Chapter 7 Rate of Return Analysis

Note: Symbol convention---The symbol *i** represents the breakeven interest rate that makes the PW of the project equal to zero. The symbol IRR represents the internal rate of return of the investment. For a simple (or pure) investment, IRR = *i**. For a nonsimple investment, generally *i** is not equal to IRR.

7.1)

$$\$2529.24 = \$1000(F/P, i\%, 5) + \$1,000(F/P, i\%, 3)$$
$$i^* = 6\%$$

7.2)

$$\$22,000 = \$547.47(P/A, i, 48)$$
$$i = 0.75\% \text{ per month}$$
$$r = 0.75\% \times 12 = 9\%$$
$$i_a = (1 + 0.0075)^{12} - 1 = 9.38\% \text{ per year}$$

7.3)

$$\$900 = \$37.5(P/A, 4.5\%, 8) + F(P/F, 4.5\%, 8)$$
$$0.7032F = \$652.6538$$
$$F = \$928.12$$

7.4)

$$\$53,900,000 = \$80,000(F/P, i, 40)$$
$$i = 17.68\%$$

7.5)

(a) Simple investment: Project A, D.
Project C (Simple borrowing)

(b) Non-simple investment: Project B

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(c)

- Project A:

$$\begin{aligned}\text{PW}(i) &= -\$22,000 + \$10,000(P/A, i, 3) \\ &\quad +\$10,000(P/G, i, 3) \\ &= 0 \\ i^* &= 57.81\%\end{aligned}$$

- Project B:

$$\begin{aligned}\text{PW}(i) &= -\$23,000 + \$32,000(P/A, i, 2) \\ &\quad -\$25,000(P/F, i, 3) \\ &= 0 \\ i^* &= 82.72\%\end{aligned}$$

- Project C:

$$\begin{aligned}\text{PW}(i) &= \$43,233 - \$18,000(P/A, i, 3) \\ &= 0 \\ i^* &= 12\% \quad \text{Borrowing rate of return.}\end{aligned}$$

- Project D:

$$\begin{aligned}\text{PW}(i) &= -\$56,500 - \$2,500(P/F, i, 1) - \$6,459(P/F, i, 2) \\ &\quad +\$88,345(P/F, i, 3) \\ &= 0 \\ i^* &= 11.37\%\end{aligned}$$

(d) The answer could project C on the grounds that that it is not in investment but a loan.

7.6)

$$\begin{aligned}\text{PW}(10\%) &= -\$1,500 + X(P/F, 10\%, 1) + \$650(P/F, 10\%, 2) \\ &\quad + X(P/F, 10\%, 3) \\ &= 0 \\ 1.6604X &= \$962.84 \\ X &= \$580\end{aligned}$$

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7.7)

$$
\begin{aligned}
\text{PW}(23\%) &= -\$12,000 + \$2,500(P/F,23\%,1) + \$5,500(P/F,23\%,2) \\
&\quad + X(P/A,23\%,2)(P/F,23\%,2) \\
&= 0 \\
\$6,332 &= 0.9743X \\
X &= \$6,498.93
\end{aligned}
$$

7.8)

Use Excel or Cash Flow Analyzer to find the rate of return:

$$
\begin{aligned}
\text{PW}(i) &= -\$1,000 \\
&\quad + [\$50(F/A,i,12) + \$50(F/A,i,5) + \$4,000](P/F,i,15) \\
&= 0
\end{aligned}
$$

Solving for i yields

$$i^* = 12.08\%$$

7.9)

(a) Classification of investment projects:

- Simple projects: A, B, and E
- Non-simple projects: C and D

(b)

$$-\$150 + \$60/(1+i) + \$900/(1+i)^2 = 0$$

Let $X = 1/(1+i)$. Then,

$$-\$150 + \$60X + \$900X^2 = 0$$

$$X = \frac{-60 \pm \sqrt{60^2 - 4(900)(-150)}}{2(900)}$$

Solving for X yields

$$X_1 = 0.37627 \text{ and } X_2 = -0.44294$$

Solving for i yields only one positive rate of return

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$$i^*_1 = 165.78\%$$

(c) Find i^* by plotting the NPW as a function of interest rate:

Project	Number of i^*
A	165.78%
B	9.67%
C	2.30%
D	12.45%
E	19.43%

7.10) Classification of investment projects

(a)

- Simple projects: A, B and D
- Nonsimple projects: C

(b)

- Project A: $i^* = 4.41\%$
- Project B: $i^* = 42.46\%$
- Project C: $i^* = 230.42\%$
- Project D: $i^* = 57.46\%$

(c) Use the PW plot command provided in Cash Flow Analyzer, or you may use the Excel's Chart Wizard.

