Lesson 11 – Incremental Analysis

Lesson 11: Learning Objectives

- Define and describe incremental analysis
- Utilize incremental analysis in NPW, EACF and IRR
- Graphical techniques to visualize problems
- Incremental analysis for multiple alternatives
- Recognizing ranges for alternative selection

Analysis Summary

Method	***MARR***	***Computations***	***Explanation***
NPV	Required for calculation	Simple and straightforward	Value added at time 0
EACF	Required for calculation	Simple and straightforward	Annual value added
IRR	Used for comparison	More complex; has drawbacks	Rate of return (internal)

Types of Projects

- Independent (stand alone)
  - The selection of a project is independent of the decision to undertake any other project(s).
- Mutually Exclusive
  - At most one project (including the status quo, or “do nothing” option) can be selected amongst competing alternatives.
- Contingent (dependent)
  - The selection of a project is dependent on the selection of at least one other project.

Incremental Analysis

- Defined as the examination of differences between alternatives to determine if the increased costs are justified by the increased benefits.
- Any two alternatives can be compared by recognizing that
  - [Higher-cost alternative] = [Lower-cost alternative] + [Increment between them]
- When there are two alternatives, only a single incremental analysis is required.
- With more alternatives, a series of comparisons is required.

Graphical Approach

- When there are multiple alternatives, graphing summarizes the information well:
  - Present Worth (P) versus interest rate

    OR
  - Uniform annual worth (EACF) versus interest rate
- By graphing each alternative on the same graph, the information we can see what is happening to the alternatives as the interest rate is adjusted.

Simple Example

We want to run a mobile welding fleet.

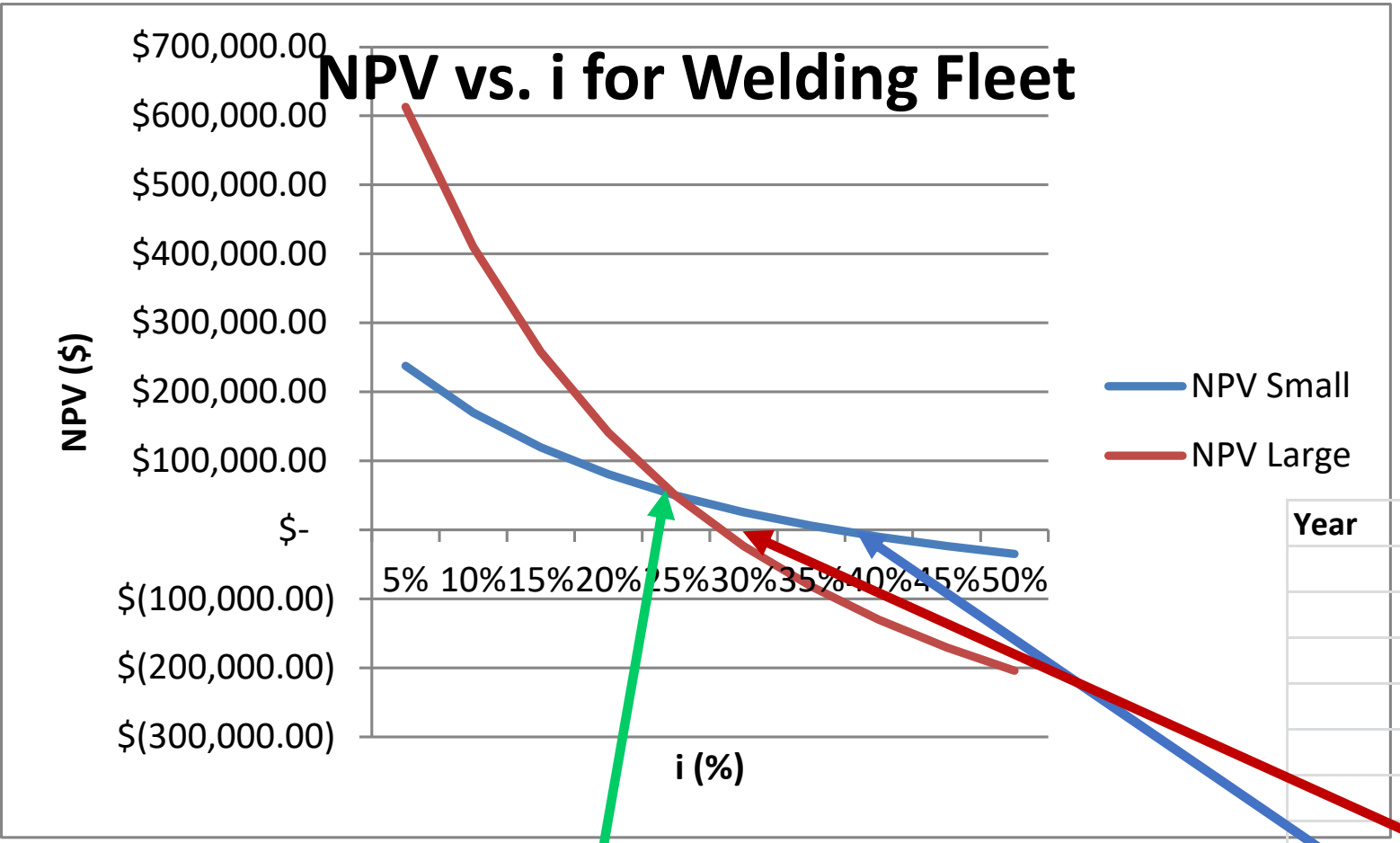
A small fleet would cost $150,000 and provide a net profit of $60,000 per year. A larger fleet would cost $550,000 and provide a net profit of $180,000 per year. Assume the business would run for eight years.

