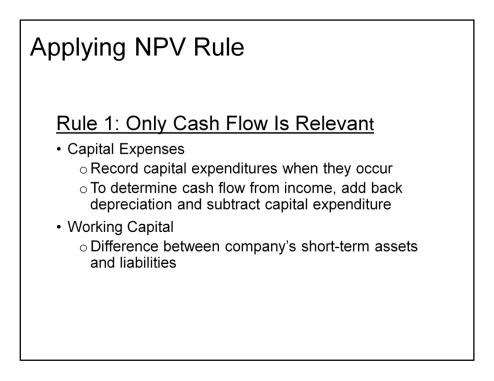


# **Topics Covered**

- Applying the Net Present Value Rule
- Example IM&C Fertilizer Project
- Using the NPV Rule to Choose among Projects
  - $_{\odot}$  The Investment Timing Problem
  - The Choice between Long- and Short-Lived Equipment
  - $_{\odot}$  When to Replace an Old Machine



Remember that only cash flows are relevant. Use incremental, after-tax cash flows to calculate NPVs. Remind students to be very careful when using accounting data.

# What To Discount

## Points to Watch Out For

Rule 2: Estimate Cash Flows on an Incremental Basis

- Remember to include taxes
- Do not confuse average with incremental payoffs
- Include all incidental effects
- Forecast sales today and recognise after-sales cash flows to come later
- Include opportunity costs
- Forget sunk costs
- Beware of allocated overhead costs
- Remember salvage value

# Inflation

Rule 3 - Treat Inflation Consistently

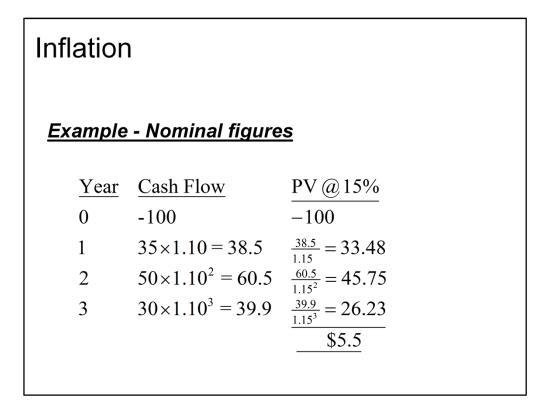
- Be consistent in how you handle inflation!!
- Use nominal interest rates to discount nominal cash flows
- Use real interest rates to discount real cash flows
- You will get the same results, whether you use nominal or real figures

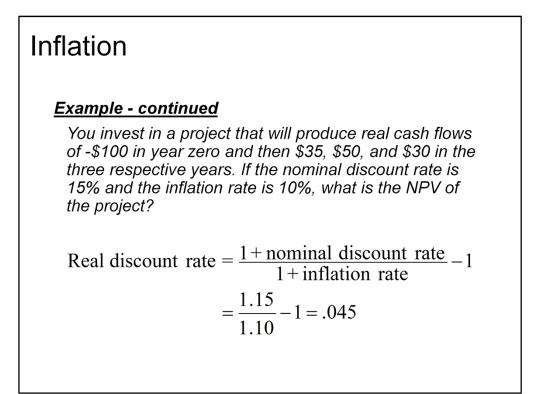
# Inflation

# <u>Example</u>

You invest in a project that will produce real cash flows of -\$100 in year zero and then \$35, \$50, and \$30 in the three respective years. If the nominal discount rate is 15% and the inflation rate is 10%, what is the NPV of the project?

Real discount rate =  $\frac{1 + \text{nominal discount rate}}{1 + \text{inflation rate}} - 1$ 





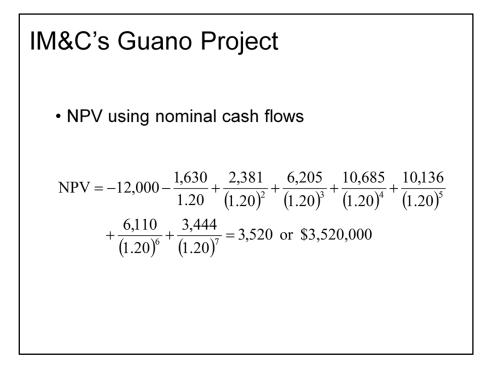
# Year Cash Flow PV@4.50% 0 -100 -100 1 35 $\frac{35}{1.045} = -33.49$ 2 50 $\frac{50}{1.045^2} = 45.79$ 3 30 $\frac{30}{1.045^3} = 26.29$ = \$5.5

Rule 4: Separate Investment and Financing Decision

<u>Question</u>: How should you treat the proceeds from the debt issue and the interest and principal payments on the debt?

