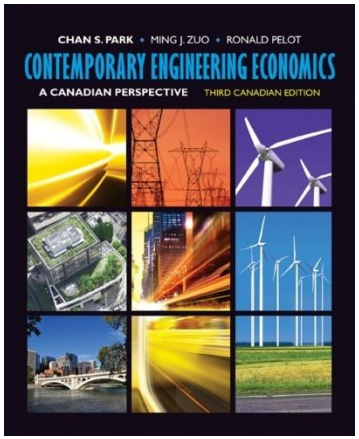
Analysis Period



Lecture No. 18

Chapter 6

Contemporary Engineering Economics
Third Canadian Edition

Lecture 18 Objectives

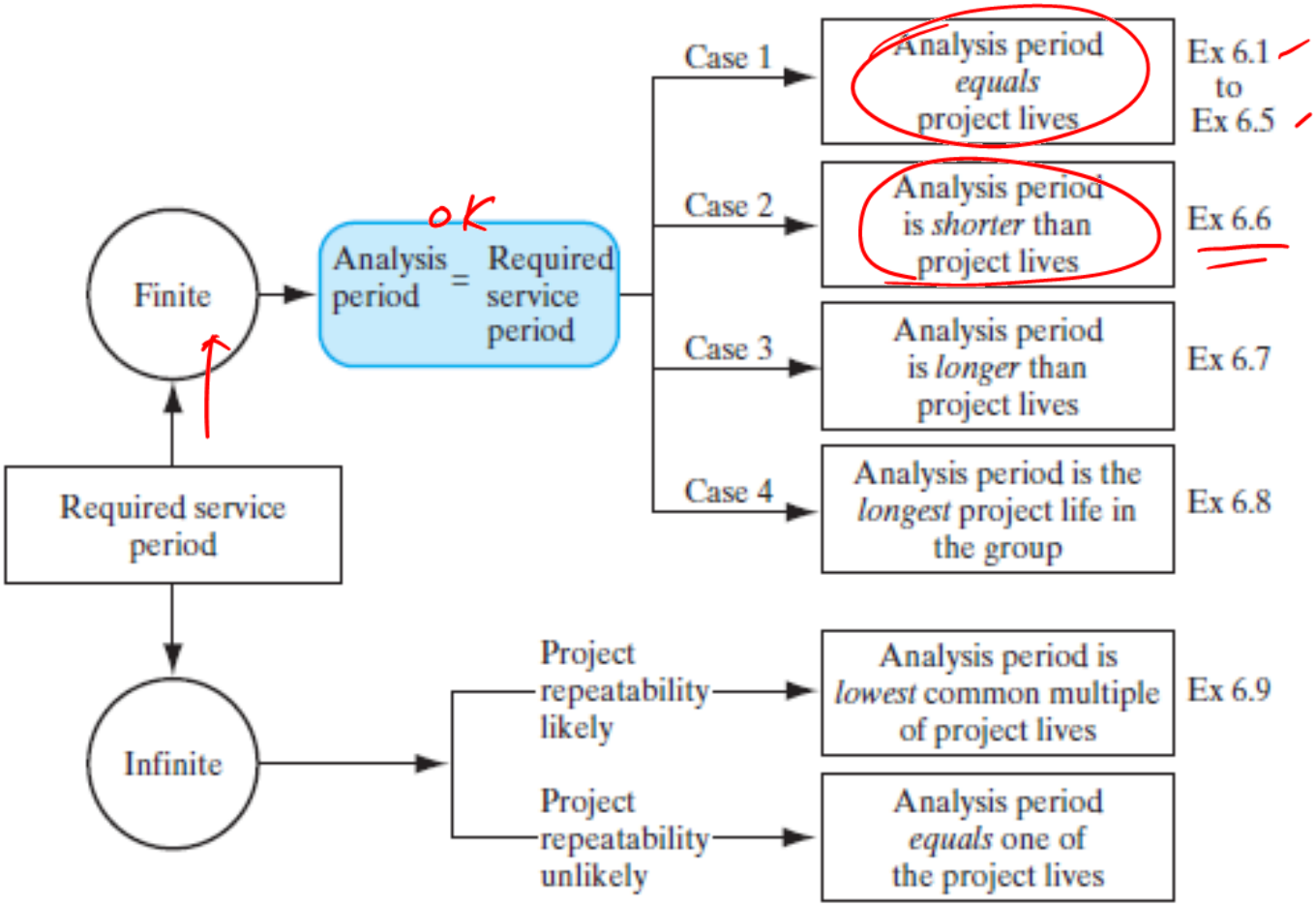
- How do firms compare options with different lifetimes?

