

ADVANCED CAPITAL BUDGETING DECISIONS

CLASS 5

Topic Sensitivity Analysis

Question 1:

Red Ltd. is considering a project with the following Cash flows:

Years	Cost of Plant	Recurring Cost	Savings
0	10,000		
1		4,000	12,000
2		5,000	14,000

The cost of capital is 9%. Measure the sensitivity of the project to changes in the levels of plant value, running cost and savings (considering each factor at a time) such that the NPV becomes zero. The P.V. factor at 9% are as under:

Year	Factor
0	1
1	0.917
2	0.842

Which factor is the most sensitive to affect the acceptability of the project?

(Source: ICAI)

ANSWER:

P.V. of Cash Flows

Year 1	Running Cost	₹ 4,000 x 0.917	=	(₹ 3,668)
	Savings	₹ 12,000 x 0.917	=	₹ 11,004
Year 2	Running Cost	₹ 5,000 x 0.842	=	(₹ 4,210)
	Savings	₹ 14,000 x 0.842	=	<u>₹ 11,788</u>
				<u>₹ 14,914</u>
Year 0	Less: P.V. of Cash Outflow	₹ 10,000 x 1		<u>₹ 10,000</u>
	NPV			<u>₹ 4,914</u>

Sensitivity Analysis

- i. Increase of Plant Value by ₹ 4,914

$$\therefore \frac{4,914}{10,000} \times 100 = 49.14\%$$

- ii. Increase of Running Cost by ₹ 4,914

$$\frac{4,914}{3,668 + 4,210} = \frac{4,914}{7,878} \times 100 = 62.38\%$$

- iii. Fall in Saving by ₹ 4,914

$$\frac{4,914}{11,004 + 11,788} = \frac{4,914}{22,792} \times 100 = 21.56\%$$

Hence, savings factor is the most sensitive to affect the acceptability of the project as in comparison of other two factors a slight % change in this fact shall more affect the NPV than others.

Alternative Solution

P.V. of Cash Flows

Year 1	Running Cost	₹ 4,000 x 0.917	=	(₹ 3,668)
	Savings	₹ 12,000 x 0.917	=	₹ 11,004
Year 2	Running Cost	₹ 5,000 x 0.842	=	(₹ 4,210)
	Savings	₹ 14,000 x 0.842	=	<u>₹ 11,788</u>
				<u>₹ 14,914</u>
Year 0	Less: P.V. of Cash Outflow	₹ 10,000 x 1		<u>₹ 10,000</u>
	NPV			<u>₹ 4,914</u>

Sensitivity Analysis

- i. If the initial project cost is varied adversely by say 10%*.

$$\text{NPV (Revised)} (\text{₹ } 4,914 - \text{₹ } 1,000) = \text{₹ } 3,914$$

$$\text{Change in NPV} = \frac{\text{₹}4,914 - \text{₹}3,914}{\text{₹}4,914} = 20.35\%$$

ii. If Annual Running Cost is varied by say 10%*.

$$\begin{aligned} \text{NPV (Revised)} &= (\text{₹}4,914 - \text{₹}400 \times 0.917 - \text{₹}500 \times 0.843) \\ &= \text{₹}4,914 - \text{₹}367 - \text{₹}421 = \text{₹}4,126 \end{aligned}$$

$$\text{Change in NPV} = \frac{\text{₹}4,914 - \text{₹}4,126}{\text{₹}4,914} = 16.04\%$$

iii. If Saving is varied by say 10%*.

$$\begin{aligned} \text{NPV (Revised)} &= (\text{₹}4,914 - \text{₹}1,200 \times 0.917 - \text{₹}1,400 \times 0.843) \\ &= \text{₹}4,914 - \text{₹}1,100 - \text{₹}1,180 = \text{₹}2,634 \end{aligned}$$

$$\text{Change in NPV} = \frac{\text{₹}4,914 - \text{₹}2,634}{\text{₹}4,914} = 46.40\%$$

Hence, savings factor is the most sensitive to affect the acceptability of the project.

