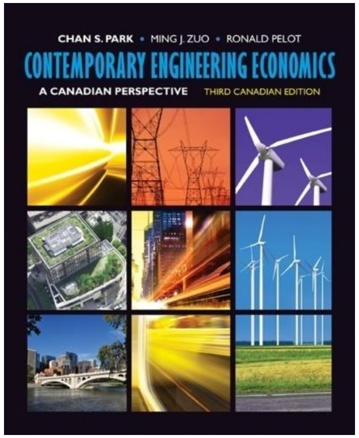
Total-Investment Approach & Incremental Investment Analysis



Lecture No. 17
Chapter 6
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Lecture 17 Objectives

- How do firms compare alternatives using a total investment approach and incremental analysis?

Example 6.1: Present-Worth Comparison: Three Alternatives

- Bullard Company (BC) is considering expanding its range of industrial machinery. Several combinations of new equipment and labour could serve to fulfill this new function:
  1. (**M1**) New machining centre with three operators
  2. (**M2**) New machining centre with automatic pallet changer and with three operators
  3. (**M3**) New machining centre with automatic pallet changer and with two task-sharing operators
- BC has a MARR = 12%. The estimated costs and additional revenues are as follows:

Example 6.1: Present-Worth Comparison: Three Alternatives (continued)

	Machining Centre Methods		
	M1	M2	M3
Investment:			
Machine tool purchase	$121,000	$121,000	$121,000
Automatic pallet changer		$ 66,600	$ 66,600
Installation	$ 30,000	$ 42,000	$ 42,000
Tooling expense	$ 58,000	$ 65,000	$ 65,000
Total investment	$209,000	$294,600	$294,600
Annual benefits: Year 1			
Additional revenues	$ 55,000	$ 69,300	$ 36,000
Direct labour savings			$ 17,300
Setup savings		$ 4,700	$ 4,700
Year 1: Net revenues	$ 55,000	$ 74,000	$ 58,000
Years 2–5: Net revenues	constant	constant	g = 13%/year
Salvage value in year 5	$ 80,000	$120,000	$120,000

– 1 person

– Geometrical series

Example 6.1: Present-Worth Comparison: Three Alternatives (continued)

n	M1	M2	M3
0	-$209,000	-$294,600	-$294,600
1	55,000	74,000	58,000
2	55,000	74,000	64,540
3	55,000	74,000	74,060
4	55,000	74,000	83,688
5	135,000	194,000	214,567

Investments

g = 13%

Salvage + Revenue

Example 6.1: Solution

- **Option M1**

$$PW(12\%)_{M1} = -\$209{,}000 + \underbrace{\$55{,}000(P/A,12\%,5) + \$80{,}000(P/F,12\%,5)}_{\text{Equal series}}$$
$$= \$34{,}657$$

- **Option M2**

$$PW(12\%)_{M2} = -\$294{,}600 + \$74{,}000(P/A,12\%,5) + \$120{,}000(P/F,12\%,5)$$
$$= \$40{,}245$$

- **Option M3**

$$PW(12\%)_{M3} = -\$294{,}600 + \$58{,}000(P/A_1,13\%,12\%,5)$$
$$+\$120{,}000(P/F,12\%,5)$$
$$= \$37{,}085$$

g=13%
geometric series

Example 6.2: Annual Equivalent Comparison: Three Alternatives

- **Option M1**

$$AE(12\%)_{M1} = -\$209{,}000(A/P,12\%,5) + \$55{,}000 + \$80{,}000(A/F,12\%,5)$$
$$= \$9614$$

- **Option M2**

$$AE(12\%)_{M2} = -\$294{,}600(A/P,12\%,5) + \$74{,}000 + \$120{,}000(A/F,12\%,5)$$
$$= \$11{,}164$$

- **Option M3**

$$\begin{aligned} AE(12\%)_{M3} &= -\$294{,}600(A/P,12\%,5) \\ &\quad +\$58{,}000(P/A_1,13\%,12\%,5)(A/P,12\%,5) \\ &\quad +\$120{,}000(A/F,12\%,5) \\ &= \$10{,}288 \end{aligned}$$

Decision Rules Using the Total Investment Approach:

- Select Project A if any one of the following conditions is met:

  $PE_A > PE_B$, $AE_A > AE_B$, $FE_A > FE_B$

  That is, select the project with the largest PE, AE or FE value, when there are more than 2 projects.