. Use expected lifetime for the project purpose.

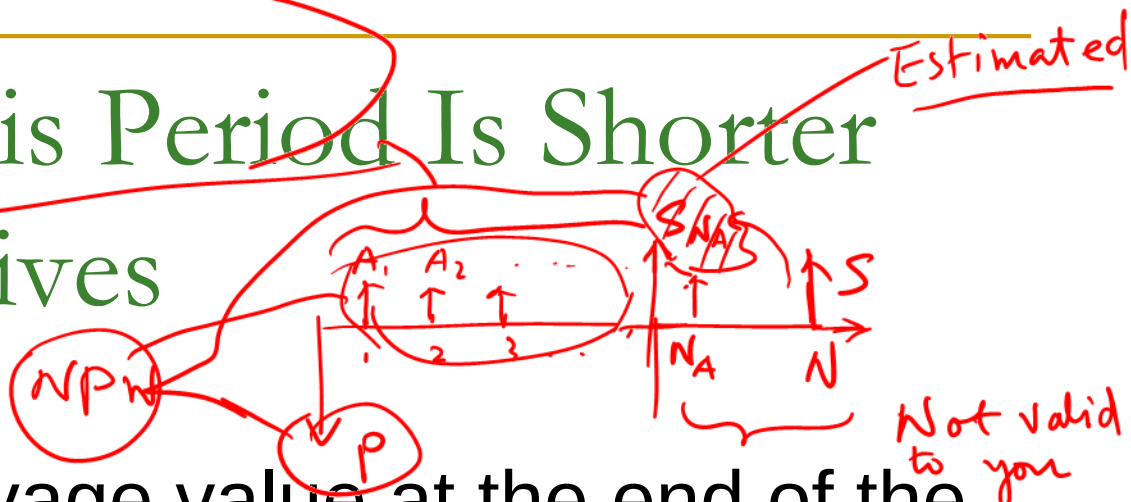
Analysis Period

- Mutually exclusive alternatives must be compared over the same analysis period.
  - **Analysis Period**: The time span over which the economic effects of an investment will be evaluated.
- In general, the analysis period should be chosen to cover the required service period. When the useful life of an investment project does not match the analysis period, adjustments must be made.

Analysis Period Implied in Comparing Mutually Exclusive Alternatives



Case 2: Analysis Period Is Shorter than Project Lives



- Estimate the salvage value at the end of the required service period.
- Compute the PW for each project over the required service period.

Example 6.6:

Waste Management Company (WMC) has won a contract that requires the firm to remove radioactive material from government-owned property and transport it to a designated dumping site. This task requires a specially made ripper–bulldozer to dig and load the material onto a transportation vehicle. Approximately 400,000 tonnes of waste must be moved in a period of two years.

