - r = 21.86%
  - Since IRR > k = 8%, accept the investment

Example: IRR (Cont'd)

Investment	Internal Rate of Return
A	20%
D	16
B	7
C	6

The firm should make investments A and D, but reject investments B and C.

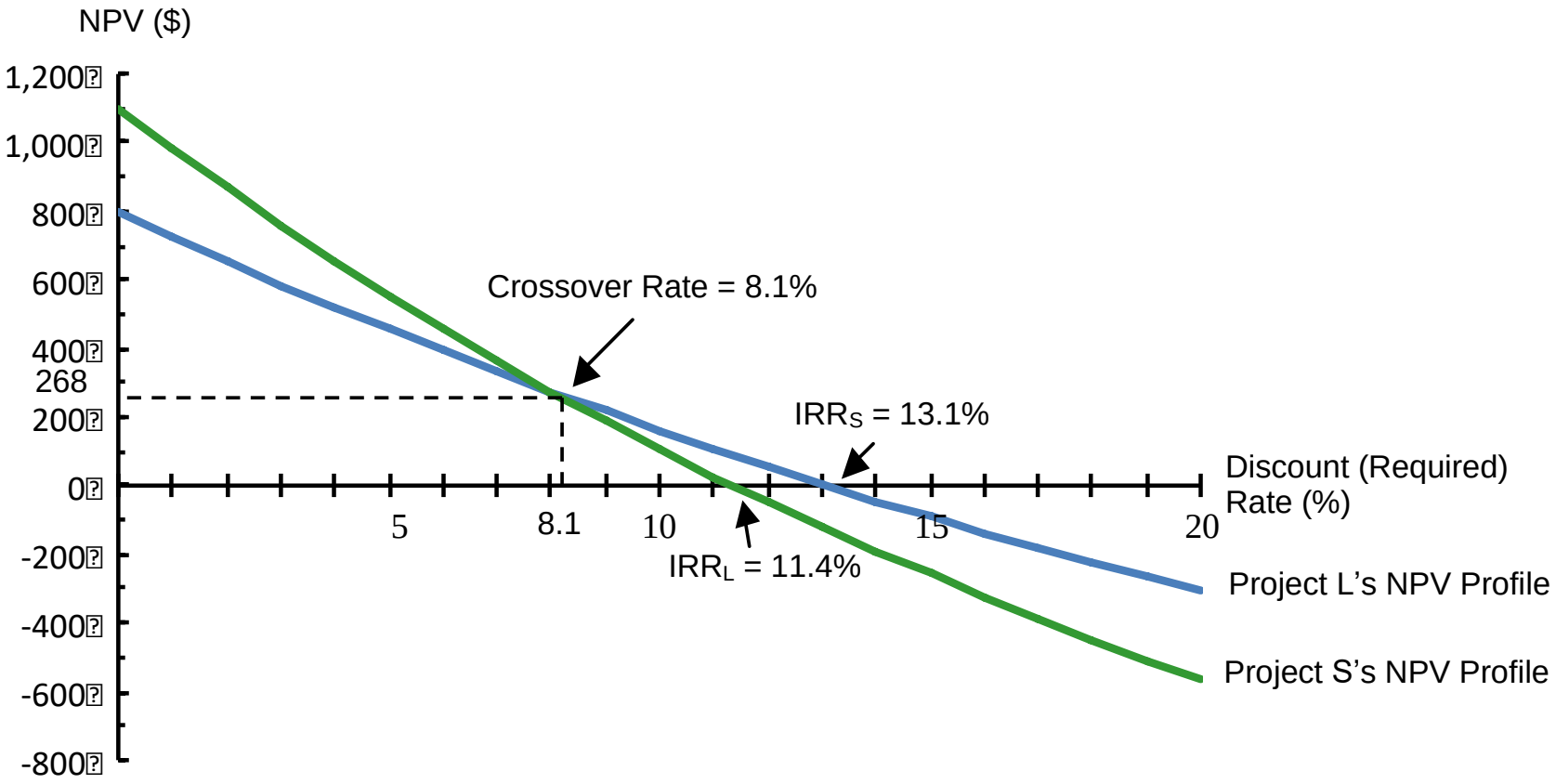
Hurdle Rate

- Management may not accept all investments with IRR > k.
- Hurdle rate is an alternative criterion that is a substitute for cost of capital
  - Return necessary to justify making an investment; usually higher than the cost of capital
  - For example, if k = 10%, the firm may make all investments with an IRR > 15%
- Helps the firm adjust for risk because it excludes the investments with the lowest anticipated internal rates of return

Comparison of the NPV and IRR Methods

- NPV profile is a graph (curve) showing the relationship between a project's NPV and various discount rates (required rates of return)
- IRR is at the point where the NPV profile crosses the X-axis
- Crossover rate
  - The discount rate at which the NPV profiles of two projects cross and thus, at the which the projects' NPVs are equal