Present values of the two alternatives are

$$PV_{small} = -\$150{,}000 + \$60{,}000(P/A, i, 8)$$

$$PV_{large} = -\$550{,}000 + \$180{,}000(P/A, i, 8)$$

Welding Example (cont'd)



Year		Small Fleet	Large Fleet
	0	$ (150,000)	$ (550,000)
	1	$ 60,000	$ 180,000
	2	$ 60,000	$ 180,000
	3	$ 60,000	$ 180,000
	4	$ 60,000	$ 180,000
	5	$ 60,000	$ 180,000
	6	$ 60,000	$ 180,000
	7	$ 60,000	$ 180,000
	8	$ 60,000	$ 180,000
IRR		37%	28%

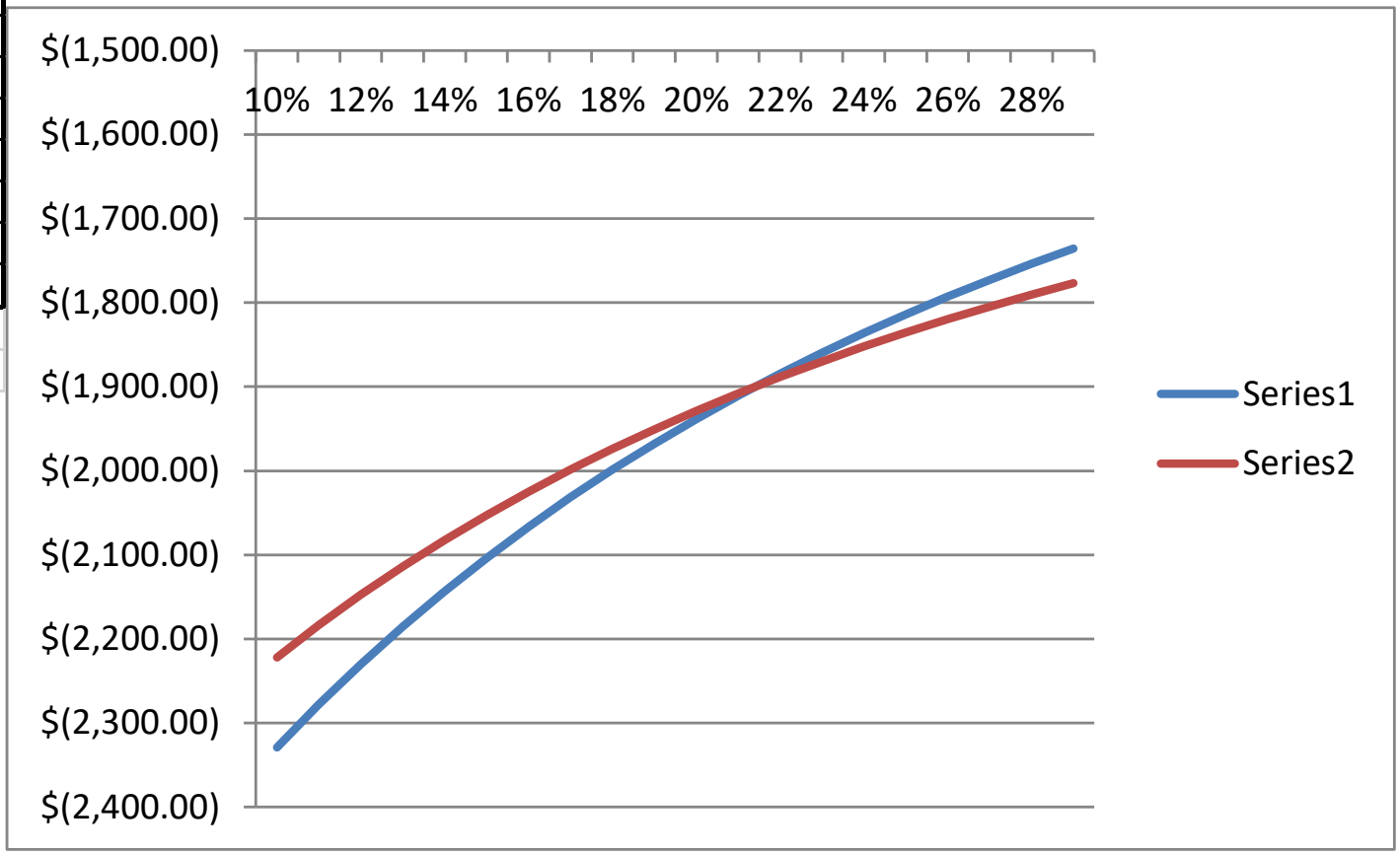
Incremental IRR: 25%

Example

- An auto repair shop is looking to purchase an air compressor. Compressor 1 costs $1,100 to purchase and $200 per year to operate. Compressor 2 costs $1,300 and $150 per year to operate. Both compressors will last 10 years.

Compressor Example

	Cashflows		
Year	Option 1	Option 2	Incremental
0	-$ 1,100	-$ 1,300	-$ 200
1	-$ 200	-$ 150	$ 50
2	-$ 200	-$ 150	$ 50
3	-$ 200	-$ 150	$ 50
4	-$ 200	-$ 150	$ 50
5	-$ 200	-$ 150	$ 50
6	-$ 200	-$ 150	$ 50
7	-$ 200	-$ 150	$ 50
8	-$ 200	-$ 150	$ 50
9	-$ 200	-$ 150	$ 50
10	-$ 200	-$ 150	$ 50
		DeltaIRR	**21%**



Graphical Approach

- Particularly helpful with more than 2 alternatives
- It becomes immediately apparent where each alternative provides value over the others.
- EUAC or EUAB can also be used for the graphs instead of PV.

Textbook Example 8-4

- Pressure vessel material selection
- Different materials have different lives
  - All will require multiple replacements
- Which analysis should we use?

- 50-75 year project lifetime.
- Alternative lifetimes 4-25 years

- Only single costs, so use Capital Recovery Factor to convert to annuity
- EAUC = Cost*(A/P, i, life)
  - Life is set by material
  - Solve for i

