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Economic Analysis of Engineering Projects (CPEN 481)
Assignment 3

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1 Problem 1

Question: A firm purchased some equipment at a very favourable price of $30,000. The equipment resulted in an annual net saving of $1,000 a year during the eight years it was used. At the end of eight years, the equipment was sold for $35,000. Assuming interest is 8%, calculate the EUAC accounting for all costs, cost savings, and revenues (rounding to the nearest dollar). Did the equipment purchase prove to be desirable?

Solution: To determine if the equipment purchase is desirable, we must find its equivalent annual cost. We will solve this in the following calculation:

$$\begin{aligned} EUAC &= P(A/P, i, n) - A - S(A/F, i, n) \\ &= 30,000(A/P, \%, 8) - 1000 - 35,000(A/F, 8\%, 8) \\ &= 30,000\frac{0.08(1+0.08)^8}{(1+0.08)^8 - 1} - 1000 - 35,000\frac{0.08}{(1+0.08)^8 - 1} \\ &= 929.93 \approx 930 \end{aligned}$$

As this would lose the firm money every year, the equipment purchase proved to be undesirable.

2 Problem 2

Question: Jenny is an engineer for a municipal power plant. The plant uses natural gas, which is currently obtained from an existing pipeline at an annual cost of $110,000 per year. Jenny is considering a project to construct a new boiler. The initial cost to purchase and install the new boiler would be $800,000, but it would reduce the annual natural gas cost to $70,000 per year. Assume the boiler will last 20 years, and that the new boiler will not have any salvage value at the end. Use an interest rate of 4.5%.

a) Determine the equivalent uniform annual cost (EUAC) for the new boiler.

b) Should the new boiler be purchased and installed?

Solution:

(a) We will determine the equivalent annual cost of the new boiler in the following calculation:

$$\begin{aligned} EUAC &= P(A/P, i, n) - A \\ &= 800,000(A/P, 4.5\%, 20) - 70,000 \\ &= 800,000\frac{0.045(1+0.045)^{20}}{(1+0.045)^{20} - 1} + 70,000 \\ &= 131,500 > 110,000 \end{aligned}$$

(b) The equivalent uniform annual cost of installing the new boiler would be greater than that of the current one, so we should not install it.

3 Problem 3

Question: An office building with 10,000 ft^2 of leasable space will be purchased. The owner will sell it after 20 years for a price that will recover 40% of the building purchase cost and all of the land purchase cost. It will be leased to commercial clients for the 20 years.

Land	\$4.2M
Building	\$3.5M
Annual operating and maintenance	\$640,000
Annual property taxes and insurance (as % of initial capital investment)	3%

Assume annual costs are distributed evenly across the months in each year.

(a) If the owner wants a 12% rate of return, what is the required monthly leasing cost per square foot, assuming the building is entirely leased out? Assume monthly compounding applies.

(b) Assume instead that the building will be vacant 10% of the time. What will the required monthly leasing cost per actively leased square foot be in this case, to achieve the same rate of return? Round to the nearest cent for both answers.

Solution:

(a) First we will determine the initial capital investment, this comes out to be

$$P = 4.2M + 3.5M = 7.7M.$$

We then know that the annual tax will be 3% of this investment. Which is \$231,000 per year. Along with the annual maintenance cost, we get an annual cost of \$871,000, which we will denote as C. We then want to determine the salvage price of the unit, which comes out to be \$5,600,000, denoted as S. Supposing that we want a nominal annual rate of return of 12%, compounded monthly, we have a rate of 1%. If we want to break It then follows that we want the minimum lease price to cost, denoted as L, as follows:

$$\begin{aligned} P &= L(P/A, 1\%, 240) - C(P/A, 1\%, 240) + S(P/F, 1\%, 240) \\ 7.7M &= L(P/A, 1\%, 240) - 79,993 + 514,112 \\ &\implies L = 80,004 \\ &\text{monthly lease cost per square ft} = \frac{L}{10,000} = \$8.00 \end{aligned}$$

(b) If we assume a 10% vacancy, we should scale our lease price accordingly:

$$\frac{7.77}{1 - 0.1} = \$8.89$$

4 Problem 4

Question: Danielle can purchase a municipal bond with a par value (list price) of \$7,000 that will mature in five years. The bond pays 6.4% interest. Payments are issued quarterly. If she can buy this bond for \$6,720, what effective annual rate of return will she earn, rounded to the nearest tenth of a percent?