Differences Between NPV and IRR



Independent Projects

- NPV and IRR will both lead to the same decision
  - If a project's NPV is positive, its IRR will exceed r, whereas if NPV is negative, r will exceed the IRR

Mutually Exclusive Projects

- Two investments for which the acceptance of one automatically excludes the acceptance of the other
- If NPV profiles cross, NPV and IRR decisions may conflict.
- Conflicts may occur if
  - the time of the cash inflows differ
  - the cost of the investments differ

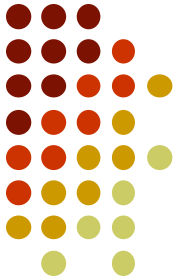
Differences in Timing of Cash Flows: Example

- Consider two mutually exclusive investments. Each investment costs $10,000, but the cash inflows occur in different time periods. Suppose the firm's cost of capital is 10%.

	Cash Inflows	
Year	A	B
1	$12,400	—
2	—	—
3	—	$15,609

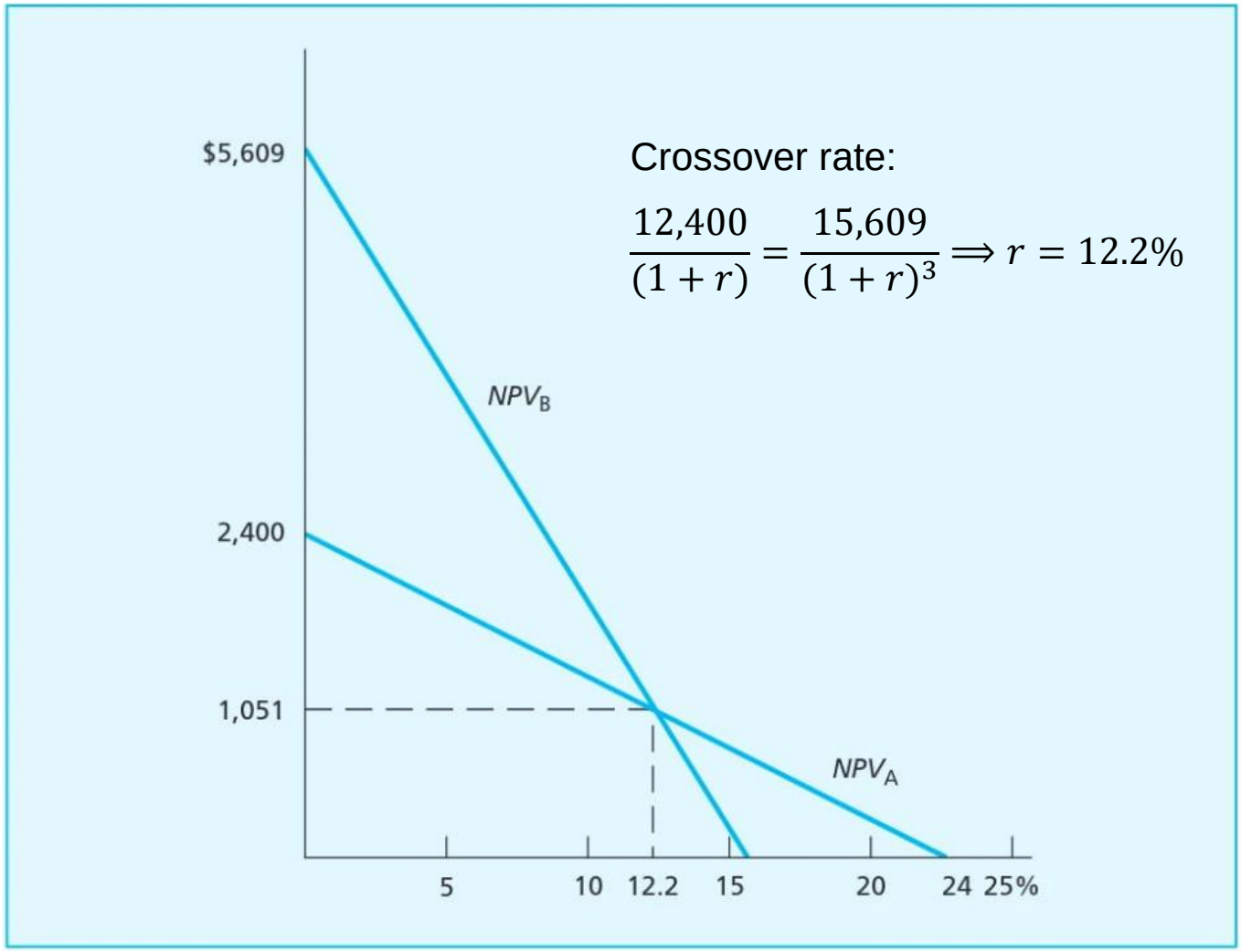
	Investment A	Investment B
Net present value	$1,272	$1,722
Internal rate of return	24%	16%