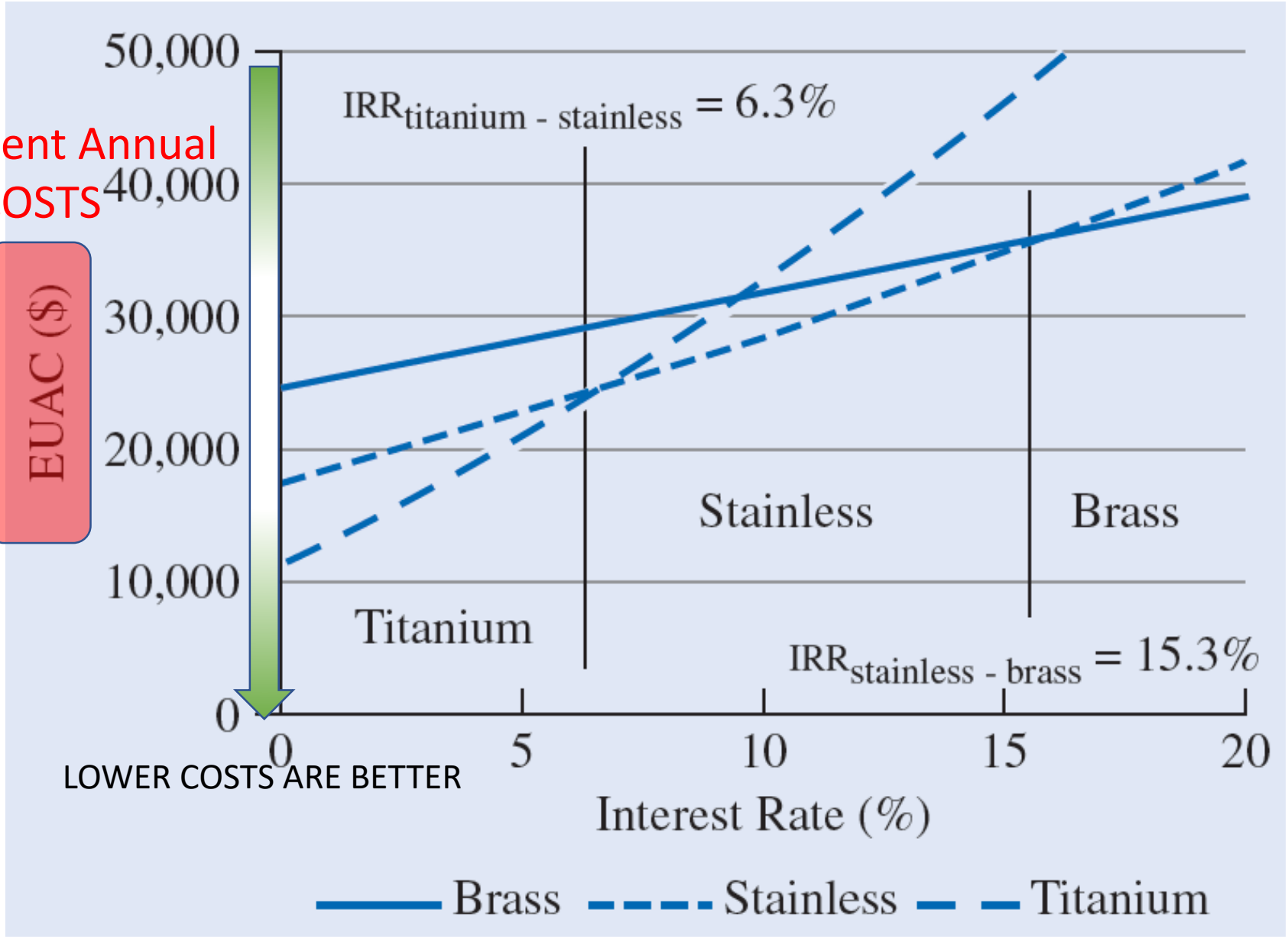
Textbook Example 8-4

- Brass: EAUC = $100,000(A/P, i, 4)
- Stainless Steel: EAUC = $175,000(A/P, i, 10)
- Titanium: EAUC = $300,000(A/P, i, 25)

Calculate the EAUC for each alternative at various interest rates and plot.