* Any percentage of variation other than 10% can also be assumed.

Question 2:

The Easygoing Company Limited is considering a new project with initial investment, for a product "Survival". It is estimated that IRR of the project is 16% having an estimated life of 5 years.

Financial Manager has studied that project with sensitivity analysis and informed that annual fixed cost sensitivity is 7.8416%, whereas cost of capital (discount rate) sensitivity is 60%.

Other information available are:

Profit Volume Ratio (P/V) is 70%,

Variable cost ₹ 60/- per unit

Annual Cash Flow ₹ 57,500/-

Ignore Depreciation on initial investment and impact of taxation.

Calculate

- i. Initial Investment of the Project
- ii. Net Present Value of the Project
- iii. Annual Fixed Cost
- iv. Estimated annual unit of sales
- v. Break Even Units

Cumulative Discounting Factor for 5 years

8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%
3.993	3.890	3.791	3.696	3.605	3.517	3.433	3.352	3.274	3.199	3.127

(Source: ICAI)

ANSWER:

i. Initial Investment

IRR = 16% (Given)

At IRR, NPV shall be zero, therefore

$$\begin{aligned}\text{Initial Cost of Investment} &= \text{PVAF (16\%,5)} \times \text{Cash Flow (Annual)} \\ &= 3.274 \times ₹ 57,500 \\ &= ₹ 1,88,255\end{aligned}$$

ii. Net Present Value (NPV)

Let Cost of Capital be X, then $\frac{16 - X}{X} = 60\%$ X = 10%

Thus NPV of the project

$$\begin{aligned}&= \text{Annual Cash Flow} \times \text{PVAF (10\%, 5)} - \text{Initial Investment} \\ &= ₹ 57,500 \times 3.791 - ₹ 1,88,255 \\ &= ₹ 2,17,982.50 - ₹ 1,88,255 = ₹ 29,727.50\end{aligned}$$

iii. Annual Fixed Cost

Let change in the Fixed Cost which makes NPV zero is X.

Then, ₹ 29,727.50 – 3.791X = 0

Thus X = ₹ 7,841.60

Let original Fixed Cost be Y then,

$$Y \times 7.8416\% = ₹ 7,841.60$$

$$Y = ₹ 1,00,000$$

Thus Fixed Cost is equal to ₹ 1,00,000

iv. Estimated Annual Units of Sales

$$\text{Selling Price per unit} = \frac{₹60}{100\% - 70\%} = ₹200$$

$$\frac{\text{Annual Cash Flow} + \text{Fixed Cost}}{\text{P/V Ratio}} = \text{Sales Value}$$

$$\frac{₹57,500 + ₹1,00,000}{0.70} = ₹2,25,000$$

$$\text{Sales in Units} = \frac{₹2,25,000}{₹200} = 1,125 \text{ units}$$

v. Break Even Units

$$\frac{\text{Fixed Cost}}{\text{Contribution Per Unit}} = \frac{1,00,000}{140} = 714.285 \text{ units}$$

Question 3:

Unnat Ltd. is considering investing ₹ 50,00,000 in a new machine. The expected life of machine is five years and has no scrap value. It is expected that 2,00,000 units will be produced and sold each year at a selling price of ₹ 30.00 per unit. It is expected that the variable costs to be ₹ 16.50 per unit and fixed costs to be ₹ 10,00,000 per year. The cost of capital of Unnat Ltd. is 12% and acceptable level of risk is 20%.

You are required to measure the sensitivity of the project's net present value to a change in the following project variables:

- sale price;
- sales volume;
- variable cost;
- On further investigation it is found that there is a significant chance that the expected sales volume of 2,00,000 units per year will not be achieved. The sales manager of Unnat Ltd. suggests that sales volumes could depend on expected economic states which could be assigned the following probabilities:

State of Economy	Annual Sales (in Units)	Prob.
Poor	1,75,000	0.30
Normal	2,00,000	0.60
Good	2,25,000	0.10

Calculate expected net present value of the project and give your decision whether company should accept the project or not.