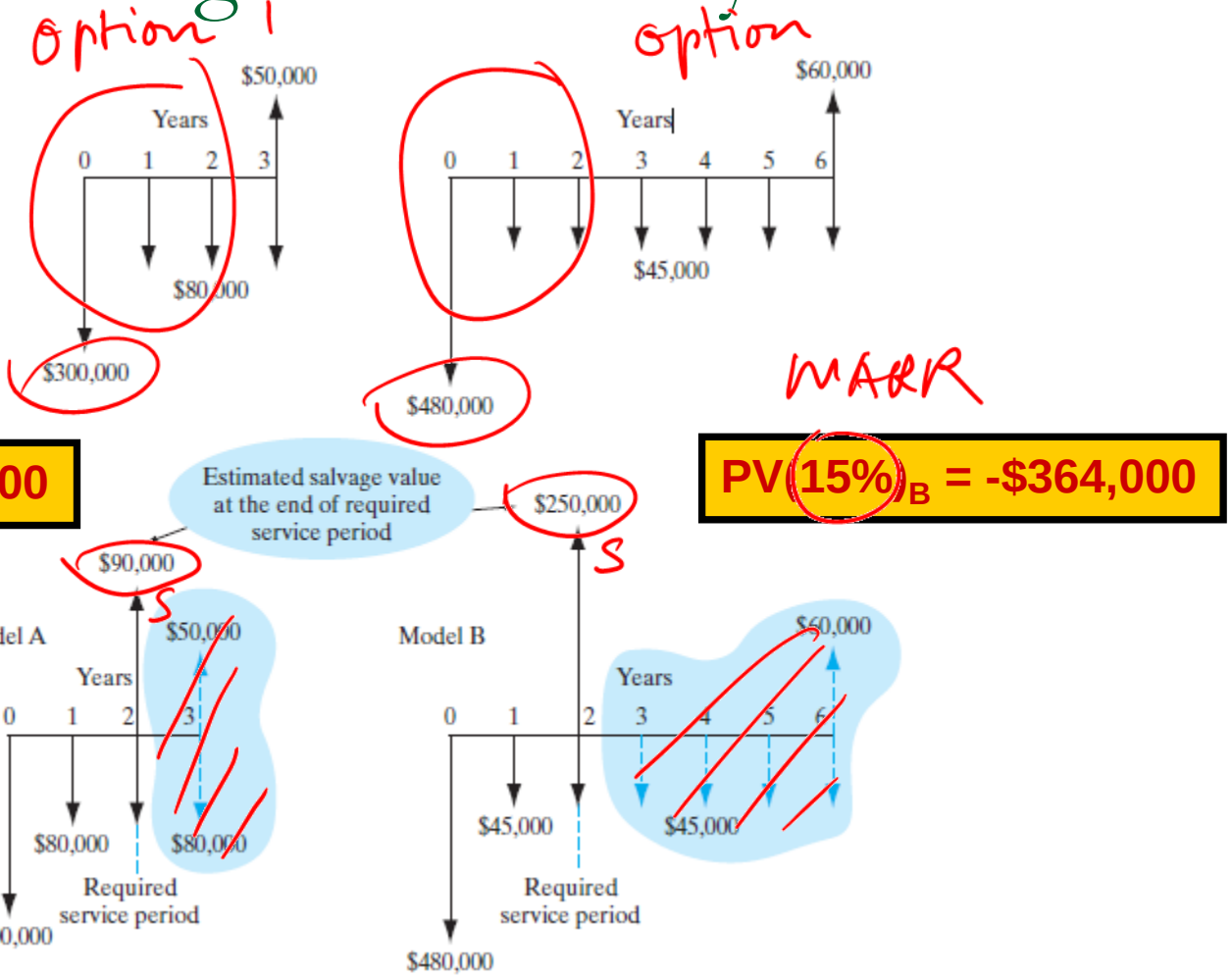
- Model A costs $150,000 and has a life of 6000 hours before it will require any major overhaul. Two units of model A would be required to remove the material within two years, and the operating cost for each unit would run to $40,000/year for 2000 hours of operation. At this operational rate, the model would be operable for three years, at the end of which time it is estimated that the salvage value will be $25,000 for each machine.
- A more efficient model B costs $240,000 each, has a life of 12,000 hours without any major overhaul, and costs $22,500 to operate for 2000 hours per year to complete the job within two years. The estimated salvage value of model B at the end of six years is $30,000. Once again, two units of model B would be required to remove the material within two years.

Example 6.6: Present-Worth Comparison: Project Lives Longer than Analysis Period

n	Model A		Model B	
0	-$300		-$480	
1	-80		-45	
2	-80	+90	-45	+250
3	-80	+50	-45	
4			-45	
5			-45	
6			-45	+60

- Boxes represent the estimated salvage values at the end of the analysis period (end of year 2)