More than 2 Alternatives: Example 8-4, Pg. 283-4

Textbook

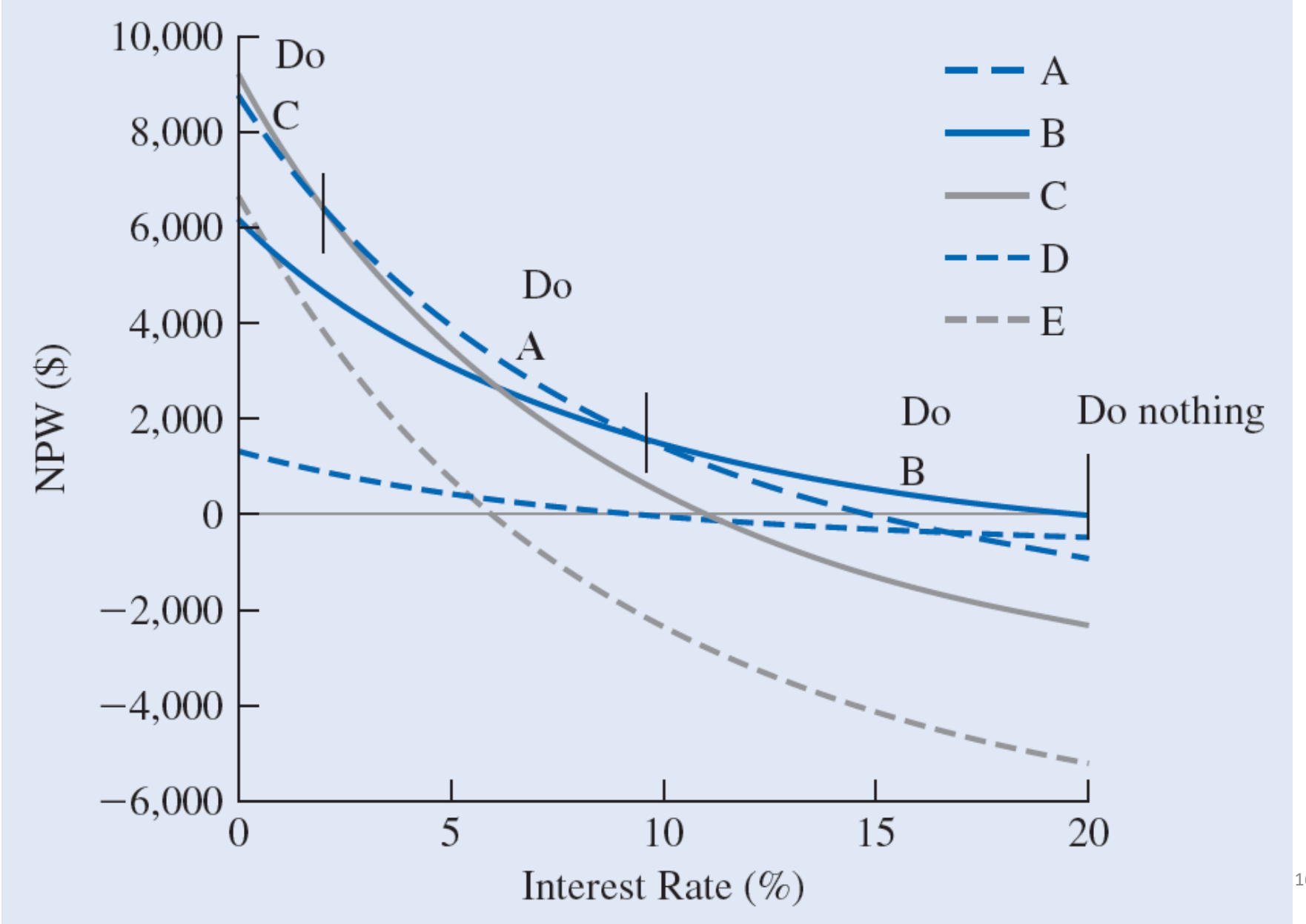


Textbook Example 8-4

- The graph shows the IRR for each pair of alternatives from highest to lowest initial cost.
- The graph shows the range(s) where each alternative should be selected

Interest Rate	Best Choice
$0\% \le i \le 6.3\%$	Titanium
$6.3\% \le i \le 15.3\%$	Stainless Steel
$15.3\% \le i$	Brass

Many Alternatives: Textbook Example 8-6, Pgs. 286-7



Textbook Example 8-6 Continued…

- The graph clearly shows in this case that alternatives D and E are never part of the solution.
- The “do-nothing” alternative is a possibility due to the present worth of all alternatives going below 0 if MARR is above 20%.