(Source: ICAI)

ANSWER:

$$\begin{aligned}
 \text{Calculation of NPV} &= - ₹ 50,00,000 + [2,00,000 (₹ 30 - ₹ 16.50) - ₹ 10,00,000] \text{ PVIAF } (12\%, 5) \\
 &= - ₹ 50,00,000 + [2,00,000 (₹ 13.50) - ₹ 10,00,000] 3.605 \\
 &= - ₹ 50,00,000 + [₹ 27,00,000 - ₹ 10,00,000] 3.605 \\
 &= - ₹ 50,00,000 + ₹ 61,28,500 \\
 &= ₹ 11,28,500
 \end{aligned}$$

Measurement of Sensitivity Analysis

a. Sales Price:

Let the sale price/Unit be S so that the project would break even with 0 NPV.

$$\therefore ₹ 50,00,000 = [2,00,000 (S - ₹ 16.50) - ₹ 10,00,000] \text{ PVIAF } (12\%, 5)$$

$$₹ 50,00,000 = [2,00,000S - ₹ 33,00,000 - ₹ 10,00,000] 3.605$$

$$₹ 50,00,000 = [2,00,000S - ₹ 43,00,000] 3.605$$

$$₹ 13,86,963 = 2,00,000S - ₹ 43,00,000$$

$$₹ 56,86,963 = 2,00,000S$$

$$S = ₹ 28.43 \text{ which represents a fall of } (30 - 28.43)/30 \text{ or } 0.0523 \text{ or } 5.23\%$$

b. Sales volume:

Let V be the sale volume so that the project would break even with 0 NPV.

$$\therefore ₹ 50,00,000 = [V (₹ 30 - ₹ 16.50) - ₹ 10,00,000] \text{ PVIAF } (12\%, 5)$$

$$₹ 50,00,000 = [V (₹ 13.50) - ₹ 10,00,000] \text{ PVIAF } (12\%, 5)$$

$$₹ 50,00,000 = [₹ 13.50V - ₹ 10,00,000] 3.605$$

$$₹ 13,86,963 = ₹ 13.50V - ₹ 10,00,000$$

$$₹ 23,86,963 = ₹ 13.50V$$

$$V = 1,76,812 \text{ which represents a fall of } (2,00,000 - 1,76,812)/2,00,000 \text{ or } 0.1159 \text{ or } 11.59\%$$

c. Variable Cost:

Let the variable cost be V so that the project would break even with 0 NPV.

$$\therefore ₹ 50,00,000 = [2,00,000(₹ 30 - V) - ₹ 10,00,000] \text{ PVIAF}(12\%, 5)$$

$$₹ 50,00,000 = [₹ 60,00,000 - 2,00,000 V - ₹ 10,00,000] 3.605$$

$$₹ 50,00,000 = [₹ 50,00,000 - 2,00,000 V] 3.605$$

$$₹ 13,86,963 = ₹ 50,00,000 - 2,00,000 V$$

$$₹ 36,13,037 = 2,00,000V \quad V = ₹ 18.07$$

$$\text{which represents a fall of } (18.07 - 16.50)/16.50 \text{ or } 0.0951 \text{ or } 9.51\%$$

d. Expected Net Present Value

$$(1,75,000 \times 0.30) + (2,00,000 \times 0.60) + (2,25,000 \times 0.10) = 1,95,000$$

$$\text{NPV} = [1,95,000 \times ₹ 13.50 - ₹ 10,00,000] 3.605 - ₹ 50,00,000 = ₹ 8,85,163$$

Further NPV in worst and best cases will be as follows:

Worst Case:

$$[1,75,000 \times ₹ 13.50 - ₹ 10,00,000] 3.605 - ₹ 50,00,000 = - ₹ 88,188$$

Best Case:

$$[2,25,000 \times ₹ 13.50 - ₹ 10,00,000] 3.605 - ₹ 50,00,000 = ₹ 23,45,188$$

Thus, there are 30% chances that the rise will be a negative NPV and 70% chances of positive NPV. Since acceptable level of risk of Unnat Ltd. is 20% and there are 30% chances of negative NPV hence project should not be accepted.