<u>Answer</u>: You should *neither* subtract the debt proceeds from the required investment *nor* recognise the interest and principal payments on the debt as cash outflows.

| N | /I&C's Gu                       | ano    | Pro    | ojec   | t      |        |           |        |        |
|---|---------------------------------|--------|--------|--------|--------|--------|-----------|--------|--------|
| R | evised projec                   | ctions | (\$10  | 00s)   | reflec | ctina  | inflat    | ion    |        |
|   |                                 | 500110 | (Ψ.Ξ   | 000,   |        | iod    | in in car |        |        |
|   |                                 | 0      | 1      | 2      | 3      | 4      | 5         | 6      | 7      |
|   | Capital investment              | 10,000 |        |        |        |        |           |        | -1,949 |
|   | Accumulated depreciation        |        | 1,583  | 3,167  | 4,750  | 6,333  | 7,917     | 9,500  | 0      |
|   | Year-end book value             | 10,000 | 8,417  | 6,833  | 5,250  | 3,667  | 2,083     | 500    | 0      |
|   | Working capital                 |        | 550    | 1,289  | 3,261  | 4,890  | 3,583     | 2,002  | 0      |
|   | Total book value (3 + 4)        |        | 8,967  | 8,122  | 8,511  | 8,557  | 5,666     | 2,502  | 0      |
|   | Sales                           |        | 523    | 12,887 | 32,610 | 48,901 | 35,834    | 19,717 |        |
|   | Cost of goods sold <sup>b</sup> |        | 837    | 7,729  | 19,552 | 29,345 | 21,492    | 11,830 |        |
|   | Other costs <sup>c</sup>        | 4,000  | 2,200  | 1,210  | 1,331  | 1,464  | 1,611     | 1,772  |        |
|   | Depreciation                    |        | 1,583  | 1,583  | 1,583  | 1,583  | 1,583     | 1,583  | 0      |
|   | Pretax profit (6 – 7 – 8 – 9)   | -4,000 | -4,097 | 2,365  | 10,144 | 16,509 | 11,148    | 4,532  | 1,449  |
|   | Tax at 35%                      | -1,400 | -1,434 | 828    | 3,550  | 5,778  | 3,902     | 1,586  | 507    |
|   | Profit after tax (10 - 11)      | -2,600 | -2.663 | 1.537  | 6,593  | 10,731 | 7,246     | 2,946  | 942    |



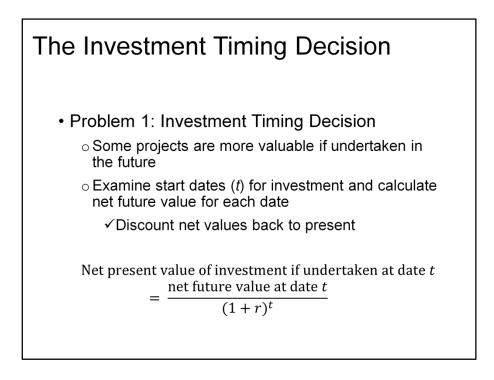
| 11 | V&C's Gua                             |         |            |        |        |        |        |        |        |
|----|---------------------------------------|---------|------------|--------|--------|--------|--------|--------|--------|
|    |                                       |         |            |        | Per    | iod    |        |        |        |
|    |                                       | 0       | 1          | 2      | 3      | 4      | 5      | 6      | 7      |
| 1  | Capital investment and disposal       | -10,000 | 0          | 0      | 0      | 0      | 0      | 0      | 1,442ª |
| 2  | Change in working capital             |         | -550       | -739   | -1,972 | -1,629 | 1,307  | 1,581  | 2,002  |
| 3  | Sales                                 | 0       | 523        | 12,887 | 32,610 | 48,901 | 35,834 | 19,717 | 0      |
| 4  | Cost of goods sold                    | 0       | 837        | 7,729  | 19,552 | 29,345 | 21,492 | 11,830 | 0      |
| 5  | Other costs                           | 4,000   | 2,200      | 1,210  | 1,331  | 1,464  | 1,611  | 1,772  | 0      |
| 6  | Tax on income                         | -1,400  | -1,434     | 828    | 3,550  | 5,778  | 3,902  | 1,586  |        |
| 7  | Operating cash flow $(3 - 4 - 5 - 6)$ | -2,600  | -1,080     | 3,120  | 8,177  | 12,314 | 8,829  | 4,529  |        |
| 8  | Net cash flow (1 + 2 + 7)             | -12,600 | -1,630     | 2,381  | 6,205  | 10,685 | 10,136 | 6,110  | 3,444  |
| 9  | Present value at 20%                  | -12,600 | -1,358     | 1,654  | 3,591  | 5,153  | 4,074  | 2,046  | 961    |
| 10 | Net present value =                   | +3,520  | (sum of 9) |        |        |        |        |        |        |
|    |                                       |         |            |        |        |        |        |        |        |