Example 6.6: Present-Worth Comparison: Project Lives Longer than Analysis Period



Case 3: Project Life Shorter than Analysis Period

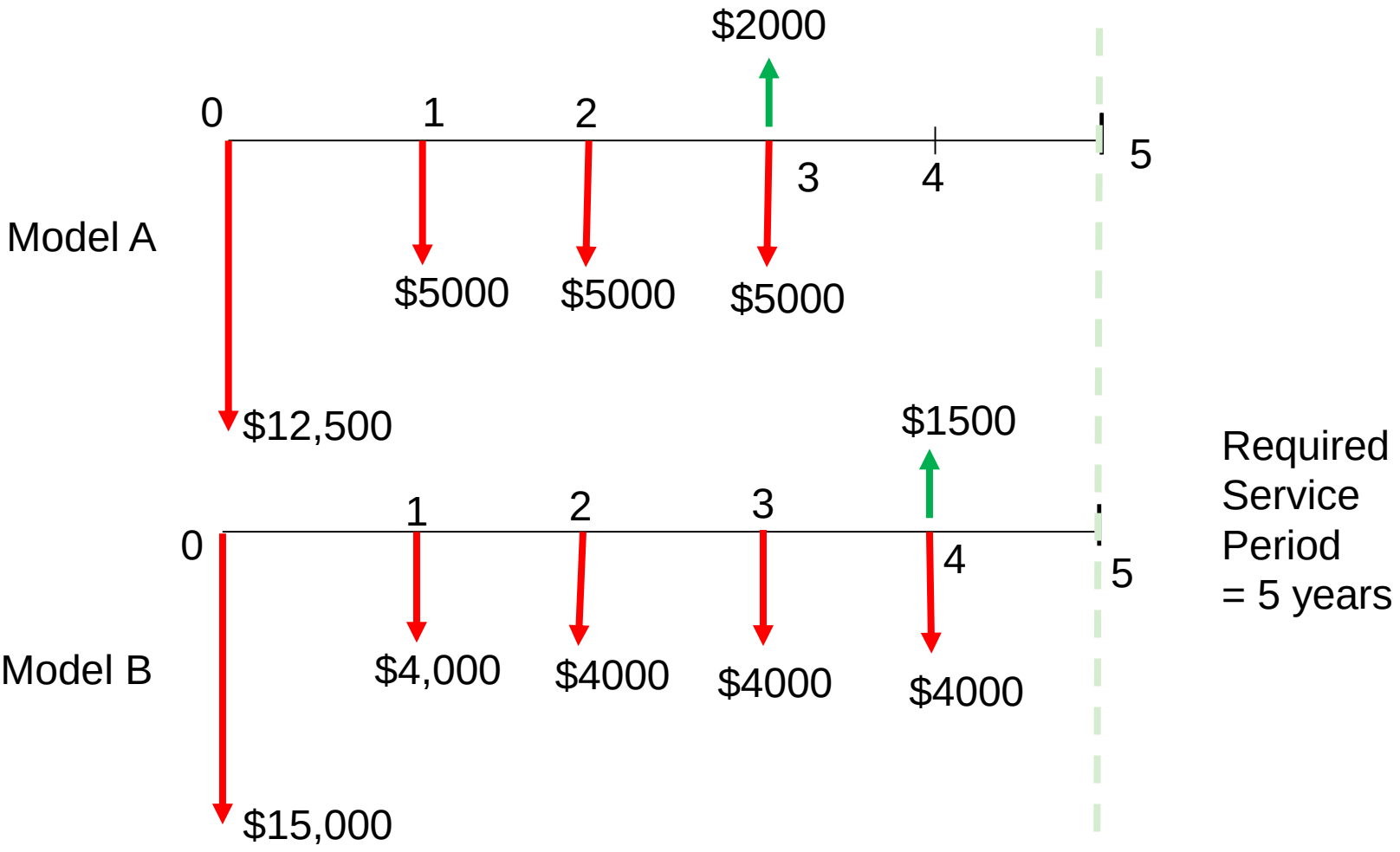
- Come up with replacement projects that match or exceed the required service period.
- Compute the PW for each project over the required service period.

Example 6.7:

The Smith Novelty Company, a mail-order firm, wants to install an automatic mailing system to handle product announcements and invoices. The firm has a choice between two different types of machines. The two machines are designed differently, but have identical capacities and do exactly the same job. The $12,500 semiautomatic model A will last three years, while the fully automatic model B will cost $15,000 and last four years. The expected cash flows for the two options are given on the next page.

As business grows to a certain level, neither of the models may be able to handle the expanded volume at the end of year 5. If that happens, a fully computerized mail-order system will need to be installed to handle the increased business volume. In the scenario just presented, which model should the firm select at MARR = 15%?