Alternate solⁿ of Q.3] NB pg. 27

Sensitivity analysis using Method 2: Shock Approach.

$$\begin{aligned} NPV &= [(Selling Price - v.c.) \times Q - F.C.] \times PVAF (12\%, 5) - I \\ &= [(30 - 16.5) \times 200000 - 10000000] \times 3.6048 - 5000000 \\ &= [13.5 \times 200000 - 10000000] \times 3.6048 - 5000000 \\ &= [2700000 - 10000000] \times 3.6048 - 5000000 \\ &= 6128160 - 5000000 \\ &= 1128160 \end{aligned}$$

① Sales Price :-

If sales price = 30 is adversely affected by 10%,
 $S.P. = 30 - 10\% \text{ of } 30 = ₹27$

$$\begin{aligned}\therefore NPV &= [(27 - 16.5) \times 200000 - 1000000] \times 3.6048 - 5000000 \\ &= 3965280 - 5000000 \\ &= -1034720\end{aligned}$$

② Sales Volume :-

If Q is adversely affected by 10%,

$$Q = 200000 - 10\% \text{ of } 200000 = 180000$$

$$\begin{aligned}\therefore NPV &= [(30 - 16.5) \times 180000 - 1000000] \times 3.6048 - 5000000 \\ &= 5154864 - 5000000 \\ &= 154864\end{aligned}$$

③ Variable cost :-

If V.C. is adversely affected by 10%,

$$V.C. = 16.5 + 16.5 \times 10\% = 18.15$$

$$\begin{aligned}\therefore NPV &= [(30 - 18.15) \times 200000 - 1000000] \times 3.6048 - 5000000 \\ &= 4938576 - 5000000 \\ &= -61424\end{aligned}$$

Calculation of changes in NPV :

Sales price	Sales Volume	Variable Cost
$1128160 - (-1034720)$	$1128160 - 154864$	$1128160 - (-61424)$
1128160	1128160	1128160
= 191.71%	= 86.27%	= 105.44%

Project is more sensitive to sales price.

Question 4:

Suppose you are the financial manager of Hindustan Flour Mills. Hindustan is considering setting up a new flour mill near Bangalore. Based on Hindustan's previous experience, the project staff of Hindustan has developed the figures shown in Exhibit 4.1. (Note that the salvage value has been assumed to be nil and the cost of capital to be 12 percent).

Exhibit 4.1 Cash flow forecast for Hindustan's Flour Mill Project

(Rs in thousands)

	Year 0	Year 1-10
1. Investment	(20,000)	
2. Sales		18,000
3. Variable costs ($66\frac{2}{3}\%$ of sales)		12,000
4. Fixed costs		1,000
5. Depreciation		2,000

Tax rate = $1/3$ i.e., 33.33%

You are, however, aware that the underlying variables can vary widely and hence you would like to explore the effect of such variations on the NPV. So you define the optimistic and pessimistic estimates for the underlying variables. These are shown in Exhibit 4.2.

Exhibit 4.2 Sensitivity of NPV to Variations in the Value of Key Variables

	Range		
	Pessimistic	Expected	Optimistic
Investment (Rs. in million)	24	20	18
Sales (Rs. in million)	15	18	21
Variable costs as a percent of sales	70	66.66	65
Fixed costs (Rs. in million)	1.3	1.0	0.8

1. Calculate NPV under each scenario.
2. Assuming each scenario to be equally probable, should the project be accepted given that the firms risk profile does not permit acceptance of projects where probability of shareholders wealth destruction is greater than 25%.
3. Now suppose we are doing sensitivity analysis i.e., we are varying only one variable at a time. Please fill up the following table:

Key Variables	Range			NPV		
	Pessimistic	Expected	Optimistic	Pessimistic	Expected	Optimistic
Investment (Rs. in million)	24	20	18	-1.40	2.60	4.60
Sales (Rs. in million)	15	18	21	-1.17	2.60	??
Variable costs as a percent of sales	70	66.66	65	??	2.60	3.73
Fixed costs (Rs. in million)	1.3	1.0	0.8	1.47	2.60	??

