ISE 2014 CHAPTER 5 – COMPARING ALTERNATIVES

Objective:

To learn how to properly apply the profitability measures described in Chapter 4 to select the best alternative out of a set of mutually exclusive alternatives (MEA).

Mutually Exclusive - the selection of one alternative excludes the consideration of any other alternative. Example: suppose you are shopping for a used automobile. You consider several cars, but will only buy one from a mutually exclusive set of choices.

Section 5.2 Fundamental Purpose of Capital Investment:

To obtain at least the MARR for every dollar invested.

Basic Rule:

Spend the least amount of capital possible unless the extra capital can be justified by the extra savings or benefits.

In other words, any increment of capital spent (above the minimum) must be able to pay its own way.

Section 5.2 Two types of decisions we'll face

1. Investment Alternatives - each alternative has an initial investment producing positive cash flows resulting from increased revenues, reduced costs, or both.

   "Do nothing" (DN) is usually an implicit investment alternative.

If Σpositive cash flows > Σnegative cash flows, then IRR>0.

If EW(MARR)≥0, investment is profitable, or

if EW(MARR)<0, do nothing (DN) is better,

where EW refers to an equivalent worth method (e.g. PW)

Section 5.2. Two types of decisions we'll face

2. Cost Alternatives - have all negative cash flows except for the salvage value (if applicable). These alternatives represent “must do” situations, and DN is not an option

IRR not defined for cost alternatives. Can you explain why?

Section 5.3. The study period must be appropriate for the decision being made.

Study Period: The time interval over which service is needed to fulfill a specified function.

Useful Life: The period over time during which an asset is kept in productive operation.

Case 1: Study period = Useful life

Case 2: Study period ≠ Useful life

Fundamental Principle: **Compare MEAs over the same period of time.**

Section 5.4.1 (Case 1) Equivalent Worth (EW) Methods: PW, AW, FW

Procedure for Selecting the Best MEA using the EW method:

1. Compute the equivalent worth of each alternative, using the MARR as the interest rate.

2. *Investment Alternative*s: Select the alternative having the greatest equivalent worth.

   Note: If all equivalent worths are < 0 for investment alternatives, then "do nothing" is the best alternative.

3. *Cost Alternative*s: Select the alternative having the smallest equivalent cost (the one that is least negative).

All three equivalent worth methods (PW, AW, FW) will identify the same "best" alternative.

Example – Problem 5-1a (p 232)

Investment Alternatives; Study Period = Useful Life

	I	II	III	IV
Investment cost (I)	$100,000	$152,000	$184,000	$220,000
Net annual receipts (A)	15,200	31,900	35,900	41,500
Salvage value (SV)	10,000	0	15,000	20,000
Useful life	10	10	10	10

If the MARR is 12%, use the PW method to select the best alternative.

5.6502 0.3220

PW(12%) = -I + A(P|A, 12%, 10) + SV(P|F, 12%, 10)

Problem 5-1a Solution

$PW_{DN}(12\%) = 0$

$PW_{I}(12\%) =$ -10,897

$PW_{II}(12\%) =$ +28.241

$PW_{III}(12\%) =$ +23,672

$PW_{IV}(12\%) =$ +20,923

Select Alternative ___ to maximize PW.

Example – Problem 5-12a (p. 234)

Cost Alternatives; Study Period = Useful Life

	A	B	C
Initial cost (I)	-$85,600	-$63,200	-$71,800
Annual expenses, years 1-7 (AC)	-7,400	-12,100	-10,050

MARR = 12%

Use the AW method to choose the best alternative.

$$AW = I(A|P, 12\%, 7) + AC$$

(0.2191)

Example – Problem 5-12a Continued

AW_A = -$85,600(A|P, 12%, 7) - $7,400 = -26,155

AW_B = = -25,947

AW_C = = -25,781

Assuming one must be chosen (i.e., DN is not an option), select alternative C to minimize annual equiv. costs.

Section 5.4.2 Comparing MEAs - using the IRR method

Why not select the investment opportunity that maximizes IRR?
Consider 2 alternatives.

	A	B	B-A(Δ)
Investment	-$100	-$10,000	-$9,900
Lump-Sum Receipt Next Year	$1,000	$15,000	$14,000
IRR	900%	50%	41.4%

If MARR = 20%, would you rather have A or B if comparable risk is involved?

Comparing MEAs - using the IRR method cont'd.