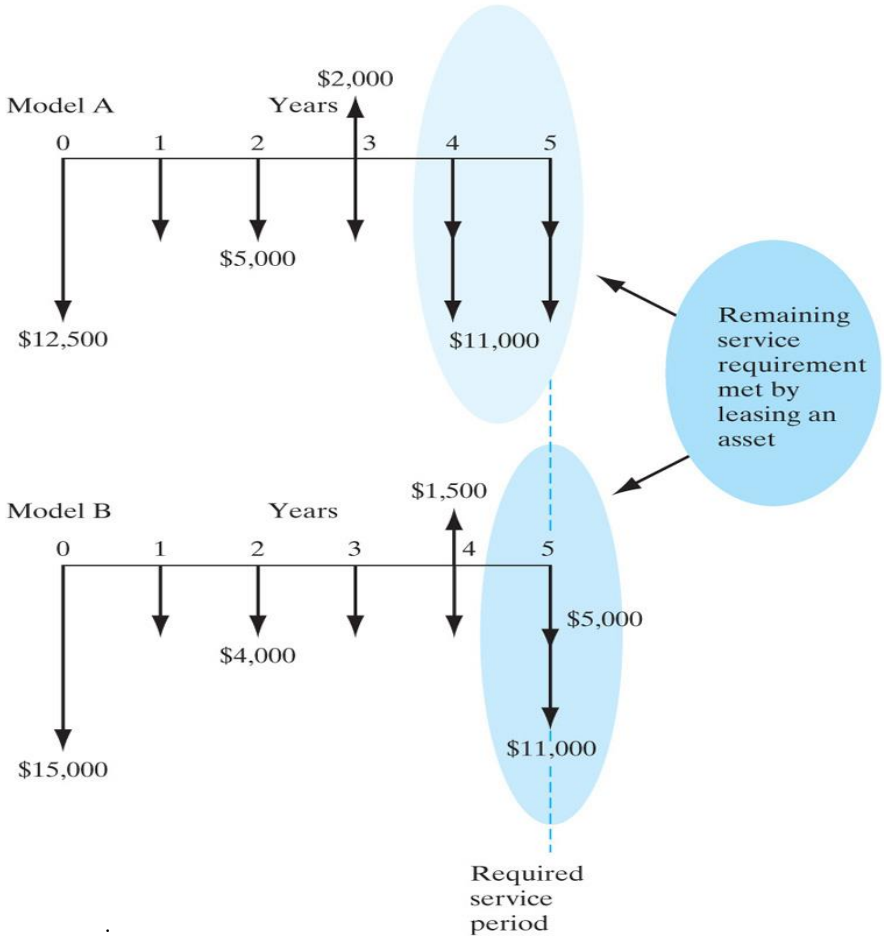
Example 6.7: Present-Worth Comparison for Projects Lives Shorter than the Analysis Period



Example 6.7: Present-Worth Comparison for Projects Lives Shorter Than the Analysis Period