7.11)

(a)

$$-\$15,000 + (\$9,229 - \$3,000)(P/A, i, 8) = 0$$

Solving for i yields $i^* = 38.45\%$

(b) With the geometric expense series

$$-\$15,000 + \$9,229(P/A, i, 8) - \$3,000(P/A_1, 7\%, i, 8) = 0$$

Solving for i^* yields $i^* = 34.79\%$

7.12)

(a) Rate of return calculation:

- Project A: $i^* = 25.66\%$
- Project B: $i^* = 57.91\%$

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(b)

$$\text{PW}(i\%)_A = -\$30,000 + \$2,000(P/F, i\%, 1) + \$6,000(P/F, i\%, 2) + \cdots\cdots + \$28,000(P/F, i\%, 5)$$

$$\text{PW}(i\%)_B = -\$15,000 + \$10,000(P/A, i\%, 4) + \$5,000(P/F, i\%, 5)$$

$$\text{PW}(i\%)_A = \text{PW}(i\%)_B$$

$$i^* = 9.75\%$$

7.13)

$$\text{PW}(15\%) = -\$150,000 + \$120,000(P/A, 15\%, 5) + \$25,000(P/F, 15\%, 5) = \$264,694$$

7.14)

$$-\$5,000 + \$4,840(P/F, i, 2) + \$1,331(P/F, i, 3) = 0$$

Solving for i^* yields

$$i^* = 10\%$$

Since this is a simple investment, $\text{IRR} = i^*$. Since IRR = MARR, this project breaks even.

7.15)

(a) Since $i^* = 10\%$ and $\text{PW}(10\%) = 0$, we have

$$\text{PW}(10\%) = -\$2,000 + \$800(P/F, 10\%, 1) + \$900(P/F, 10\%, 2) + X(P/F, 10\%, 3) = 0$$

Solving for X yields

$$X = \$704$$

(b) Since $\text{IRR} > 8\%$, the project is acceptable.

7.16)

$$\text{PW}(15\%) = -\$12,500,000 - \$250,000(P/A, 15\%, 5) - \$50,000(P/G, 15\%, 5) + \$14,000,000(P/F, 15\%, 5) - \$80,000(P/A, 15\%, 5) + A(P/A, 15\%, 5) = 0$$

$$A = \$2,068,546$$

$$A/50 = \$41,371 \text{ per unit}$$

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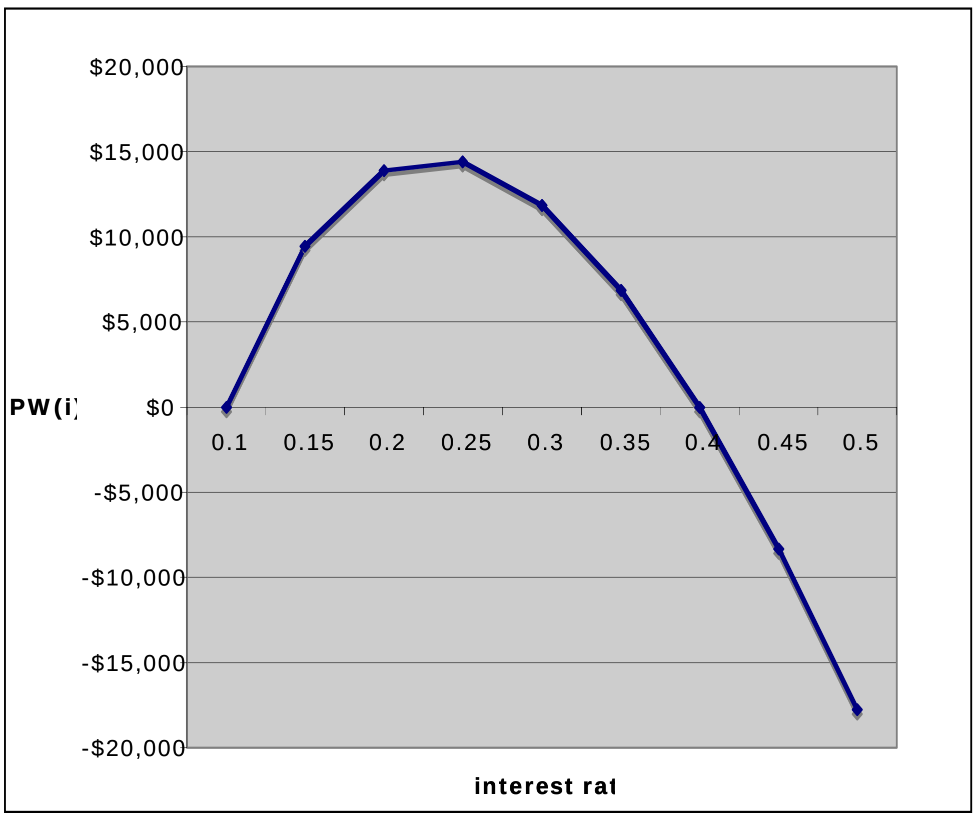
7.17)