### IM&C's Guano Project Details of cash flow forecast in year 3 (\$1000s) **Data from Forecasted Cash Flows Income Statement** Working-Capital Changes Cash inflow Sales Increase in accounts receivable = \_ \$31,110 32,610 1,500 = \_ Cash outflow Cost of goods sold, other costs, Increase in inventory net of increase + = in accounts payable and taxes \$24,905 (19,552 + 1,331 + 3,550) (972 – 500) + = Net cash flow = cash inflow - cash outflow 6,205 = 31,110 - 24,905

| IM&C's Gua               | an | o P     | roje       | ct           |               |             |         |         |
|--------------------------|----|---------|------------|--------------|---------------|-------------|---------|---------|
| Tax depressistion        |    |         | Tax Deprec | iation Sched | lules by Reco | very-Period | Class   |         |
| Tax depreciation         |    | Year(s) | 3-year     | 5-year       | 7-year        | 10-year     | 15-year | 20-year |
| allowed under            | 1  | 1       | 33.33      | 20.00        | 14.29         | 10.00       | 5.00    | 3.75    |
| the modified             | 2  | 2       | 44.45      | 32.00        | 24.49         | 18.00       | 9.50    | 7.22    |
| accelerated cost         | 3  | 3       | 14.81      | 19.20        | 17.49         | 14.40       | 8.55    | 6.68    |
|                          | 4  | 4       | 7.41       | 11.52        | 12.49         | 11.52       | 7.70    | 6.18    |
| recovery system          | 5  | 5       |            | 11.52        | 8.93          | 9.22        | 6.93    | 5.71    |
| (MACRS)                  | 6  | 6       |            | 5.76         | 8.92          | 7.37        | 6.23    | 5.28    |
| (Figures in represent of | 7  | 7       |            |              | 8.93          | 6.55        | 5.90    | 4.89    |
| (Figures in percent of   | 8  | 8       |            |              | 4.46          | 6.55        | 5.90    | 4.52    |
| depreciable              | 9  | 9       |            |              |               | 6.56        | 5.91    | 4.46    |
| investment)              | 10 | 10      |            |              |               | 6.55        | 5.90    | 4.46    |
|                          | 11 | 11      |            |              |               | 3.28        | 5.91    | 4.46    |
|                          | 12 | 12      |            |              |               |             | 5.90    | 4.46    |
|                          | 13 | 13      |            |              |               |             | 5.91    | 4.46    |
|                          | 14 | 14      |            |              |               |             | 5.90    | 4.46    |
|                          | 15 | 15      |            |              |               |             | 5.91    | 4.46    |
|                          | 16 | 16      |            |              |               |             | 2.95    | 4.46    |
|                          | 17 | 17-20   |            |              |               |             |         | 4.46    |
|                          | 18 | 21      |            |              |               |             |         | 2.23    |
|                          |    |         |            |              |               |             |         |         |

