

Project Risk Problems

1. (Park, Contemporary Engineering Economics, 1997, Problem 12.1) Ford Construction Company is considering the proposed acquisition of a new earthmover. The mover's basic price is \$70,000 and it will cost another \$15,000 to modify it for special use by the company. This earthmover falls into the MACRS 5-year class. It will be sold after 4 years for \$30,000. The earthmover purchase will have no effect on revenues, but it is expected to save the firm \$32,000 per year in before-tax operating costs, mainly labor. The firm's marginal tax rate (federal plus state) is 40% and its MARR is 15%.

(a) Is this project acceptable based on the most-likely estimates given in the problem?

(b) Suppose that the project will require an increase in net working capital (spare parts inventory) of \$2,000, which will be recovered at the end of year 5. With consideration of this new requirement, would the project still be acceptable?

Solution:

First compute depreciation and book value and capital gains on salvage.

MACRS Depr. Note only half taken in year of sale.

Year	1	2	3	4
%	20%	32%	19.2%	0.5*11.52%
Depr.	17000	27200	16320	4896

total depreciation=\$65,416.

book value = \$19,584

taxable gain = \$30,000 - \$19,584 = \$10,416

gains tax = \$4,166

n	Net Cash Flow	
	(a)	(b)
	Without Working Capital	With Working Capital
0	-\$85,000	-\$87,000
1	26,000	26,000
2	30,080	30,080
3	25,728	25,728
4	<u>46,992</u>	<u>46,992</u>
NPW(15%)	\$4,137	\$3,281

The project is acceptable under either situation.

(c) If the firm's MARR is increased to 20%, what would be the required savings so that the project remains profitable?

Solution:

Required annual savings (X):

$$\begin{aligned} \$85,000 = & (0.6X) (P/A, 2\%, 4) + \$6,800 (P/F, 2\%, 1) + \\ & \$10,880 (P/F, 2\%, 2) + \$6,258 (P/F, 2\%, 3) + \\ & (\$1,958 + \$25,834) (P/F, 2\%, 4) \end{aligned}$$

$$X = \$35,150$$

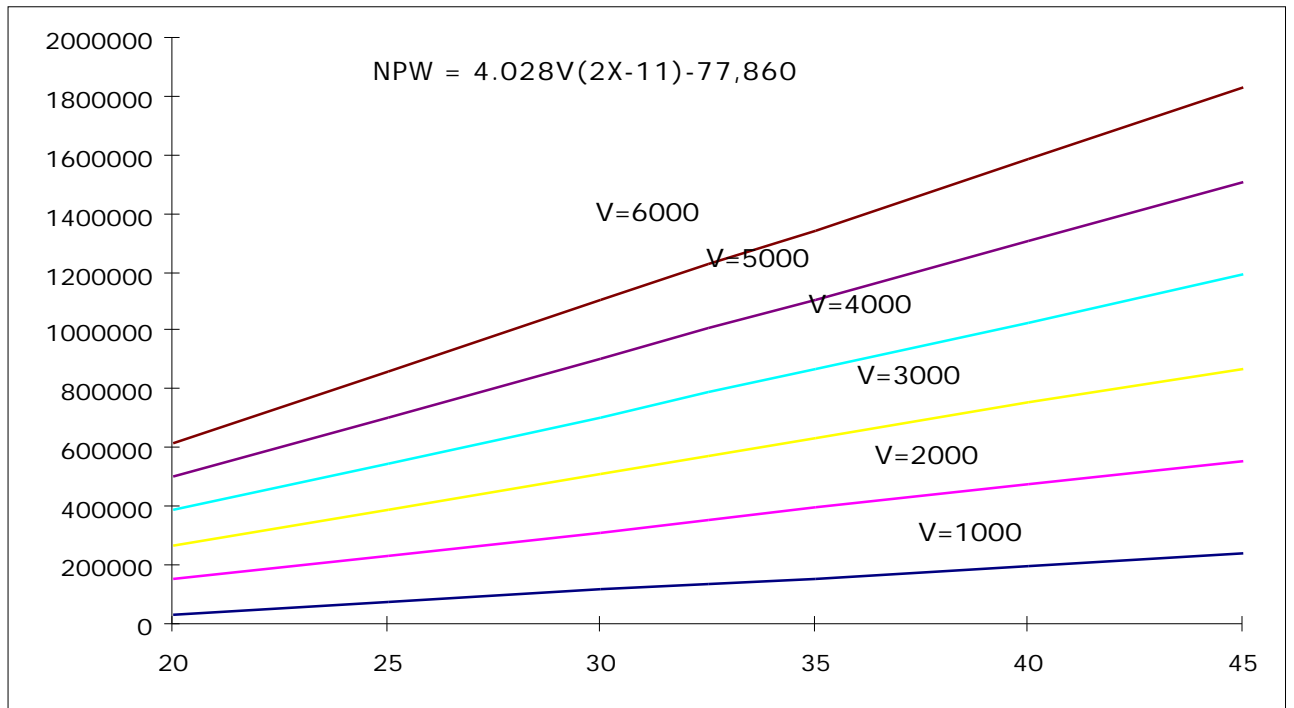
Note the numbers in the equation are the depreciation multiplied by 0.4. For example for the first year $\$17,000 \times (0.4) = \$6,800$.