Solution: We can use the rate function in excel to determine the quarterly rate of return, where

$$\begin{aligned} NPER &= 4 * 5 \text{ years} = 20 \text{ periods} \\ PV &= -6,720 \\ FV &= 7,000 \\ PMT &= 7,000 \cdot 6.4\% \cdot \frac{1}{4} = 112 \end{aligned}$$

this yields a quarterly rate of return of 1.84%. knowing this, we can determine an effective annual rate of return of

$$(1 + 0.0184)^4 - 1 = 1.076 - 1 = 7.6\% \tag{1}$$

5 Problem 5

Question: A company is offering to sell an annuity for $20,000 cash. In return, the firm will guarantee to pay the purchaser 20 annual end-of-year payments, with the first payment of $1,000. Subsequent payments will increase at a uniform 10% rate each year. What rate of return will the purchaser receive if she buys the annuity, rounded to one decimal place (x.x%)?

Solution: From the following spreadsheet:

Year		
0	-20000	
1	1000	
2	1100	Rate of return 9.02%
3	1210	
4	1331	
5	1464.1	
6	1610.51	
7	1771.561	
8	1948.7171	
9	2143.58881	
10	2357.947691	
11	2593.74246	
12	2853.116706	
13	3138.428377	
14	3452.271214	
15	3797.498336	
16	4177.248169	
17	4594.972986	
18	5054.470285	
19	5559.917313	
20	6115.909045	

We get an internal rate of return of 9.0%

6 Problem 6

Question: Consider three alternatives: A, B, and do nothing. Construct a choice table for these alternatives.

Year	A	B
0	-$100	-$150
1	+30	+42
2	+30	+42
3	+30	+42
4	+30	+42
5	+30	+42

Round your answers to the nearest tenth of a percent (x.x%). **Solution:** We get the following table

Choice Table				
If	0	$<$ borrowing rate $\leq$	6.4	Select B
If	6.4	$<$ borrowing rate $\leq$	15.2	Select A
If	15.2	$<$ borrowing rate		Do nothing

7 Problem 7

Question: The owner of a corner lot wants to find a use that will yield a desirable return on his investment. After much study and calculation, he decides that the two best alternatives are the following:

	Build Gas Station	Build Soft Ice Cream Stand
First cost	\$80,000	\$120,000
Annual property taxes	\$3,000	\$5,000
Annual income	\$11,000	\$16,000

Neither option is expected to have any salvage value. Both investments are expected to last twenty years. If the owner wants a minimum attractive rate of return on his investment of 6%, which of the two alternatives would you recommend?

Solution:

Year	Gas Station CF	Ice Cream CF	Ice Cream vs Gas station
0	-80000	-120000	-40000
1	8000	11000	3000
2	8000	11000	3000
3	8000	11000	3000
4	8000	11000	3000
5	8000	11000	3000
6	8000	11000	3000
7	8000	11000	3000
8	8000	11000	3000
9	8000	11000	3000
10	8000	11000	3000
11	8000	11000	3000
12	8000	11000	3000
13	8000	11000	3000
14	8000	11000	3000
15	8000	11000	3000
16	8000	11000	3000
17	8000	11000	3000
18	8000	11000	3000
19	8000	11000	3000
20	8000	11000	3000
		IRR=	4.22%

Since the incremental rate of return is below the MARR of 6%, I would recommend that the owner chooses the gas station.

8 Appendix

Additional calculations from excel spreadsheet will be included here

Land Cost	4200000	Discount Factor (monthly)	90.8194
Building Cost	3500000		
Initial Capital Investment=	7700000		
Property Tax=	231000	present value of salvage	514112.6845
Annual Maintenance=	640000	present value of costs	79993.87355
Annual Cost=	871000		
monthly cost	72583.33333		
Salvage Value=	5600000		
Annual Rate of return	12.00%		
Monthly Rate of return	0.01		
months	240		
square footage=	10000		
years	20		
Minimum Monthly Lease Rental=	80003.61025		
lease per square ft=	8.000361025		
10% vacancy lease=	8.889290028		

Figure 1: Problem 3

PV($)=	-6720
FV($)=	7000
PMT($)=	112
n=	20
rate of return=	1.84%

Figure 2: Problem 4

	A	B	C		Incremental vs A	s B C
	income/payment					
	-100	-150	0		50	150
	30	42	0		-12	-42
	30	42	0		-12	-42
	30	42	0		-12	-42
	30	42	0		-12	-42
	30	42	0		-12	-42
IRR:		15.24%	12.38%		6.40%	12.38%

Figure 3: Problem 6