$$PW(15\%)_{\text{Model A}} = -\$34,359$$

$$PW(15\%)_{\text{Model B}} = -\$31,031$$



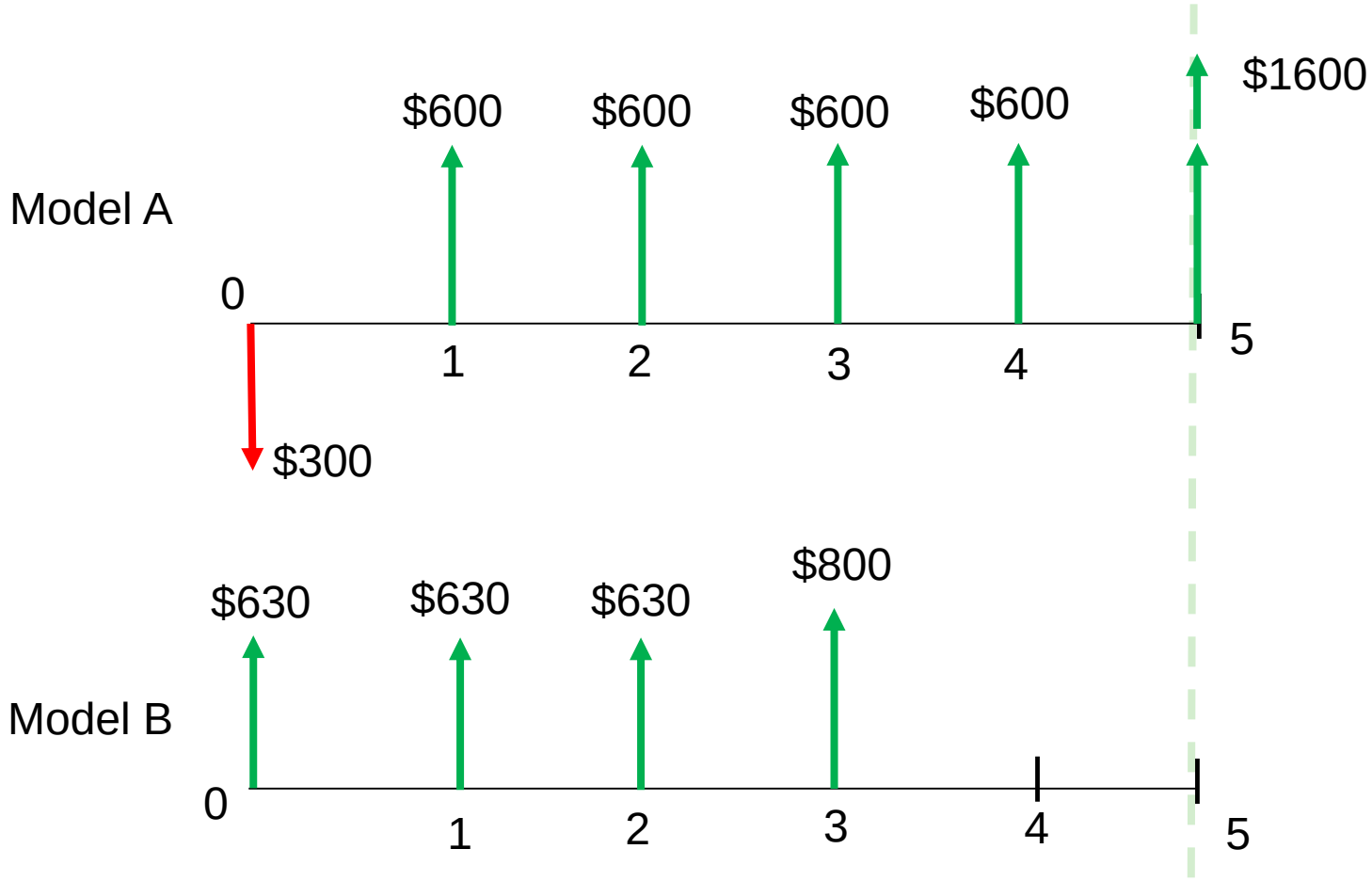
Example 6.8:

The family-operated Foothills Ranching Company (FRC) owns the mineral rights to land used for growing grain and grazing cattle. Recently, oil was discovered on this property. The family has decided to extract the oil, sell the land, and retire. The company can lease the necessary equipment and extract and sell the oil itself, or it can lease the land to an oil-drilling company:

- **Drill option.** If the company chooses to drill, it will require $300,000 leasing expenses up front, but the net annual cash flow after taxes from drilling operations will be $600,000 at the end of each year for the next five years. The company can sell the land for a net cash flow of $1,000,000 in five years, when the oil is depleted.
- **Lease option.** If the company chooses to lease, the drilling company can extract all the oil in only three years, and FRC can sell the land for a net cash flow of $800,000 at that time. (The difference in resale value of the land is due to the increasing rate of land appreciation anticipated for this property.) The net cash flow from the lease payments to FRC will be $630,000 at the *beginning* of each of the next three years.

All benefits and costs associated with the two alternatives have been accounted for in the figures listed. Which option should the firm select at MARR = 15%?

Example 6.8: Present-Worth Comparison: A Case Where the Analysis Period Coincides With the Project With the Longest Life in the Mutually Exclusive Group



Example 6.8: Present-Worth Comparison: A Case Where the Analysis Period Coincides With the Project With the Longest Life in the Mutually Exclusive Group (continued)

$$\begin{aligned} PW(15\%)_{Drill} &= -\$300,000 + \$600,000(P/A,15\%,4) \\ &\quad +\$1,600,000(P/F,15\%,5) \\ &= \$2,208,470 \end{aligned}$$

$$\begin{aligned} PW(15\%)_{Lease} &= +\$630,000 + \$630,000(P/A,15\%,2) \\ &\quad +\$800,000(P/F,15\%,3) \\ &= \$2,180,210 \end{aligned}$$

Case 4: Analysis Period Is Not Specified

- This is the most likely scenario in most stable industrial operations
- Common assumptions used for this scenario:

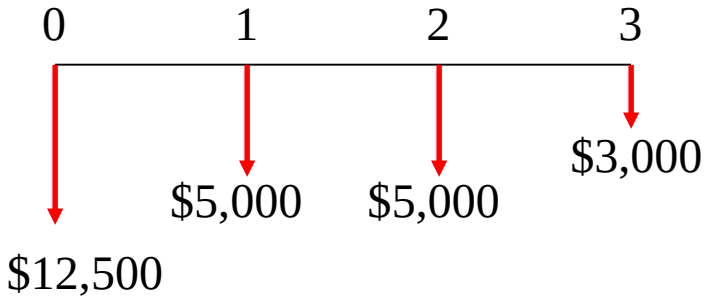
  (1) The required service life is very long

  (2) The so-called like-for-like replacement options are available.