- Important: Don't make decision based on direct comparison of IRR_A and IRR_B ← check Sign changes in Net Cash flow

Flaws in Project Ranking by IRR

- Issue: Can we rank the mutually exclusive projects by the magnitude of its IRR?

n	A1		A2
0	-$1,000		-$5,000
1	$2,000		$7,000
IRR	100%	>	40%
PW (10%)	$818	<	$1,364

Tool

Is relative to investment amount

(less attractive)

Decision making

Absolute returns

Incremental Investment Analysis

n	Project A1	Project A2	Incremental Investment (A2 – A1)
0	-$1,000	-$5,000	-$4,000
1	$2,000	$7,000	$5,000
IRR	100% > MARR	40% > MARR	25% > MARR
PW(10%)	$818	$1,364	$546

- Assuming a MARR of 10%, you can always earn that rate from other investment source, i.e., $4,400 at the end of one year for $4,000 investment.

$400 is the interest

- By investing the additional $4,000 in A2, you would make an additional $5,000, which is equivalent to earning at the rate of 25%. Therefore, the incremental investment in A2 is justified.

> 10% (MARR)

Incremental Investment Analysis

A B

Smaller bigger

- For two mutually exclusive projects, rate-of-return analysis is done by computing the internal rate of return on the incremental investment *(IRR∆)*. Always subtract the lower cost investment from the highest cost one.

MARR

- Decision Rule:
  - If IRR_{B-A} > MARR, select B.
  - If IRR_{B-A} = MARR, select either project.
  - If IRR_{B-A} < MARR, select A.

IRR(A) > MARR

- If a "do-nothing" alternative is allowed, each alternative's IRR must be greater than MARR.

IRR A > MARR
IRR B > MARR

check

commercial interest only

Incremental Investment Analysis

- Incremental analysis may also be used for PW, FW, and AE analyses.
- Decision Rules:

accept bigger option

Accept smaller option

	> 0	= 0	< 0
PW_{B-A} (MARR)	select B	select either one	select A
AW_{B-A} (MARR)	select B	select either one	select A
FW_{B-A} (MARR)	select B	select either one	select A