$$\begin{aligned}\text{PW}(10\%) &= -\$25,000 - (\$3,000 - A)(P/A, 10\%, 6) + \$5,000(P/F, 10\%, 6)\\ &= -\$25,000 + 4.3553A - \$13,065.9 + \$2822.37 = 0\end{aligned}$$

$$A = \$8,092.15$$

7.18)

(a)



(b) $i^*_1 = 10\%$ and $i^*_2 = 40\%$

(c)

$$\begin{aligned}\text{PW}(14\%) &= -\$1,000,000 + \$2,500,000(P/F, 14\%, 1)\\ &\quad -\$1,540,000(P/F, 14\%, 2)\\ &= \$8,000 > 0 \text{ (Accept the investment.)}\end{aligned}$$

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7.19)

Net cash flow (unit: million $):

n	Land	Bldg.	Equip.	Revenue	Expenses	Net Cash Flow
0	-$1.5	-$3				-$4.50000
1			-$4			-$4.00000
2				$3.50000	-$1.4000	$2.10000
3				$3.67500	-$1.4700	$2.20500
4				$3.85875	-$1.5435	$2.31525
5				$4.05169	-$1.6207	$2.43101
⋮	⋮	⋮	⋮	⋮	⋮	⋮
11				$5.42965	-$2.1719	$3.25779
12				$5.42965	-$2.1719	$3.25779
13				$5.42965	-$2.1719	$3.25779
14	$2	$1.4	$0.5	$5.42965	-$2.1719	$7.15779

Rate of return calculation:

$$\begin{aligned}\text{PW}(i) &= -\$4.5 - \$4(P/F,i,1) + \$2.1(P/A_1,5\%,i,10)(P/F,i,1) \\ &\quad + \$3.25779(P/A,i,2)(P/F,i,11) + \$7.15779(P/F,i,14) \\ &= 0\end{aligned}$$

Solving for i yields

$$i^* = 24.85\%$$

Since this is a simple investment, $\text{IRR} = i^* = 24.85\%.$ At a MARR of 15%, the project is economically attractive.

7.20)

(a)

$$\begin{aligned}\text{PW}(i) &= -\$20 + \$8(P/F,i,1) + \$17(P/F,i,2) + \$19(P/F,i,3) \\ &\quad + \$18(P/F,i,4) + \$10(P/F,i,5) + \$3(P/F,i,6) \\ &= 0\end{aligned}$$

This is a simple investment. Therefore, $\text{IRR} = i^* = 60.52\%.$ Since $\text{IRR} > 18\%,$ the project is a acceptable.

