

## Exercise 13.5

## Question

## 13.5. Machine Purchase

The manager of a production plant has space for one new machine. The possible choices, with estimates of costs and benefits, are shown below. Each machine is assumed to have a five-year life.

Benefits and cost items	Values of machine (\$ $\times 10^3$ )			
	A	B	C	D
Initial cost	72	25	180	26.8
Annual net benefits	20	7.45	50	8
Salvage value at end of life	0	0	15	0

- (a) For each machine, using a discount rate of 8%, calculate the net present value, the benefit-cost ratio, and the payback period.  
 (b) Which machine should be chosen? Why?

## Solution from Manual

## 13.5 Machine Purchase

a)

	Machine			
	A	B	C	D
Net Present Value (\$1000s)	7.9	4.8	21.2	5.1
Benefit/Cost Ratio	1.109	1.191	1.110	1.194
Payback Period (years)	3.60	3.36	3.78	3.35

b) The three above criteria give different ranking of the machines. NPV would not be appropriate for values of initial investments so different. Based on B/C ratio, Machine D looks best; but, redoing these calculations with a higher discount rate ("10%), you would obtain still another ranking from the B/C ratio. This illustrates the dependence of alternatives ranking on both the evaluation criterion selected and the discount rate.

**Additional Notes**

- a) Calculation done in Excel, see file 13.5.xls. The formulas used here are as follows:

$$NPV = \sum_{i=0}^N \frac{CF_i}{(1+r)^i}$$

$$\frac{Benefit}{Cost} = \frac{PV \text{ all benefits}}{PV \text{ all costs}} = \frac{PV B}{PV C_k + C_r}$$

$$Payback \ Period = \frac{Initial \ Investment}{Annual \ Net \ Undiscounted \ Benefits}$$

**Machine A**

year	0	1	2	3	4	5
net benefits	0	20	20	20	20	20
investment	72	0	0	0	0	0
net value	-72	20	20	20	20	20
discount factor	1.00	0.93	0.86	0.79	0.74	0.68
present value	-72.00	18.52	17.15	15.88	14.70	13.61
<b>NPV</b>	<b>7.85</b>					
present value annual benefits	0.00	18.52	17.15	15.88	14.70	13.61
present value investment	72	0	0	0	0	0
<b>PV total benefits (B)</b>	<b>79.85</b>					
<b>PV total costs (C<sub>k</sub> + C<sub>r</sub>)</b>	<b>72.00</b>					
<b>PV benefit/cost ratio B/(C<sub>k</sub> + C<sub>r</sub>)</b>	<b>1.11</b>					
<b>Payback period (Investment / Ann. Undiscounted net benefits) (yrs)</b>	<b>3.6</b>					

**Machine B**

year	0	1	2	3	4	5
net benefits	0	7	7	7	7	7
investment	25	0	0	0	0	0
net value	-25	7	7	7	7	7
discount factor	1.00	0.93	0.86	0.79	0.74	0.68
present value	-25.00	6.90	6.39	5.91	5.48	5.07
<b>NPV</b>	<b>4.75</b>					
present value annual benefits	0.00	6.90	6.39	5.91	5.48	5.07
present value investment	25	0	0	0	0	0
<b>PV total benefits (B)</b>	<b>29.75</b>					
<b>PV total costs (C<sub>k</sub> + C<sub>r</sub>)</b>	<b>25.00</b>					
<b>PV benefit/cost ratio B/(C<sub>k</sub> + C<sub>r</sub>)</b>	<b>1.19</b>					
<b>Payback period (Investment / Ann. Undiscounted net benefits) (yrs)</b>	<b>3.4</b>					

Machine C

year	0	1	2	3	4	5
net benefits	0	50	50	50	50	50
investment	189	0	0	0	0	0
salvage value	0	0	0	0	0	15
net value	-189	50	50	50	50	65
discount factor	1.00	0.93	0.86	0.79	0.74	0.68
present value	-189.00	46.30	42.87	39.69	36.75	44.24
<b>NPV</b>	<b>20.84</b>					
present value annual benefits	0.00	46.30	42.87	39.69	36.75	44.24
present value investment	189	0	0	0	0	0
<b>PV total benefits (B)</b>	<b>209.84</b>					
<b>PV total costs (C<sub>k</sub> + C<sub>i</sub>)</b>	<b>189.00</b>					
<b>PV benefit/cost ratio B/(C<sub>k</sub> + C<sub>i</sub>)</b>	<b>1.11</b>					
<b>Payback period (Investment / Ann. Undiscounted net benefits) (yrs)</b>	<b>3.8</b>					

Machine D

year	0	1	2	3	4	5
net benefits	0	8	8	8	8	8
investment	26.8	0	0	0	0	0
salvage value	0	0	0	0	0	0
net value	-26.8	8	8	8	8	8
discount factor	1.00	0.93	0.86	0.79	0.74	0.68
present value	-26.80	7.41	6.86	6.35	5.88	5.44
<b>NPV</b>	<b>5.14</b>					
present value annual benefits	0.00	7.41	6.86	6.35	5.88	5.44
present value investment	26.8	0	0	0	0	0
<b>PV total benefits (B)</b>	<b>31.94</b>					
<b>PV total costs (C<sub>k</sub> + C<sub>i</sub>)</b>	<b>26.80</b>					
<b>PV benefit/cost ratio B/(C<sub>k</sub> + C<sub>i</sub>)</b>	<b>1.19</b>					
<b>Payback period (Investment / Ann. Undiscounted net benefits) (yrs)</b>	<b>3.4</b>					