2. (Park, *Contemporary Engineering Economics*, 1997, Problem 12.8) Mike Lazenby, an industrial engineer at Energy Conservation, has found that the anticipated profitability of a newly developed water-heater temperature control device can be measured by present worth as follows:

$$NPW = 4.028V(2X - \$11) - \$77,860$$

where V is the number of units produced and sold, and X is the sales price per unit. Mike also found that the V parameter value could occur anywhere between \$20 to \$45 per unit. Develop a sensitivity graph as a function of number of units produced and sales price per unit.

Solution:



3. (*Park, Contemporary Engineering Economics, 1997, Problem 12.11*) Robert Cooper is considering a piece of business rental property containing stores and offices at a cost of \$250,000. Cooper estimates that annual receipts from rentals will be \$35,000 and that annual disbursements, other than income taxes, will be about \$12,000. The property is expected to appreciate at the annual rate of %5. Copper expects to retain the property for 20 years once it is acquired. Then, it will be depreciated based on the 39-year real property class (MACRS), assuming that the property would be placed in service on January 1. Cooper's marginal tax rate is 30% and his MARR is 15%. What would be the minimum annual total of rental receipts that would make the investment break even?

Solution:

PW of net investment:

$$P_0 = \$250,000$$

PW of after-tax rental revenue:

$$P_1 = X (1 - 0.30) (P/A, 15\%, 20) = \$4.3815X$$

PW of after-tax operating costs:

$$P_2 = - (1 - 0.30), \$12,000 (P/A, 15\%, 20) = - \$52,578$$

PW of tax credit (shield) on depreciation: (In this problem, we assume that the purchasing cost of \$250,000 does not include any land value. Therefore, the entire purchasing cost will be the cost basis for depreciation purposes.

n	Depreciation Building	Combined tax savings
1	\$6,143	\$6,143 (0.30) = \$1,843
2-19	6,410	6,140 (0.30) = 1,923
20	6,143	6,143 (0.30) = 1,843

$$P_3 = \$1,843 (P/F, 15\%, 1) = \$1,923 (P/A, 15\%, 19) (P/F, 15\%, 1) + 1,843 (P/F, 15\%, 20) = \$11,962$$

NPW of net proceeds from sale:

$$\begin{aligned} \text{total depreciation} &= \$127,666 \\ \text{book value} &= \$250,000 - \$127,666 \end{aligned}$$

$$\begin{aligned}
&= \$122,334 \\
\text{salvage value} &= \$250,000 (1.05)^{20} = \$663,324 \\
\text{taxable gain} &= \$663,324 - \$122,334 \\
&= \$540,990 \\
\text{gains tax} &= \$540,990 (0.30) = \$162,297 \\
\text{net proceeds from sale} &= \$663,324 - \$162,297 \\
&= \$501,027 \\
P_4 &= \$501,027 (P/F, 15\%, 20) \\
&= \$30,613
\end{aligned}$$

The break-even rental

$$\text{NPW (10\%)} = P_0 + P_1 + P_2 + P_3 + P_4 = - \$260,003 + 4.3815X = 0. X = \$59,341$$

4. (Park, *Contemporary Engineering Economics*, 1997, Problem 12.17) A financial investor has an investment portfolio worth \$350,000. A bond in his portfolio will mature next month and provide him with \$25,000 to reinvest. The choices have been narrowed down to the following two options.
- Option 1: Reinvest in a foreign bond that will mature in one year. This will entail a brokerage fee of \$150. For simplicity, assume that the bond will provide interest over the 1-year period of \$2450, \$2000, or \$1675 and that the probabilities of these occurrences are assessed to be 0.25, 0.45 and 0.30, respectively.
 - Option 2: Reinvest in a \$25,000 certificate with a savings and loan association. Assume that this certificate has an effective annual rate of 7.5%.

(a) Which form of reinvestment should the investor choose in order to maximize his expected financial gain?

Solution:

Expected value criterion: Assume that the investor's opportunity cost rate is 7.5%.

- Option 1:

$$\begin{aligned} E[R]_1 &= \$2,450(0.25) + \$2,000(0.45) + \$1,675(0.30) \\ &\quad - \$150(F/P, 7.5\%, 1) \\ &= \$1,854 \end{aligned}$$

- Option 2:

$$E[R]_2 = \$25,000(0.075) = \$1,875$$

Option 2 is the better choice based on the principle of expected value maximization.