If MARR = 20%, PW_A = \$733 and PW_B = \$2,500.

* Never simply maximize the IRR.
* Never compare the IRR to anything except the MARR.

$IRR_{A \rightarrow B}$: $PW_{A \rightarrow B} = 0 = -9{,}900 + 14{,}000(P|F, i'\%, 1)$

$$9{,}900/14{,}000 = (P|F, i'\%, 1)$$

$$i' = 41.4\% > \text{MARR}$$

Section 5.4.2.1 Ranking Inconsistency with the IRR Method (Refer to page 200)

IRR_A: 0 = -\$60,000 + \$22,000(P/A, i_A'%, 4)i_A' = 17.3%

IRR_B: 0 = -\$73,000 + \$26,225(P/A, i_B'%, 4)i_B' = 16.3%

> NEVER simply select the MEA that MAXIMIZES the IRR. We don't maximize rate of return. Look at the increment.

$IRR_{A\rightarrow B}$: 0 = -\$13,000 + \$4,225(P/A, $i_{A\rightarrow B}$',4) $i_{A\rightarrow B}$' = 11.4%

The rate of return on the increment, 11.4%, >MARR. It is worth the additional investment to select Alternative B.

Section 5.4.2 Example – Problem 5-2 on page 232

Given three MEAs and MARR = 15% per year

	1	2	3
Investment (FC)	-28,000	-16,000	-23,500
Net Cash Flow/year	5,500	3,300	4,800
Salvage Value	1,500	0	500
Useful Life	10 yrs	10 yrs	10 yrs
Study Period	10 yrs	10 yrs	10 yrs

Use the Incremental IRR procedure to choose the best alternative.

Example 5-2 Continued

Step 1. DN→2→3→1 (rank order alternatives from low capital investment to high capital investment)

Step 2. Compare DN→2

	(2 - DN) Δ cash flows	
Δ Investment	-16,000 - 0 =	-$16,000
Δ Annual Receipts	3,300 - 0 =	3,300
Δ Salvage Value	0 - 0 =	0

Compute $\Delta IRR_{DN\rightarrow 2}$

$PW(\Delta i') = 0 = -\$16{,}000 + \$3{,}300(P|A, \Delta i'\%, 10)$

$i'_{DN\rightarrow 2} \approx 15.9\%$

Step 3. Since Di' > MARR, keep alt. 2 (higher FC) as current best alternative. Drop DN from further consideration.

Example 5-2 Continued

Step 4. Compare 2→3

	(3 – 2) Δ cash flows	
Δ Investment	-23,500 – (-16,000) =	-$7,500
Δ Annual Receipts	4,800 – 3,300 =	1,500
Δ Salvage Value	500 - 0 =	500

Compute $\Delta IRR_{2\rightarrow3}$

$$PW(\Delta i') = 0 = -\$7,500 + \$1,500(P|A, \Delta i'\%, 10) + \$500(P|F, \Delta i'\%, 10)$$

$$i'_{2\rightarrow3} \approx 15.5\%$$

Since Δi' > MARR, keep alt. 3 (higher FC) as current best alternative. Drop alt. 2 from further consideration.

Example 5-2 Continued

Next comparison: 3→1

	(1 – 3) Δ cash flows	
Δ Investment	-28,000 – (-23,500) =	-$4,500
Δ Annual Receipts	5,500 – 4,800 =	700
Δ Salvage Value	1,500 – 500 =	1,000

Compute $\Delta IRR_{3\rightarrow1}$

$PW(\Delta i') = 0$

$= -\$4{,}500 + \$700(P|A, \Delta i'\%, 10) + \$1{,}000(P|F, \Delta i'\%, 10)$

$\Delta i'_{3\rightarrow1} \approx 10.9\%$

Since Δi' < MARR, keep alt. 3 (lower FC) as current best alternative. Drop alt. 1 from further consideration.

Step 5. All alternatives have been considered.

Recommend alternative 3 for investment.