  (3) We can use the lowest common multiple of the project lives as our analysis period.

Example 6.9: Present Worth Comparison: Unequal Lives, Lowest-Common-Multiple Method

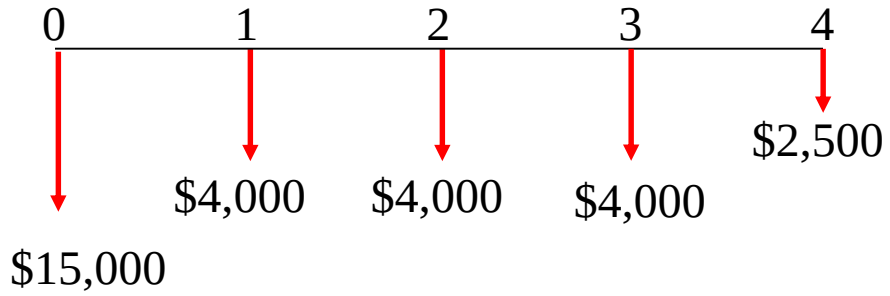
Model A:



Required service Period = Indefinite

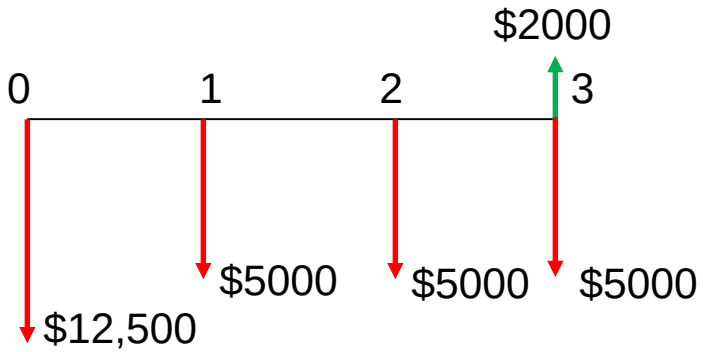
Analysis period = LCM (3,4) = 12 years

Model B:



Example 6.9: Present Worth Comparison of Unequal Lives, Lowest-Common-Multiple Method (continued)

Model A:



First Cycle:

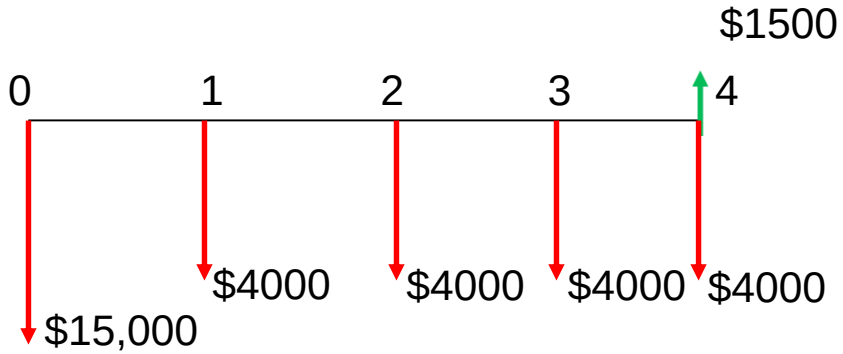
$$PW(15\%) = -\$12{,}500 - \$5000(P/A,15\%,3) + \$2000(P/F,15\%,3)$$
$$= -\$22{,}601$$
$$AE(15\%) = -\$22{,}601(A/P,15\%,3) = -\$9899$$

With 4 replacement cycles:

$$PW(15\%) = -\$22{,}601[1 + (P/F,15\%,3)$$
$$+(P/F,15\%,6) + (P/F,15\%,9)]$$
$$= -\$53{,}657$$
$$AE(15\%) = -\$53{,}657(A/P,15\%,12) = -\$9899$$