Multiple Alternatives - Process

1. Order from lowest to highest cost, including Do Nothing if applicable
2. Calculate IRR for lowest cost option. IRR > MARR?
    1. No: Go to next lowest cost option and try again
    2. First option that has i > MARR becomes defender.
    3. Next lowest cost option becomes challenger
3. Calculate incremental IRR for challenger – defender
    1. i > MARR: Challenger becomes new defender
    2. i < MARR: Defender remains
    3. Go to next option and repeat until only one option remains.

Incremental Analysis: Example

The CROC Co. is considering a new milling machine. They have narrowed the choices down to three alternatives in addition to the "do nothing" alternative.

	Economy	Regular	Deluxe
First cost	$75,000	$125,000	$220,000
Annual Benefit	$28,000	$43,000	$79,000
M&O Costs	$8000	$13,000	$38,000
Salvage Value	$3000	$6900	$16,000

All machines have a life of 10 years. Using incremental rate of return analysis, which alternative should the company choose? Use a MARR of 15%.

Incremental Analysis: Example

Solution:

Order of increasing First Cost: Null, Economy, Regular & Deluxe. MARR = 15%.

Increment: first option

Incremental First Cost: $75,000 - $0 = $75,000
Incremental Annual Benefit: $28,000 - $0 = $28,000
Incremental M&O Costs: $8,000 - $0 = $8,000
Incremental Salvage: $3,000 - $0 =$3000

Incremental Analysis: Example

First Option (Economy Mill):

NPV = –75,000 + {(28,000 – 8000) (*P*/*A*, *i*, 10)} + {(3000 (*P*/*F*, *i*, 10)}

= –75,000 + {20,000 (*P*/*A*, 15%, 10)} + {3000 (*P*/*F*, 15%, 10)}

= $26,121.60

Since, NPV is greater than $0, incremental ROR is greater than MARR. Therefore, we accept the Economy option. It now becomes the defender.

Also, can calculate the incremental IRR directly: IRR = 23.6%

Incremental Analysis: Example

Increment: Economy as Defender, Regular as Challenger

NPV = (125,000 – 75,000) + [{(43,000 – 13,000) – (28,000 – 8000)} (*P*/*A*, *i*, 10)] + {(6900 – 3000) (*P*/*F*, *i*, 10)}

= –50,000 + {10,000 (*P*/*A*, 15%, 10)} +{(3900 (*P*/*F*, 15%, 10)}

= $1154.08

Since, NPW is greater than $0, incremental ROR is greater than MARR. Therefore, accept Regular.

Or incremental IRR = 15.6%

Incremental Analysis: Example

Increment: Regular as Defender, Deluxe as Challenger

NPW = –(220,000 – 125,000) + [{(79,000 – 38,000) – (43,000 – 13,000)} (*P*/*A*, *i*, 10)] + {(16,000 – 6900) (*P*/*F*, *i*, 10)}