(b) $\text{IRR} = 67.03\%$

(c) $\text{IRR} = 48.06\%$

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7.21)

$$PW(20\%) = -C + \$50,000(P/A, 20\%, 10) + 0.1C(P/F, 20\%, 10)$$
$$= 0$$
$$0.98385C = \$209,625$$

$$C = \$213,066.02$$

7.22)

- Fidelity rate of return:
$$\$5,245(1+i)^{22} = \$289,556$$
$$i = 20\%$$
- After 10 years, Wal-Mart investment grows to:

$$\$1,650(1.32)^{10} = \$26,499$$
- Reinvest in Fidelity:

$$\$26,499(1.20)^{22} = \$1,462,854$$
- Select (c)

7.23)

(a) Project A: IRR = 6.37%
Project B: IRR = 9.18%

(b) Neither project is acceptable
(c)

n	Project A	Project B	A-B
0	-$150,000.00	-$120,000.00	-$30,000.00
1	$30,000.00	$25,000.00	$5,000.00
2	$25,000.00	$15,000.00	$10,000.00
3	$120,000.00	$110,000.00	$10,000.00

Neither project. Since $\text{IRR}_{\text{A-B}} = -7.87\% < 15\%$ (MARR), project B is better choice if there is no "do-nothing" alternative.

7.24)

(a) Project A: IRR = 18.33%
Project B: IRR = 23.77%
(b) Both projects are acceptable

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(c)

n	Project A	Project B	A-B
0	-$100,000.00	-$100,000.00	$0.00
1	$10,500.00	$70,000.00	-$59,500.00
2	$60,000.00	$50,000.00	$10,000.00
3	$80,000.00	$20,500.00	$59,500.00

$\text{IRR}_{\text{A-B}} = 8.76\% < 10\%(MARR)$ Project B is better choice.

7.25)

Option 1: Buy a certificate,
Option 2: Purchase a bond, and assume that $\text{MARR} = 9\%$

Net Cash Flow			
n	Option 1	Option 2	Option 1 – Option 2
0	-$10,000	-$10,000	0
1	0	1,000	-1,000
2	0	1,000	-1,000
3	0	1,000	-1,000
4	0	1,000	-1,000
5	16,105	11,000	5,105

The rate of return on incremental investment is

$$i^*_{1-2} = 10\% > 9\%$$

Thus, Option 1 is a better choice.

7.26)

n	Project 1	Project 2	1-2
0	-$2,200.00	-$2,000.00	-$200.00
1	$1,200.00	$1,200.00	$0.00
2	$1,650.00	$1,400.00	$250.00

$\text{IRR}_{\text{1-2}} = 11.8\% < MARR$ and $\text{IRR}_2 = 18.88\% > MARR$, thus select (c).

7.27)

Determine the cash flow on incremental investment:

Net Cash Flow			
n	Project A	Project B	B - A
0	-$2,000	-$3,000	-$1,000
1	$1,400	$2,400	$1,000
2	$1,640	$2,000	$360

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$$i^*_{B-A} = 28.11\% > 15\%$$

Select project B.

7.28)

(a) IRR on the incremental investment:

Net Cash Flow			
n	Project A1	Project A2	A2 – A1
0	-$10,000	-$12,000	-$2,000
1	$5,000	$6,100	$1,100
2	$5,000	$6,100	$1,100
3	$5,000	$6,100	$1,100

$$i^*_{A2-A1} = 29.92\%$$

(b) Since it is an incremental simple investment, $\text{IRR}_{\text{A2-A1}} = 29.92\% > 10\%$.
Therefore, select project A2.

7.29)

(a)

n	A1	A2	A2 – A1
0	-$16,000	-$20,000	-$4,000
1	$7,500	$5,000	-$2,500
2	$7,500	$15,000	$7,500
3	$7,500	$8,000	$500

$$\text{IRR}_{A2-A1} = 13.08\%$$

(b) Select Project A2.

7.30) Incremental cash flows (Model A – Model B):

n	A – B
0	-$2,376
1	$0
2	$0
3	$0
4	$2,500

$$\text{IRR}_{A-B} = 1.28\%$$

If $\text{MARR} < 1.28\%$, Model A is preferred.

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7.31) Given: IRR for Model A: 10.49%, IRR for Model B: 12.34%;
Incremental cash flows:

n	B – A
0	-$2,000
1-19	$350
20	$450

$$\text{IRR}_{B-A} = 16.75\%$$

Model B is a better choice.