| 11 | M&C's Gu<br><sub>Tax Pay</sub>  |        |        | -      |        |        |        |        |                    |
|----|---------------------------------|--------|--------|--------|--------|--------|--------|--------|--------------------|
|    |                                 |        |        |        | Per    | riod   |        |        |                    |
|    |                                 | 0      | 1      | 2      | 3      | 4      | 5      | 6      | 7                  |
| 1  | Sales <sup>a</sup>              |        | 523    | 12,887 | 32,610 | 48,901 | 35,834 | 19,717 |                    |
| 2  | Cost of goods sold <sup>a</sup> |        | 837    | 7,729  | 19,552 | 29,345 | 21,492 | 11,830 |                    |
| 3  | Other costs <sup>a</sup>        | 4,000  | 2,200  | 1,210  | 1,331  | 1,464  | 1,611  | 1,772  |                    |
| 4  | Tax depreciation                |        | 2,000  | 3,200  | 1,920  | 1,152  | 1,152  | 576    |                    |
| 5  | Pretax profit (1 – 2 – 3 – 4)   | -4,000 | -4,514 | 748    | 9,807  | 16,940 | 11,579 | 5,539  | 1,949 <sup>b</sup> |
|    | Tax at 35%°                     | -1,400 | -1,580 | 262    | 3,432  | 5,929  | 4,053  | 1,939  | 682                |
|    |                                 |        |        |        |        |        |        |        |                    |

| 11 | <b>V&amp;C's Gu</b><br>Revised cas  |         |            | 2      |        | 00s)   |        |        |       |
|----|-------------------------------------|---------|------------|--------|--------|--------|--------|--------|-------|
|    |                                     |         |            |        | Pe     | riod   |        |        |       |
|    |                                     | 0       | 1          | 2      | 3      | 4      | 5      | 6      | 7     |
| 1  | Capital investment and disposal     | -10,000 | 0          | 0      | 0      | 0      | 0      | 0      | 1,949 |
| 2  | Change in working capital           |         | -550       | -739   | -1,972 | -1,629 | 1,307  | 1,581  | 2,002 |
| 3  | Sales <sup>a</sup>                  | 0       | 523        | 12,887 | 32,610 | 48,901 | 35,834 | 19,717 | 0     |
| 4  | Cost of goods solda                 | 0       | 837        | 7,729  | 19,552 | 29,345 | 21,492 | 11,830 | 0     |
| 5  | Other costs <sup>a</sup>            | 4,000   | 2,200      | 1,210  | 1,331  | 1,464  | 1,611  | 1,772  | 0     |
| 6  | Tax <sup>b</sup>                    | -1,400  | -1,580     | 262    | 3,432  | 5,929  | 4,053  | 1,939  | 682   |
| 7  | Operating cash flow (3 – 4 – 5 – 6) | -2,600  | -934       | 3,686  | 8,295  | 12,163 | 8,678  | 4,176  | -682  |
| 8  | Net cash flow $(1 + 2 + 7)$         | -12,600 | -1,484     | 2,947  | 6,323  | 10,534 | 9,985  | 5,757  | 3,269 |
| 9  | Present value at 20%                | -12,600 | -1,237     | 2,047  | 3,659  | 5,080  | 4,013  | 1,928  | 912   |
| 10 | Net present value =                 | 3,802   | (sum of 9) |        |        |        |        |        |       |
|    |                                     |         |            |        |        |        |        |        |       |
|    |                                     |         |            |        |        |        |        |        |       |



It is important to explain that NPVs can be calculated at any point in time. Students are most familiar with time = 0. This kind of case shows how we must be flexible in our calculations. It is an "outside the box" concept and hard for students to grasp.

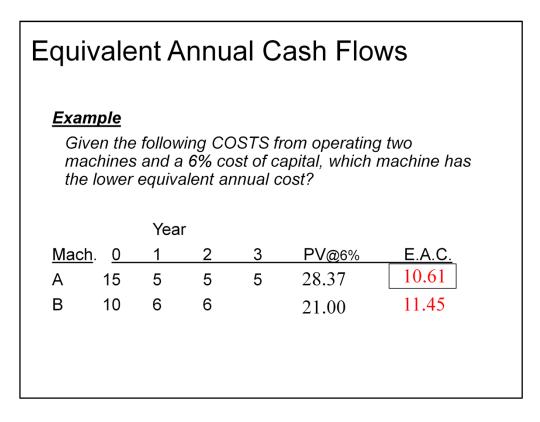
# **Investment Timing**

### <u>Example</u>

You own a large tract of inaccessible timber. To harvest it, you have to invest a substantial amount in access roads and other facilities. The longer you wait, the higher the investment required. On the other hand, lumber prices will rise as you wait, and the trees will keep growing, although at a gradually decreasing rate. Given the following data and a 10% discount rate, when should you harvest?