Differences in Timing of Cash Flows



- The reconciliation is built around to the answer to the question: What will the firm do with the cash inflow generated by investment A in year 1 (i.e., what is the reinvestment rate)?
  - Suppose the firm could reinvest the $12,400 at 14% for the next two years.
    - $12,400(1+0.14)^2 = \$16,120 > \$15,609$
  - Suppose the firm could reinvest the $12,400 at 12% for the next two years.
    - $12,400(1+0.12)^2 = \$15,549.60 < \$15,609$

Differences in Timing of Cash Flows



Crossover rate:

$$\frac{12{,}400}{(1+r)} = \frac{15{,}609}{(1+r)^3} \Rightarrow r = 12.2\%$$

Differences in Cost

- Consider the following mutually exclusive investments:

	Investment	
	A	B
Cost	$1,000	$600
Cash flow year 1	$1,150	$700
Cost of capital: 10 percent		

	Investment A	Investment B
Net present value	$45.35	$36.30
Internal rate of return	15%	16.7%

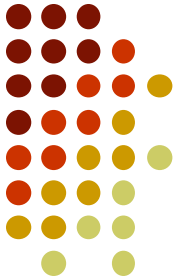
Differences in Cost

- The conflict may be resolved by asking what the firm can do with the money it saves by selecting B instead of A.
  - The worst alternative return is the cost of capital (management can save 10% by repurchasing stock and retiring debt)
    - The return on $1,000 = 0.4(10) + 0.6(16.7) = 14.02%
    - NPV = 700/1.1 + 400(1.1)/1.1 – (600 + 400) = $36
  - If the firm earns 13% on $400
    - The return on $1,000 = 0.4(13) + 0.6(16.7) = 15.22%
    - NPV = 700/1.1 + 400(1.13)/1.1 – (600 + 400) = $47

Differences between NPV and IRR

- NPV assumes cash flows are reinvested at the firm's cost of capital
- IRR assumes cash flows are reinvested at the investment's IRR
- NPV is the more conservative technique and may be preferred.

Risk Adjustments in Capital Budgeting



- NPV= $CF_1/(1+k) + \ldots + CF_n/(1+k)^n - C$
  - Cost C (cash outflows) is known.
  - Incorporation of risk must either affect the project's estimated cash inflows or affect the cost of capital
- Risk adjustments
  - Adjusting the cash inflows for the probability of occurrence
  - Adjusting the cost of capital for a risk premium

Adjusting Cash Inflows

- Scenario analysis

State of the Economy	Probability of Occurrence	Net Present Value
Recession	.20	$ 0
No growth	.30	100
Mild growth	.50	300

NPV = 0.2(0) + 0.3(100) + 0.5(300) = $180

(1) Individual NPV	(2) Expected NPV	(3) Difference (1) − (2)	(4) Difference Squared	(5) Probability of Occurrence	(6) Difference Squared Times the Probability (4) × (5)
$ 0	$180	$ 180	$32,400	.2	$ 6,480
100	180	−80	6,400	.3	1,920
300	180	−120	14,400	.5	7,200
				Sum of the weighted squared differences:	15,600

Standard deviation = $\sqrt{15{,}600} = 125$

Adjusting Cash Inflows

- Scenario analysis
  - Comparisons are made by calculating the coefficient of variation
    - Standard deviation/expected value
    - Standardizes for differences in scale
    - Coefficient of variation of the example = 125/180 = 0.69

Adjusting Cash Inflows

- Certainty equivalents
  - Express expected cash inflows as certain cash inflow.
  - Suppose a risky $1,000 investment is expected to generate the following cash inflows. Suppose the firm's cost of capital is 12%.

Year	1	2	3
	$300	$445	$568

  - An alternative use for the $1,000 is a three-year U.S. Treasury bond that pays $100 annually

Year	1	2	3
	$100	$100	$1,100

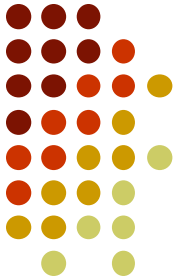
Adjusting Cash Inflows

- Certainty equivalents
  - Suppose the financial manager believes that cash flows from the risky investment are only equivalent to 95% of the certain investment and this percentage declines by 5% with each subsequent year.

Year	1	2	3
	(0.95)$300	(0.90)$445	(0.85)$568
	$285.00	$400.50	$482.80

  - After this adjustment, the firm's cost of capital cannot be used, because the cash flows are now considered to be equivalent of certain cash flows.
  - The risk-free rate should be used. Suppose the three-year Treasury bond offered 10%.