7.32) Let $\text{A0} = \text{current practice}, \text{A1} = \text{just-in-time system}, \text{A2} = \text{stock less supply system}.$

- Comparison between A0 and A1:

n	A0	A1	A1 – A0
0	0	-$2,500,000	-$2,500,000
1-8	-$5,000,000	-$2,900,000	$2,100,000

$$i^*_{A1-A0} = \text{IRR}_{A1-A0} = 83.34\% > 10\%$$

A1 is a better choice.

- Comparison between A1 and A2:

n	A2	A1	A2 – A1
0	-$5,000,000	-$2,500,000	-$2,500,000
1-8	-$1,400,000	-$2,900,000	$1,500,000

$$i^*_{A2-A1} = \text{IRR}_{A2-A1} = 58.49\% > 10\%$$

A2 is a better choice. That means that the stockless supply system is the final choice.

7.33)

(a)

$$i_1^* = 85.08\%,\ i_2^* = 57.61\%, \text{ and } i_3^* = 44.30\%$$

(b)

- Project 1 versus Project 2:

n	Project 2 – Project 1
0	-$4,000
1	$7,000
2	-$1,900

This is a non-simple incremental investment. So, we may abandon the IRR

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analysis and select the project based on the PW decision rule.

$$PW(15\%)_{2-1} = \$650$$

Select Project 2.

- Project 2 versus Project 3:

n	Project 2 – Project 3
0	-$3,000
1	$6,000
2	-$1,400

This is another non simple incremental investment, so we may use again the PW decision rule.

$$PW(15\%)_{2-3} = \$1,158$$

Again, select Project 2.

Comments: If you want to apply the IRR decision rule to the non-simple investments, you should apply the net investment test and make the selection by calculating the return on invested capital (or true internal rate of return) as discussed in Chapter 7A.

7.34)

(a) $IRR_B = 25.99\%$

(b) $PW(15\%)_A = -\$10,000 + \$5,500(P/A, 15\%, 3) = \$2,558$

(c) Incremental analysis:

Net Cash Flow			
n	Project A	Project B	B – A
0	-$10,000	-$20,000	-$10,000
1	$5,500	0	-$5,500
2	$5,500	0	-$5,500
3	$5,500	$40,000	$34,500

Since $IRR_{B-A} = 24.24\% > 15\%$, select project B.

7.35) All projects would be acceptable because individual ROR exceed the MARR. Based on the incremental analysis, we observe the following relationships:

$IRR_{A2-A1} = 10\% < 15\%$ (Select A1)

$IRR_{A3-A1} = 18\% > 15\%$ (Select A3)

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$$\text{IRR}_{A3-A2} = 23\% > 15\% \quad \text{(Select A3)}$$

Therefore, A3 is the best alternative.

7.36) From the incremental rate of return table, we can deduce the following relationships:

$$\text{IRR}_{A2-A1} = 9\% < 15\% \quad \text{(Select A1)}$$
$$\text{IRR}_{A3-A2} = 42.8\% > 15\% \quad \text{(Select A3)}$$
$$\text{IRR}_{A4-A3} = 0\% < 15\% \quad \text{(Select A3)}$$
$$\text{IRR}_{A5-A4} = 20.2\% > 15\% \quad \text{(Select A5)}$$
$$\text{IRR}_{A6-A5} = 36.3\% > 15\% \quad \text{(Select A6)}$$

It is necessary to determine the preference relationship among A1, A3, and A6.

$$\text{IRR}_{A3-A1} = 16.66\% > 15\% \quad \text{(Select A3)}$$
$$\text{IRR}_{A6-A3} = 20.18\% > 15\% \quad \text{(Select A6)}$$
$$\text{IRR}_{A6-A1} = 18.24\% > 15\% \quad \text{(Select A6)}$$

A6 is the best alternative.

7.37)

Relationships:

IRR (D1-D2) = 27.62% > 15% (Select D1)

IRR (D1-D3) = 14.26% < 15% (Select D3)

IRR (D1-D4) = 25.24% > 15% (Select D1)

IRR (D3-D2) = 30.24% > 15% (Select D3)

IRR (D2-D4) = 17.34% > 15% (Select D2)

IRR (D3-D4) = 16.14% > 15% (Select D3)

D3 is the best alternative.

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7.38)

For each power saw model, we need to determine the incremental cash flows over the "by-hand" operation that will result over a 20-year service life.