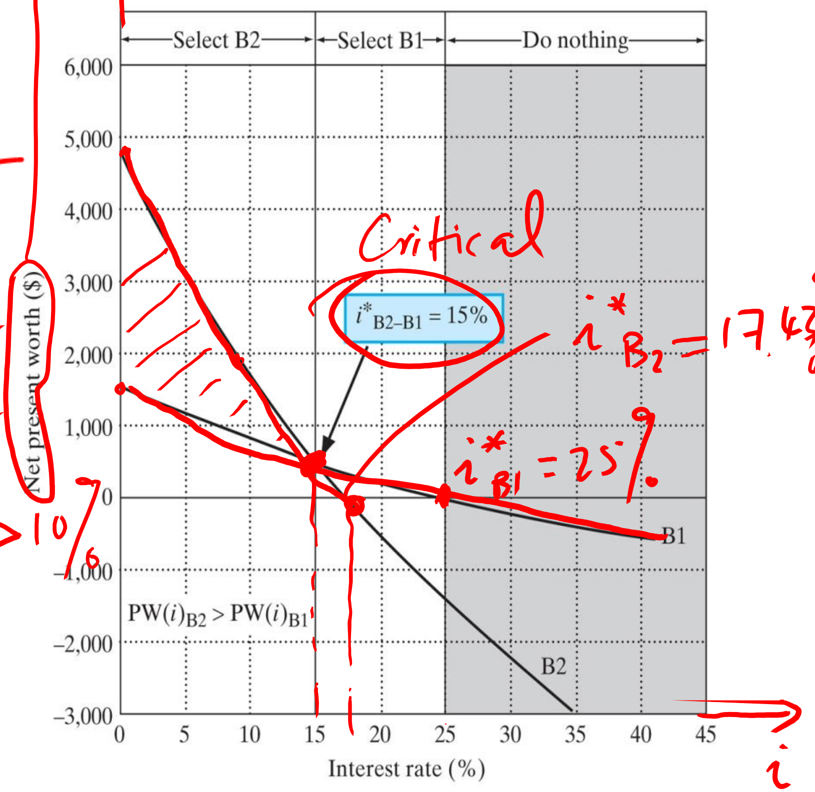
Consistent

No justification

Example 6.3: IRR on Incremental Investment: Two Alternatives

Incremental

n	B1	B2 Bigger	B2 - B1
0	-\$3,000	-\$12,000	-\$9,000
1	1,350	4,200	2,850
2	1,800	6,225	4,425
3	1,500	6,330	4,830
IRR	25.00%	17.43%	15.00% > 10%
PW	\$841	\$1718	\$877
AE	\$338	\$691	\$353
FW	\$1120	\$2287	\$1167



Given MARR = 10%, which project is a better choice?

Since IRR_{B2-B1}=15% > 10%, and also IRR_{B2} > 10%, select B2.

Example 6.4: IRR on Incremental Investment: Three Alternatives

n	M1	M2	M3
0	-$209,000	-$294,600	-$294,600
1	55,000	74,000	58,000
2	55,000	74,000	64,540
3	55,000	74,000	74,060
4	55,000	74,000	83,688
5	135,000	194,000	214,567
IRR =	17.62%	16.60%	15.99%

g=13%

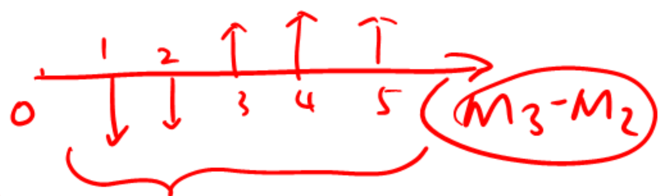
>MARR? >12% >12% >12%

Example 6.4: IRR on Incremental Investment: Three Alternatives (continued)

- Step 1: Examine the IRR for each alternative. When "do nothing" is an option, we can eliminate any project that fails to meet the MARR. In this example all three alternatives exceed the MARR of 12%.

- Step 2: Compare M1 and M2 in pairs.
  - IRR_{M2-M1}=14.61% > 12%, MARR
  - so select M2. M2 becomes the current best.

- Step 3: Compare M3 and M2.
  - IRR_{M3-M2}= 6.66% < 12%, MAR
  - so select M2 again.



- Here, we conclude that M2 is the best alternative.

Example 6.5:

cell A cell B

Falk Corporation is considering two types of manufacturing systems to produce its shaft couplings over six years:

(1) a cellular manufacturing system (CMS) and

(2) a flexible manufacturing system (FMS). – Computerization ↑
– Control software ↑

The average number of pieces to be produced with either system would be 544,000 per year. The operating cost, initial investment, and salvage value for each alternative are given on the following page.

The firm's MARR is 15%. On the basis of the IRR criterion, which alternative would be a better choice?

Example 6.5: Incremental Analysis for Cost-Only Projects

Items	CMS Option	FMS Option
Annual O&M costs:		
Annual labour cost	Higher $1,169,600	$707,200
Annual material cost	832,320	598,400
Annual overhead cost	3,150,000	1,950,000
Annual tooling cost	470,000	300,000
Annual inventory cost	141,000	31,500
Annual income taxes	1,650,000	1,917,000
Total annual costs (AEC)	$7,412,920	$5,504,100
Investment (P)	$4,500,000	$12,500,000
Net salvage value (S)	$500,000	$1,000,000

Example 6.5: Incremental Cash Flow (FMS – CMS)