Adjusting the Discount Rate

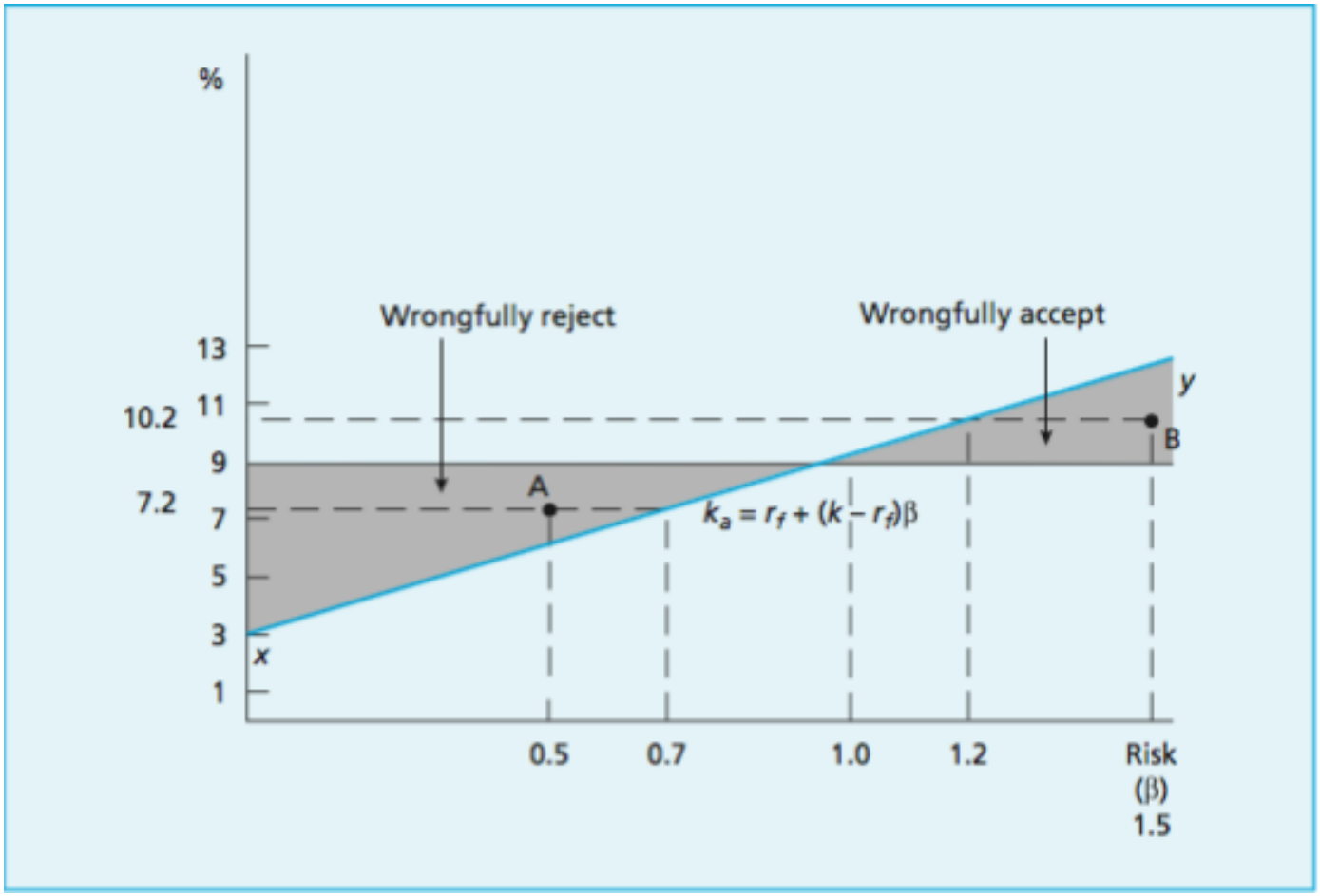


- Beta coefficients and the application of the CAPM

$$k_a = r_f + (k - r_f)\beta$$

  - k_a: risk-adjusted required return for an investment
  - k: firm's cost of capital
  - r_f: risk-free rate
  - β: beta coefficient associated with the investment being considered

Adjusting the Discount Rate



Summary

- Capital budgeting:
  - The process of selecting long-term investments, primarily plant and equipment
- Net present value
  - $NPV = CF_1/(1+k) + \ldots + CF_n/(1+k)^n - C$
  - Decision criterion
- Internal rate of return
  - $C = CF_1/(1+r) + \ldots + CF_n/(1+r)^n$
  - Decision criterion

Summary

- Comparison of the NPV and IRR Methods
  - NPV profile
  - Crossover rate
- Mutually exclusive projects
  - The time of the cash inflows differs
  - The cost of the investments differs
- Risk adjustments in capital budgeting
  - Adjusting cash inflows
  - Adjusting the discount rate