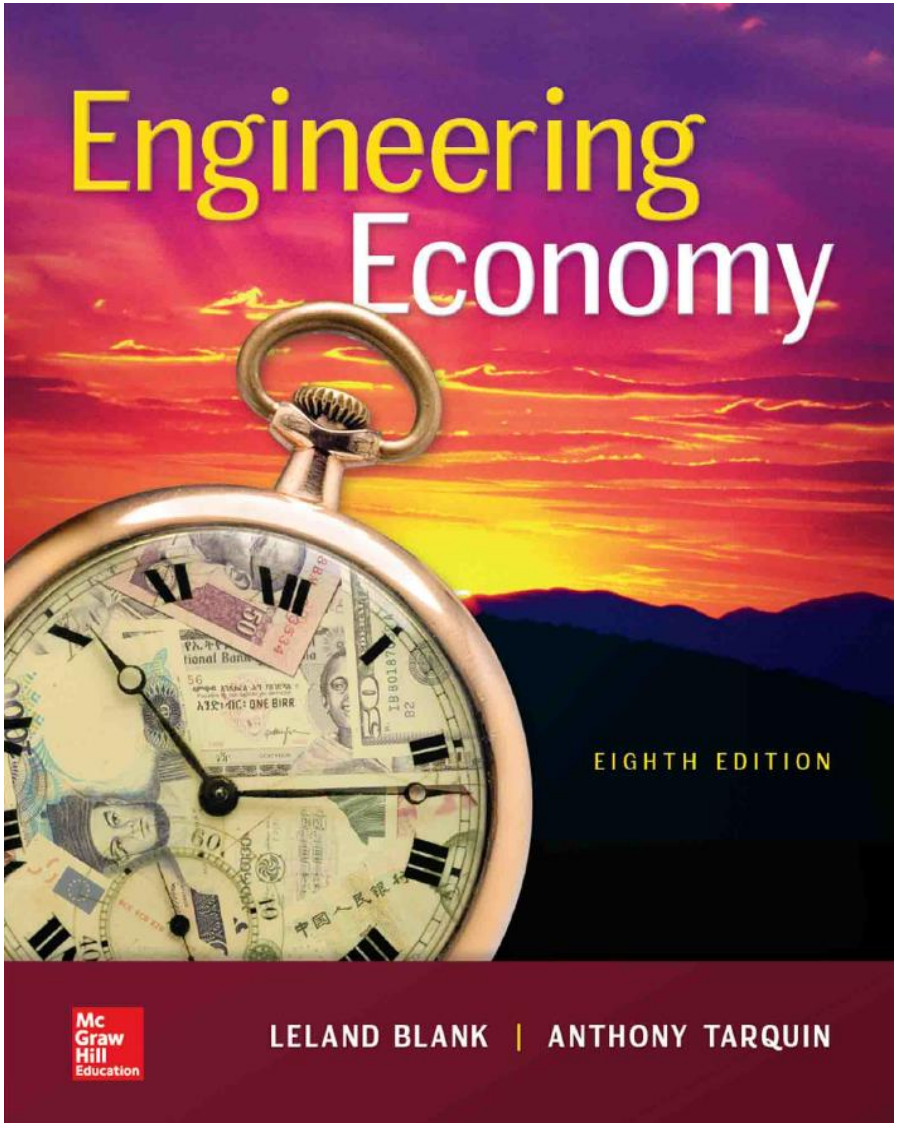

Chapter 8

Rate of Return Multiple Alternatives

Lecture slides to accompany

Engineering Economy

8th edition

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LEARNING OUTCOMES

1. **Why incremental analysis is required in ROR**
2. **Incremental cash flow (CF) calculation**
3. **Interpretation of ROR on incremental CF**
4. **Select alternative by ROR based on PW relation**
5. **Select alternative by ROR based on AW relation**
6. **Select best from several alternatives using ROR method**

Why Incremental Analysis is Necessary

- Selecting the alternative with _____ ROR may ____ yield _____ return on ***available capital***
- Must consider _____ ***average*** of total capital available
- Capital ***not*** invested in a project is assumed to ***earn at*** ____

Example: Assume $90,000 is available for investment and MARR = 16% per year. If alternative A would earn 35% per year on investment of $50,000, and B would earn 29% per year on investment of $85,000, the weighted averages are:

Overall ROR_A = [50,000(0.35) + 40,000(0.16)]/90,000 = 26.6%

Overall ROR_B = [85,000(0.29) + 5,000(0.16)]/90,000 = 28.3%

Which investment is better, economically?

Why Incremental Analysis is Necessary

If selection basis is higher ROR:

Select alternative A **(_____ answer)**

If selection basis is higher _____ ROR:

Select alternative B

Conclusion: Must use an _____ ROR analysis to make a consistently correct selection

Unlike PW, AW, and FW values, if not analyzed correctly, ROR values can lead to an incorrect alternative selection. This is called the ranking _____ problem (discussed later)

Calculation of Incremental CF

_____ cash flow = cash flow$_B$ – cash flow$_A$

where _____ *initial investment* is Alternative B

Example: Either of the cost alternatives shown below can be used in a grinding process. Tabulate the incremental cash flows.

	A	B	B - A
First cost, $	-40,000	- 60,000	-20,000
Annual cost, $/year	-25,000	-19,000	+6000
Salvage value, $	8,000	10,000	+2000

The incremental CF is shown in the (B-A) column

The ROR on the _____ $20,000 investment in B determines which alternative to select (as discussed later)

Interpretation of ROR on Extra Investment

Based on concept that any _____ *investment* that does not yield at least the MARR should ___ be made.