Scenario Analysis

Q.4

1) NPV under each scenario :

(£ in millions)

Scenarios	Pessimistic	Expected	Optimistic
Sales	15	18	21
(-) Variable cost (%)	70%	2/3 rd	65%
Contribution	4.5	6	7.35
(-) Fixed Cost	1.3	1	0.8
(-) Depreciation	2	2	2
NOPAT ($t = 1/3$)	0.8	2	3
(+) Depreciation	2	2	2
CFAT	2.8	4	5
PVAF (12%, 10)	5.650	5.650	5.650
Investment	24	20	18
NPV	-8.18	2.6	10.25

2) Since the firm's risk profile does not permit accept^{nc} of projects where prob. of SHs wealth destruction is 25%. we should not accept since NPV of pessimistic scenario is negative.

3) Varying only on variable at a time -

(a) Investment → Pessimistic.

$$I = 24$$

$$S.P. = 18$$

$$V.C. = 2/3^{rd} \quad \therefore \text{Contribution} = 18 - 2/3^{rd} \text{ of } 18 = ₹6$$

$$F.C. = 1$$

$$\text{Depr}^n = 2 \quad \therefore \text{NOPAT} = (6 - 1 - 2) \times 2/3 \quad (t = 1/3) \\ = ₹2 \text{ millions}$$

$$\therefore \text{CFAT} = 2 + 2 = ₹4 \text{ millions}$$

$$\text{NPV} = 4 \times \text{PVAF}(12\%, 10) - 24$$

$$= 4 \times 5.650 - 24$$

$$= -1.4 \text{ millions}$$

(b) Sales → Optimistic.

$$I = 20$$

$$S.P. = 21$$

$$\therefore \text{Contribution} = 21 - 2/3^{rd} \text{ of } 21 = 7$$

$$V.C. = 2/3^{rd}$$

$$F.C. = 1$$

$$\therefore \text{NOPAT} = (7 - 1 - 2) \times 2/3 \quad (t = 1/3)$$

$$\text{Depr}^n = 2$$

$$= 8/3$$

$$\therefore \text{CFAT} = 8/3 + 2 = 14/3$$

$$\text{NPV} = 14/3 \times 5.650 - 20$$

$$= 6.367$$

(c) Variable cost → Pessimistic

$$I = 20$$

$$S.P. = 18$$

$$V.C. = 70\%$$

$$\therefore \text{Contribution} = 18 - 70\% \text{ of } 18 = 5.4$$

$$F.C. = 1$$

$$\text{Depr}^n = 2 \quad \therefore \text{NOPAT} = (5.4 - 1 - 2) \times 2/3 \quad (t=3)$$

$$= 1.6$$

$$\therefore \text{CFAT} = 1.6 + 2 = 3.6$$

$$\text{NPV} = 3.6 \times 5.650 - 20$$

$$= 0.34 \text{ millions}$$

(d) Fixed cost $\rightarrow$ Optimistic

$$I = 20$$

$$S.P. = 18$$

$$V.C. = 2/3^{\text{rd}}$$

$$F.C. = 0.8$$

$$\text{Depr}^n = 2$$

$$\therefore \text{Contribution} = 18 - 2/3^{\text{rd}} \text{ of } 18 = ₹6$$

$$\therefore \text{NOPAT} = (6 - 0.8 - 2) \times 2/3 \quad (t=1/3)$$

$$= 2.13$$

$$\therefore \text{CFAT} = 2.13 + 2 = 4.13$$

$$\text{NPV} = 4.13 \times 5.650 - 20$$

$$= +3.35$$

Table :-

Key Variables	Range			NPV		
	Pessimistic	Expected	Optimistic	Pessimistic	Expected	Optimistic
Investment	24	20	18	-1.4	2.6	4.6
Sales	15	18	21	-1.17	2.6	6.367
Variable Cost	70	66.66	65	0.34	2.6	3.73
Fixed Cost	1.3	1	0.8	1.47	2.6	+3.35