Example 6.9: Present Worth Comparison of Unequal Lives, Lowest-Common-Multiple Method (continued)

Model B:



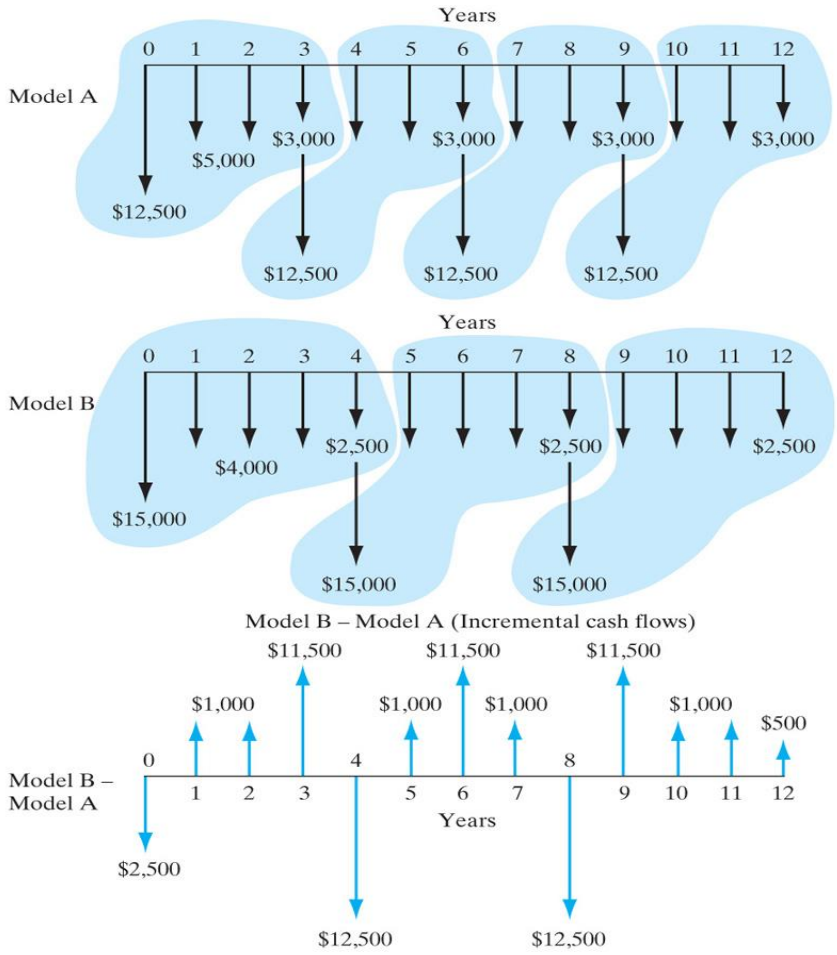
First Cycle:

$$PW(15\%) = -\$15{,}000 - \$4000(P/A,15\%,4) + \$1500(P/F,15\%,4)$$
$$= -\$25{,}562$$
$$AE(15\%) = -\$25{,}562(A/P,15\%,4) = -\$8954$$

With 3 replacement cycles:

$$PW(15\%) = -\$25{,}562[1 + (P/F,15\%,4) + (P/F,15\%,8)]$$
$$= -\$48{,}534$$
$$AE(15\%) = -\$48{,}534(A/P,15\%,12) = -\$8954$$

Example 6.11: IRR Analysis for Projects With Different Lives



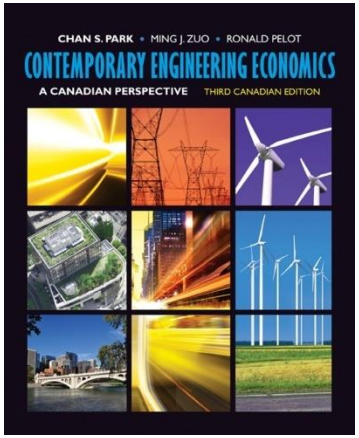
MARR = 15%

- The incremental cash flows (Model B – Model A) result in a nonsimple and mixed investment.

- $RIC_{B-A} = 50.68\% > 15\%$
  Select Model B. This is the IRR. We have assumed an external rate of return of 15%.

* RIC: Return on invested capital

Summary



AE analysis is recommended for many situations involving the comparison of options with differing lives. When comparing options with different lifetimes, the incremental cash flows often exhibit multiple sign changes, hence the IRR method becomes impractical to use.