Problem 5-12 Revisited with the IRR (incremental) method

Cost Alternatives; Study Period =Useful Life =7 years, MARR =12%

	A	B	C
Investment cost	-$85,600	-$63,200	-$71,800
Annual costs (years 1-7)	-7,400	-12,100	-10,050
Salvage Value	0	0	0

Cost Only Procedure

Step 1: B $\rightarrow$ C $\rightarrow$ A

Step 2: Compare B $\rightarrow$C

	(C - B) Δ cash flows	
Δ Investment	-71,800 - (-63,200) =	-8,600
Δ Annual Costs	-10,050 - (-12,100) =	2,050

Compute $\Delta IRR_{B \rightarrow C}$

$$AW(\Delta i') = 0 = -\$8,600(A|P, \Delta i'\%, 7) + \$2,050$$

Problem 5-12, Comparing B ® C Continued

AW(12%) = +166 > 0; therefore, Δi' B→C > MARR

(*Di' B ® C ≈ 14.7%)*

Step 3: Keep C, Reject B

Step 4: Next comparison: C → A

	(A - C) Δ cash flows	
Δ Investment	-85,600 -(-71,800) =	-13,800
Δ Annual Costs	-7,400 -(-10,050) =	2,650

Compute $\Delta IRR_{C\rightarrow A}$: AW(Δi') =0 = -13,800(A|P, Δi'%, 7) + 2650

AW(12%) = -374 < 0; therefore, $\Delta i'_{C\rightarrow A}$ < MARR

(*Di'$_{C ® A}$ ≈ 8%)*

Reject A, Keep C.

Step 5. All alternatives have been considered. Recommend alternative C to minimize total equivalent cost to the consumer.

Example – Problem 5-1 Revisited with the IRR method

Investment Alternatives, MARR = 12%, Study Period = Useful Life = 10 years

	I	II	III	IV
Investment cost (I)	-$100,000	-$152,000	-$184,000	-$220,000
Net annual receipts (A)	15,200	31,900	35,900	41,500
Salvage value (SV)	10,000	0	15,000	20,000

1. DN $\rightarrow$ I $\rightarrow$ II $\rightarrow$ III $\rightarrow$ IV

2. Compare DN $\rightarrow$ I

	(I - DN) Δ cash flows	
Δ Investment	-100,000 - 0 =	-100,000
Δ Annual Receipts	15,200 - 0 =	15,200
Δ Salvage Value	10,000 - 0 =	10,000

Compute $\Delta IRR_{DN \rightarrow I}$

$PW(\Delta i') = 0$

$= -100{,}000 + 15{,}200(P|A, \Delta i'\%, 10) + 10{,}000(P|F, \Delta i'\%, 10)$

$\Delta i'_{DN \rightarrow I} \approx 9.4\% < MARR$

Problem 5-1 Revisited Continued

Step 3. Since $\Delta i' < MARR$, keep DN (lower FC) as current best alternative. Drop I from further consideration.

Step 4. Next comparison: DN $\rightarrow$ II

	(II - DN) Δ cash flows	
Δ I	-152,000 - 0 =	-152,000
Δ AR	31,900 - 0 =	31,900
Δ SV	0 - 0 =	0

Compute $\Delta IRR_{DN \rightarrow II}$

$$PW(\Delta i') = 0 = -\$152{,}000 + \$31{,}900(P|A, \Delta i'\%, 10)$$

$$\Delta i'_{DN \rightarrow II} \approx 16.4\% > MARR$$

Keep Alternative II, Drop DN

Problem 5-1 Revisited Continued

Step 4. Next comparison: II $\rightarrow$ III

	(III - II) Δ cash flows	
Δ I	-184,000 - (-152,000) =	-32,000
Δ AR	35,900 - 31,900 =	4,000
Δ SV	15,000 - 0 =	15,000

$PW(\Delta i') = 0$

$= -\$32,000 + \$4,000(P|A, \Delta i'\%, 10) + \$15,000(P|F, \Delta i'\%, 10)$

$\Delta i'_{II \rightarrow III} \approx 9\% < MARR$

Keep Alternative II, Drop III from further consideration

Problem 5-1 Revisited Continued

Step 4. Next comparison: II $\rightarrow$ IV

	(IV – II) Δ cash flows	
Δ I	-220,000 - (-152,000) =	-$68,000
Δ AR	41,500 - 31,900 =	9,600
Δ SV	20,000 - 0 =	20,000

$PW(\Delta i') = 0$

$= -68{,}000 + 9{,}600(P|A, \Delta i'\%, 10) + 20{,}000(P|F, \Delta i'\%, 10)$

$\Delta i'_{II \rightarrow IV} \approx 9.6\% < MARR$

Keep Alternative II, Drop IV from further consideration

5. All have been considered. Select II as preferred alternative.