Power Saw			
Category	Model A	Model B	Model C
Investment cost	$4,000	$6,000	$7,000
Salvage value	$400	$600	$700
Annual labor savings	$1,296	$1,725	$1,944
Annual power cost	$400	$420	$480
Net annual savings	$896	$1,305	$1,464

Net Cash Flow			
n	Model A	Model B	Model C
0	-$4,000	-$6,000	-$7,000
1	$896	$1,305	$1,464
2	$896	$1,305	$1,464
⋮	⋮	⋮	⋮
20	$400 + $896	$600 + $1,305	$700 + $1,464
IRR	22.03%	21.35%	20.46%
PW(10%)	$3,688	$5,199	$5,568

- Model A versus Model B:

$$PW(i)_{B-A} = -\$2,000 + \$409(P/A, i, 20) + \$200(P/F, i, 20)$$
$$= 0$$
$$\text{IRR}_{B-A} = 19.97\% > 10\%$$

Select Model B.

- Model B versus Model C:

$$PW(i)_{C-B} = -\$1,000 + \$159(P/A, i, 20) + \$100(P/F, i, 20)$$
$$= 0$$
$$\text{IRR}_{C-B} = 15.03\% > 10\%$$

Select Model C. The PW rule also selects Model C, as indicated in the table above.

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7.39) With the least common multiple of 6 project years,

Net Cash Flow			
n	Project A	Project B	B – A
0	-$100	-$200	-$100
1	$60	$120	$60
2	$50	$150-$200	-$100
3	$50-$100	$120	$170
4	$60	$150-$200	-$110
5	$50	$120	$70
6	$50	$150	$100

Since the incremental cash flow series is a nonsimple investment, we may abandon the IRR analysis, and use the PW decision rule.

$$\begin{aligned}\text{PW}(15\%)_{B-A} &= -\$100 + \$60(P/F,15\%,1) \\ &\quad + \cdots + \$100(P/F,15\%,6) \\ &= \$3.48\end{aligned}$$

Since $\text{PW}(15\%)_{B-A} > 0$, or $\text{PW}(15\%)_B > \text{PW}(15\%)_A$, select project B.

Comments: Even though the incremental flow is a nonsimple, it has a unique rate of return. As shown in Chapter 7A, this incremental cash flow will pass the net investment test, indicating that the incremental cash flow is a pure investment.

$$\text{IRR}_{B-A} = 15.98\% > 15\%$$

Select project B.

7.40)

(a) Since there is not much information given regarding the future replacement options and required service period, we may assume that the required service period is indefinite and both projects can be repeated at the same cost in the future.

(b) The analysis period may be chosen as the least common multiple of project lives, which is 3 years.

n	A2 – A1
0	-$5,000
1	$0
2	$0
3	$15,000

$$\text{IRR}_{A2-A1} = 44.22\%$$

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The MARR must be greater than 44.22% for Project A1 to be preferred.

7.41)

(a)

$$\begin{aligned} \text{PW}(i) &= -\$1,250,000 + \$731,500(P/A, i, 15) + \$80,000(P/F, i, 15) \\ &= 0 \\ i^* &= 58.47\% \end{aligned}$$

(c) IRR exceeds Marco's MARR, the project is attractive and should be accepted.

$$i^* = 58.47\% > \text{MARR} \ (=18\%)$$

7.42)

(a) Analysis period of 40 years (unit: thousand $):

- Without "mothballing" cost:

$$\begin{aligned} \text{PW}(i) &= -\$1,500,000 + (\$207,000 - \$69,000)(P/A_1, 0.05\%, i, 40) \\ &= 0 \\ i^* &= 8.95\% \end{aligned}$$

- With "mothballing" cost of $0.75 billion:

$$\begin{aligned} \text{PW}(i) &= -\$1,500,000 + (\$207,000 - \$69,000)(P/A_1, 0.05\%, i, 40) \\ &\quad - \$750,000(P/F, i, 40) \\ &= 0 \\ i^* &= 8.77\% \end{aligned}$$

For a 40-year analysis period, the drop of IRR with the mothballing cost is only 0.18%, which is relatively insignificant.