Net Cash flows

n	CMS Option	FMS Option	Incremental (FMS-CMS)
0	-$4,500,000	-$12,500,000	-$8,000,000
1	-7,412,920	-5,504,100	1,908,820
2	-7,412,920	-5,504,100	1,908,820
3	-7,412,920	-5,504,100	1,908,820
4	-7,412,920	-5,504,100	1,908,820
5	-7,412,920	-5,504,100	1,908,820
6	-7,412,920	-5,504,100	$2,408,820
Salvage	+ **$500,000**	+ **$1,000,000**	

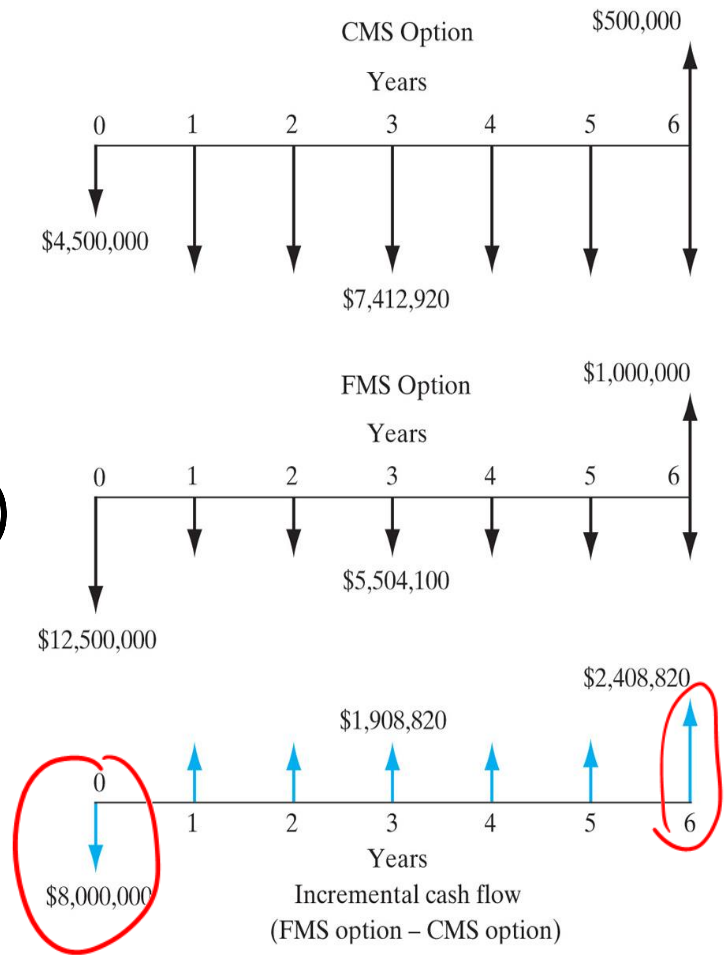
There is no "Do Nothing". IRR_{CMS} or IRR_{FMS} is not checked

Example 6.5: Solution

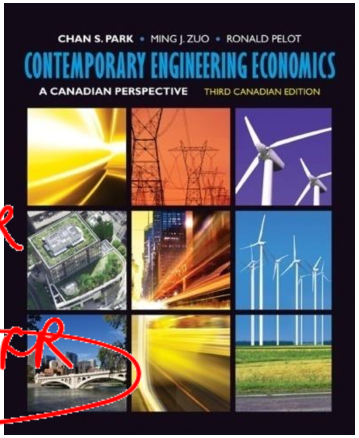
$$PW(i)_{FMS-CMS} = -\$8{,}000{,}000 + \$1{,}908{,}820(P/A,i,5) + \$2{,}408{,}820(P/F,i,6) = 0$$

$$IRR_{FMS-CMS} = 12.43\% < 15\%,$$

select CMS.



Summary



Absolute Amount

PW
AEW
FW

IRR — MARR

IRRΔ - MARR

In total investment analysis, the PW of each mutually exclusive alternative is calculated separately, and the best choice is the one with the highest PW. In incremental investment analysis, the differences in cash flows between pairs of mutually exclusive alternatives are used as the basis for analysis.