(b) If the investor can obtain professional investment advice from a broker, what would be the maximum amount the investor should pay for this service?

Solution:

We need to make an explicit assumption about the reliability of the investment firm. If the investment firm tells the investor with certainty that the bond's yield will be \$2,450, the investor's strategy would be to purchase the bond. After paying \$150 brokerage fee (which is worth about \$161 at 7.5% at the end of year 1), his net gain is \$2,289. If the investment firm tells him otherwise, his best strategy would be to buy the CD. Before receiving the perfect information from the investment firm, he

can calculate the expected profit with perfect information. This is done by summing for each possible state; the probability that a particular state will occur multiplied by the maximum net gain achievable for that state.

$$\begin{aligned}\text{expected net gain} &= (\$2,289 - \$1,875) (0.25) \\ &\quad \$0 (0.45) + \$0 (0.30) \\ &= \$104\end{aligned}$$

The investor should not solicit professional advice at any expense higher than \$104 (P/F, 7.5%, 1) = \$96 in today's dollars.

5. (Park, *Contemporary Engineering Economics*, 1997, Problem 12.21) Two alternative machines are being considered for a cost reduction project.
- Machine A has first cost of \$60,000 and a salvage cost (after-tax) of \$22,000 at the end of the 6 years' service life. Probabilities of annual after-tax operating costs of this machine are estimated as follows:

Annual Operating and Maintenance Costs	Probabilities
\$5,000	0.2
\$8,000	0.3
\$10,000	0.3
\$12,000	0.2

- Machine B has first cost of \$35,000 and its estimated salvage value (after-tax) at the end of the 4 years of service is assumed to be negligible. The annual after-tax operating costs are estimated as follows:

Annual Operating and Maintenance Costs	Probabilities
\$8,000	0.1
\$10,000	0.3
\$12,000	0.4
\$14,000	0.2

The MARR on this project is 10%. The required service period of these machines is estimated to be 12 years, and no technological advance in either machine is expected.

(a) Assuming independence, calculate the mean and variance of the equivalent annual cost of operating each machine.

(b) From the results of part (a), calculate the probability that the annual cost of operating Machine A will exceed the cost of operating Machine B.

Solution:

(a)

- Machine A:

$$\begin{aligned} \text{CR}(10\%) \text{ of A} &= (\$60,000 - \$22,000) (A/P, 10\%, 6) \\ &\quad + (0.10) (\$22,000) \\ &= \$10,924 \end{aligned}$$

$$\begin{aligned} E[\text{NAW}(10\%)] \text{ of A} &= (\$5,000) (0.20) + (\$8,000) (0.30) \\ &\quad + (\$10,000) (0.30) + (\$12,000) (0.20) \\ &\quad + \$10,924 \\ &= \$19,725 \end{aligned}$$

$$\begin{aligned} \text{Var}[\text{NAW}(10\%)] \text{ of A} &= (15,924 - 19,725)^2 (0.20) \\ &\quad + (18,924 - 19,725)^2 (0.30) \end{aligned}$$

$$\begin{aligned}
&+ (20,924 - 19,725)^2 (0.30) \\
&+ (22,924 - 19,725)^2 (0.20) \\
&= 5,560,000
\end{aligned}$$

• Machine B:

$$\begin{aligned}
\text{CR}(10\%) \text{ of B} &= \$35,000 \text{ (A/P, 10\%, 4)} \\
&= \$11,042 \\
\text{E[NAW}(10\%)] \text{ of B} &= (\$8,000) (0.10) + (\$10,000) (0.30) \\
&\quad + (\$12,000) (0.40) + (\$14,000) (0.20) \\
&\quad + \$11,042 \\
&= \$22,442 \\
\text{Var[NAW}(10\%)] \text{ of B} &= (19,042 - 22,442)^2 (0.10) \\
&\quad + (21,042 - 22,442)^2 (0.30) \\
&\quad + (23,042 - 22,442)^2 (0.40) \\
&\quad + (25,042 - 22,442)^2 (0.20) \\
&= 3,240,000
\end{aligned}$$

(b) Prob[NAW(10%) of A > NAW(10%) of B]:

Joint event		Joint probability
(O&M of A, O&M of B)	(NAW of A > NAW of B)	
(\$10,000, \$8,000)	(\$20,924, \$19,042)	(0.30) (0.10) = 0.03
(12,000, 8,000)	(\$22,924, \$19,042)	(0.20) (0.10) = 0.02
(12,000, 10,000)	(\$22,924, \$21,042)	(0.20) (0.30) = 0.06
		0.11