(b) Analysis period of 25 years (unit: thousand $):

- Without "mothballing" cost:

$$\begin{aligned} \text{PW}(i) &= -\$1,500,000 + (\$207,000 - \$69,000)(P/A_1, 0.05\%, i, 25) \\ &= 0 \\ i^* &= 7.84\% \end{aligned}$$

- With "mothballing" cost of $0.75 billion:

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$$\begin{aligned}\text{PW}(i) &= -\$1,500,000 + (\$207,000 - \$69,000)(P/A_1, 0.05\%, i, 25) \\ &\quad - \$750,000(P/F, i, 25) \\ &= 0 \\ i^* &= 6.80\%\end{aligned}$$

For a 25-year analysis period, the drop of IRR with the mothballing cost is about 1.04%, which is relatively significant.

7.43)

(a) Assumptions required:

- There is no information regarding the expected cash flows from the current operation if B&E Cooling decides to defer the introduction of the absorption chiller technology for 3 years. Therefore, we need to make an explicit assumption of the expected cash flow for the first three years if B&E Cooling decides to defer the decision. Assume that the annual cash flow during this period would be *X*.
- Another assumption we have to make is about the analysis period. Assuming that the firm will be in business for an indefinite period, we also need to make an explicit assumption regarding the future cooling technology. Since there is no information about the future cooling technology options, we may assume that the best cooling technology will be the absorption technology that will be introduced 3 years from now. Therefore, if B&E Cooling decides to select Option 1, we assume that, at the end of 8 years, Option 2 (the best cooling technology at that time) will be adopted for an indefinite period.

(b) Investment decision:

- Present worth analysis: First, we will determine the equivalent present worth for each option:

$$\begin{aligned}\text{PW}(i)_1 &= -\$6\text{M} + \$9\text{M}(P/A, i, 8) + \$1\text{M}(P/F, i, 8) \\ &\quad + \frac{[-\$5\text{M} + \$4\text{M}(P/A, i, 8) + \$2\text{M}(P/F, i, 8)](A/P, i, 8)}{i} \\ &\quad \times (P/F, i, 8) \\ \text{PW}(i)_2 &= X(P/A, i, 3) \\ &\quad + \frac{[-\$5\text{M} + \$4\text{M}(P/A, i, 8) + \$2\text{M}(P/F, i, 8)](A/P, i, 8)}{i} \\ &\quad \times (P/F, i, 3)\end{aligned}$$

Now we can determine the value *X* that makes the two options economically equivalent at an interest rate of 15%. In other words, if we evaluate the two present worth functions at $i = 15\%$, we have

$$\begin{aligned}\text{PW}(15\%)_1 &= \$41.32\text{M} \\ \text{PW}(15\%)_2 &= 2.2832X + \$13.29\text{M}\end{aligned}$$

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Letting $\text{PW}(15\%)_1 = \text{PW}(15\%)_2$ and solving for X gives

$$X = \$12.28\text{M}$$

As long as the current operation continues to generate annual net revenue of at least \$12.28 million for 3 years, Option 2 is a better choice.

- Rate of return analysis: The present worth analysis above indicates that, if $X = \$12.28M$, the break-even rate of return on incremental investment is $i^*_{1-2} = 15\%$.

Therefore, the ultimate choice will depend on the level of annual revenues generated during the first 3 years when the advanced cooling technology is deferred. Clearly, if

$X < \$12.28\text{M}$, then $i^*_{1-2} > 15\%$, Option 1 is preferred.

7.44)

n	Current Pump(A)	Larger Pump(B)	B-A	
0	\$0	-\$1,600,000	-\$1,600,000	
1	\$10,000,000	\$20,000,000	\$10,000,000	
2	\$10,000,000	\$0	-\$10,000,000	
		IRR =	25%	
			400%	

The incremental cash flows result in multiple rates of return (25% and 400%), so we may abandon the rate of return analysis. Using the PW analysis,

$$\begin{aligned}\text{PW}(20\%) &= -\$1.6\text{M} + \$10\text{M}(P/F, 20\%, 1) - \$10\text{M}(P/F, 20\%, 2)\\ &= -\$0.21\text{M} < 0\end{aligned}$$

Reject the larger pump.

Comments: If we follow the procedure outlined in Appendix 7A, we will find the return on invested capital to be 4.16% at MARR of 20%, so we will reject the larger pump.

7.45) Not provided.

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