|   |    |      |         |          |      | Y    | ear of | Harvest |           |       |
|---|----|------|---------|----------|------|------|--------|---------|-----------|-------|
|   |    |      |         |          |      | 2    | 2      | 3       | 4         |       |
| Net <i>future</i> value<br>(\$ thousands) |    |      | 50      |          | 64.4 | 77   | .5     | 89.4    | 100       | 109.4 |
| Change in value from<br>previous year (%) | n  |      |         | +2       | 28.8 | +20  | ).3    | +15.4   | +11.9     | +9.4  |
|   |    |      | Year of | f Harves | t    |      |        |         |           |       |
|   |    |      |         |          |      | 5    |        | Ansv    | ver: Year | 4     |
| Net present value<br>(\$ thousands)       | 50 | 58.5 | 64.0    | 67.2     | 68.3 | 67.9 |        | 7 (110) | ion rour  |       |

| Using the NPV Rule to Choose among Projects   |
|---|
| Problem 2: The Choice between Long- and<br>Short-Lived Equipment  |
| <u>Equivalent Annual Cash Flow</u> - The cash flow<br>per period with the same present value as the<br>actual cash flow as the project. |
| Equivalent annual cost (annuity) = $\frac{\text{present value of cash flows}}{\text{annuity factor}}$                                   |
|   |



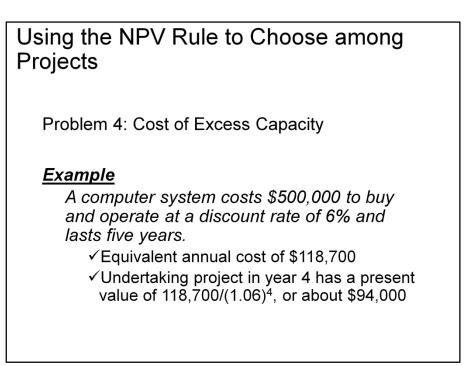
| Equival | ent A   | Ann    | ual   | Ann     | uity  |                     |               |
|---------|---------|--------|-------|---------|-------|---------------------|---------------|
|         | t one c | of the | two   | followi | 0,    | rojects,<br>nnuity" | based<br>(r = |
| Project | $C_0$   | $C_1$  | $C_2$ | $C_3$   | $C_4$ | NPV                 | EAA           |
| A       | -15     | 4.9    | 5.2   | 5.9     | 6.2   | 2.82                | .87           |
| В       | -20     | 8.1    | 8.7   | 10.4    |       | 2.78                | 1.10          |
|         |         |        |       |         |       |                     |               |

Using the NPV Rule to Choose among projects Problem 3: When to Replace an Old Machine <u>Example</u> A machine is expected to produce a net inflow of \$4,000 this year and \$4,000 next year before breaking. You can replace it now with a machine that costs \$15,000 and will produce an inflow of \$8,000 per year for three years. Should you replace now or wait a year?

In practice, the point at which equipment is replaced reflects economics, not physical collapse. *We must decide when to replace.* 

| Problem 3:                  | When       | to Re                 | eplace      | e an O     | ld Machine               |
|-----------------------------|------------|-----------------------|-------------|------------|--------------------------|
| <u>Example - c</u>          | contir     | nued                  |             |            |                          |
|                             |            | Cash Flows            | (\$ thousan | ds)        |                          |
|                             | <b>C</b> 0 | <b>C</b> <sub>1</sub> | <b>C</b> 2  | <b>C</b> 3 | NPV at 6% (\$ thousands) |
| New machine                 | -15        | +8                    | +8          | +8         | 6.38                     |
| Equivalent annual cash flow |            | +2.387                | +2.387      | +2.387     | 6.38                     |

The cash flows of the new machine are equivalent to an annuity of \$2,387 per year.



When recognized, the NPV of the project may prove to be negative. If so, we still need to check whether it is worthwhile undertaking the project now and abandoning it later, when the excess capacity of the present system disappears.