= –95,000 + {11,000 (*P*/*A*, 15%, 10)} + {(9100 (*P*/*F*, 15%, 10)}

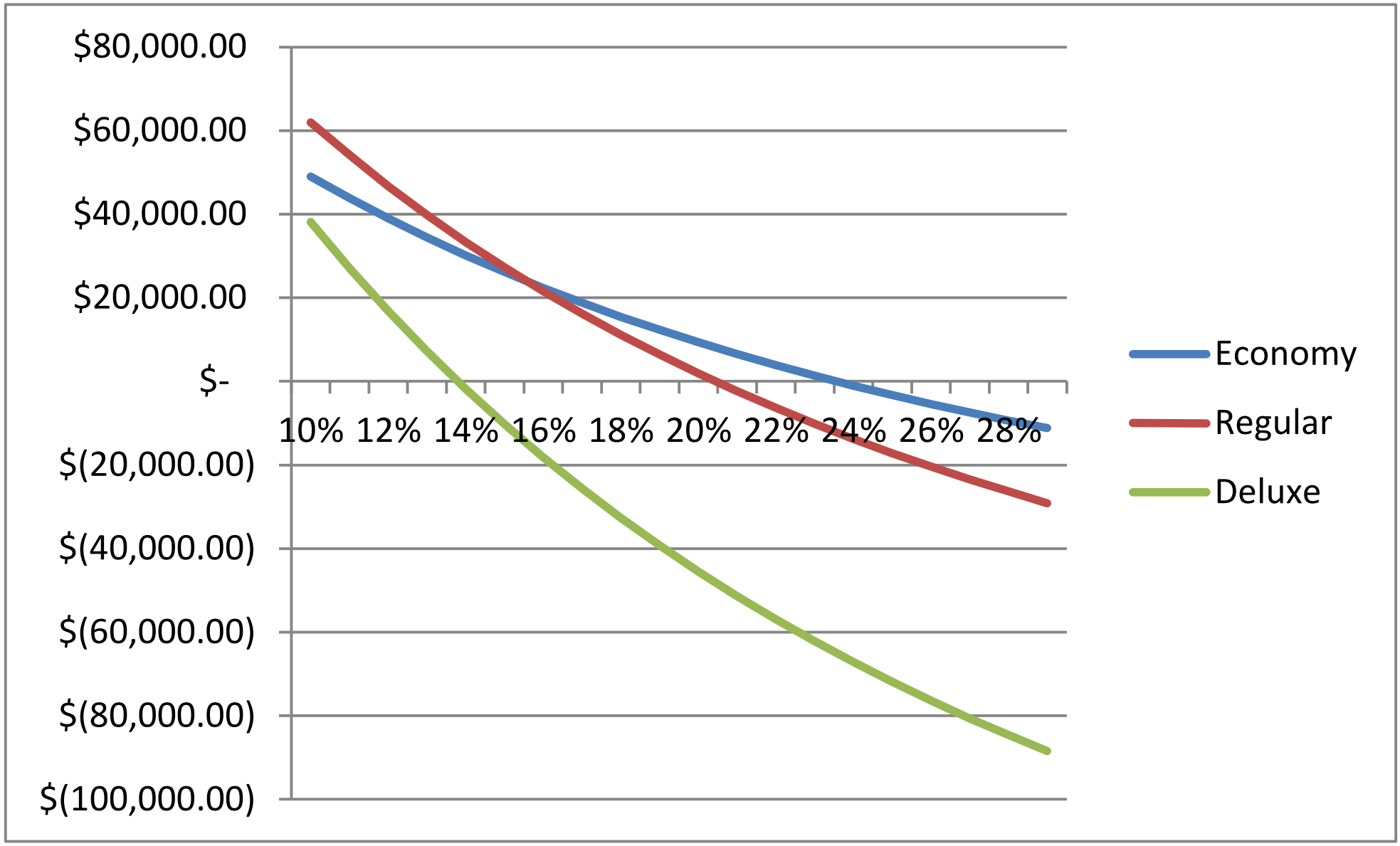
= –$37,541.48

Since, NPW is less than $0, incremental RoR is than MARR. Therefore, reject Deluxe.

Or, incremental IRR = 4.1%

‘Regular’ is the best choice.

Incremental Analysis: Example



Elements in Incremental Rate of Return Analysis

- Be sure all the alternatives are identified.
- Construct an NPV or EACF graph showing all alternatives plotted on the same axes.
- Examine the line of maximum values and determine which alternatives create it, and over what range.
- Determine the changeover points.
- Create a choice table.

Which method should be used when?

- Present and annual worth analysis often require far less computation than ROR.
- Rate of return might be easier to explain to people unfamiliar with economic analysis.
- Businesses tend to adopt one type of analysis and rate of return is popular.

Do what your boss tells you: Perform an analysis with more than one method if other methods add beneficial information.

Chapter 8: Suggested Problems

- Chapter 8: 2, 5, 13, 19, 23, 25, 33, 37, 38, 45