Once a lower-cost alternative *has been economically* justified, the ROR on the _____ *investment* *(i.e., additional amount of money* associated with a higher first-cost alternative) must also yield a ROR < MARR (because the extra investment *is* _____ by selecting the economically-justified lower-cost alternative).

This incremental ROR is identified as ____

For _____ projects, select all that have ROR ≥ MARR
(___ incremental analysis is necessary)

ROR Evaluation for Two ME Alternatives

(1) Order alternatives by _____ *initial investment cost*

(2) *Develop incremental CF series* using LCM of years

(3) Draw incremental *cash flow diagram*, if needed

(4) Count sign changes to see if *multiple Δi^* values exist*

(5) Set up PW, AW, or FW = 0 relation and *find Δi^*_{B-A}*

Note: Incremental ROR analysis requires _____ comparison. The LCM of lives must be used in the relation

(6) If $\Delta i^*_{B-A} <$ MARR, *select* __; otherwise, select __

If multiple Δi^* values exist, ***find EROR*** using either MIRR or ROIC approach.

Example: Incremental ROR Evaluation

Either of the cost alternatives shown below can be used in a chemical refining process. If the company's MARR is 15% per year, determine which should be selected on the basis of ROR analysis?

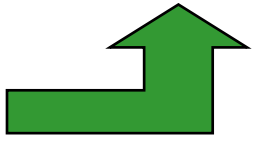
	A	B
First cost ,$	-40,000	-60,000
Annual cost, $/year	-25,000	-19,000
Salvage value, $	8,000	10,000
Life, years	5	5

Initial observations: ME, cost alternatives with equal life estimates and no multiple ROR values indicated

Example: ROR Evaluation of Two Alternatives

Solution, using procedure:

	A	B	B - A
First cost , $	-40,000	-60,000	-20,000
Annual cost, $/year	-25,000	-19,000	+6000
Salvage value, $	8,000	10,000	+2000
Life, years	5	5	



Order by ____ ***cost*** **and** ***find*** _____ ***cash flow*** **B - A**

Write ROR equation **(in terms of PW, AW, or FW) on incremental CF**

$$0 = -20{,}000 + 6000(P/A,\Delta i^*,5) + 2000(P/F,\Delta i^*,5)$$

Solve **for** Δi^* **and** ***compare*** **to MARR**

$\Delta i^*_{B-A} = 17.2\% > \text{MARR of } 15\%$

ROR on $20,000 extra investment is acceptable: **Select** ___

ROR Analysis – Multiple Alternatives

Six-Step Procedure for Mutually (_____) Alternatives

(1) Order alternatives from _____ *to largest initial investment*
(2) For revenue alts, calculate **i*** (vs. DN) and _____ *all with i* < MARR*; remaining alternative with lowest cost is ***defender*****. F**or cost alternatives, go to step (3)
(3) Determine incremental CF between ***defender*** and ***next lowest-cost*** alternative (known as the ***challenger***). Set up ROR relation
(4) Calculate **Δi*** on incremental CF between *two alternatives from step (3)*
(5) If **Δi* ≥ MARR,** *eliminate* _____ and *challenger becomes new defender* against next alternative on list
(6) Repeat steps (3) through (5) *until only* ____ *alternative* remains. ***Select it***.

For Independent Projects

Compare each alternative vs. DN and select ***all with ROR ≥ MARR***

Example: ROR for Multiple Alternatives

The five mutually exclusive alternatives shown below are under consideration for improving visitor safety and access to additional areas of a national park. If all alternatives are considered to last indefinitely, determine which should be selected on the basis of a rate of return analysis using an interest rate of 10%.

	A	B	C	D	E
First cost, $ millions	-20	-40	-35	-90	-70
Annual M&O cost, $ millions	-2	-1.5	-1.9	-1.1	-1.3

Solution: **Rank on the basis of initial cost: A,C,B,E,D; calculate CC values**

C vs. A: $0 = -15 + 0.1/\Delta i^*$ $\Delta i^* = 6.7\%$ (eliminate C)

B vs. A: $0 = -20 + 0.5/\Delta i^*$ $\Delta i^* = 25\%$ (eliminate A)

E vs. B: $0 = -30 + 0.2/\Delta i^*$ $\Delta i^* = 6.7\%$ (eliminate E)

D vs. B: $0 = -50 + 0.4/\Delta i^*$ $\Delta i^* = 8\%$ (eliminate D)

Select alternative ____

Summary of Important Points

- Must consider _____ ***cash flows*** for _____ _____alternatives

  Incremental cash flow = cash flow$_B$ – cash flow$_A$

  where alternative with _____ initial investment is **Alternative B**

- Eliminate __ if incremental ROR Δ**i* < *MARR*;** *otherwise,* **eliminate** __

- For multiple mutually exclusive alternatives, compare two at a time and eliminate alternatives until ***only*** ____ ***remains***

- For independent alternatives, compare each against **DN** and ***select*** ____ ***that have ROR ≥ MARR***

HOMEWORK

1. Please solve every Examples in your textbook. You do not have to submit your works.

2. Please upload following “PROBLEMS” solution file on “Assignment” menu in e-Class.
   - ① 8.17
   - ② 8.23
   - ③ 8.34
   - ④ 8.39
   - ⑤ 8.57