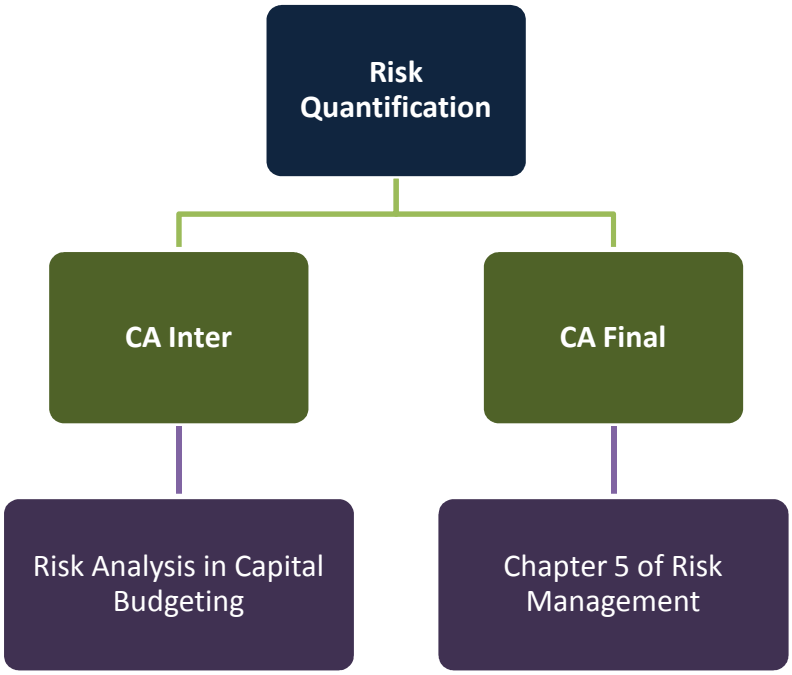
Lecture Note 5

Risk Management



Risk Analysis in Capital Budgeting

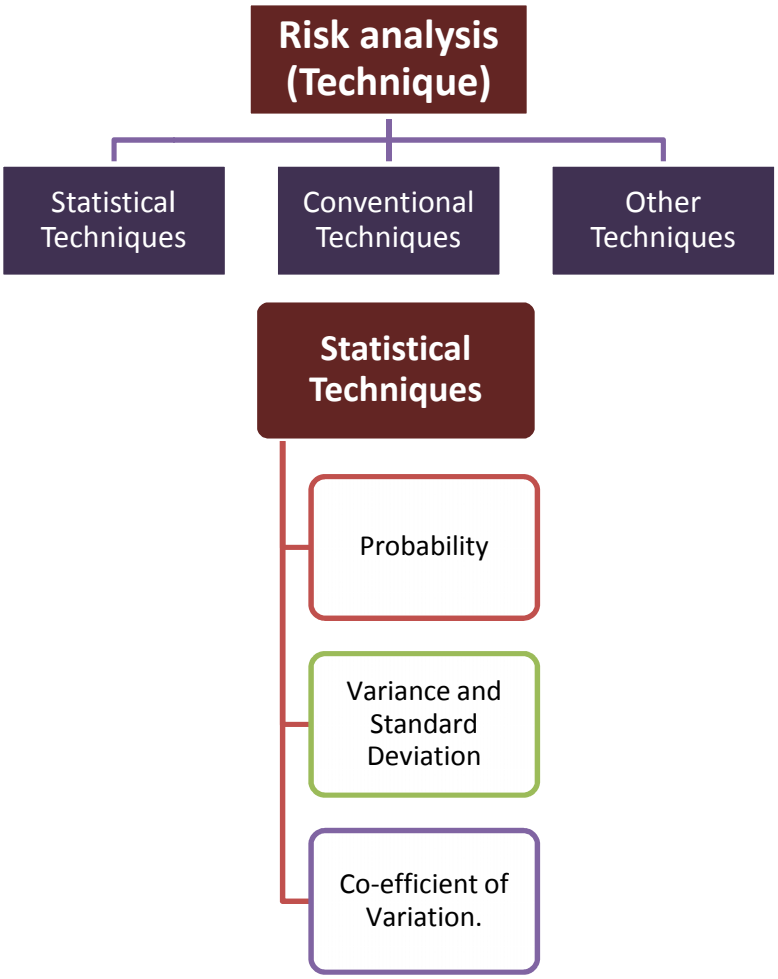
Why risk analysis?

Risk Analysis in Capital Budgeting : Standard Capital Budgeting we forecast the expected cash flows of the project then we use cost of capital as the discount rate to calculate NPV of the project.

If NPV is positive project is accepted.

If NPV is negative project is rejected.

However, discounting expected cash flows at cost of capital presumes that the new project has the same risk as the existing risk of the firm. This means that a Cement firm is doing Cement project and IT firm is doing an IT project etc. However, If a cement firm is doing IT project then the risk complaction of the new project not equal to the risk of the firm so we cannot use cost of capital as discount rate we have to carry out risk analysis.



a. Probability i.e., Expected Value

Expected Value i.e., mean = $\sum P_x$

E(x) or $\bar{x}$ = $\sum Px$

Example

A Project cash flows are uncertain

Year 1		Year 2	
CF	Probability	CF	Probability
400	0.2	600	0.4
700	0.5	900	0.3
800	0.3	1000	0.3

Calculate Expected CF for each year.

Answer :

Year 1		
CF(x)	Probability (P)	Px
400	0.2	80

700	0.5	350
800	0.3	240
	$\overline{CF_1}$	670

Year 2		
CF(x)	**Probability (P)**	**Px**
600	0.4	240
900	0.3	270
1000	0.3	300
	$\overline{CF_2}$	810

Example

Suppose in the previous sum
Initial Investment = 900
Discount rate = 15%
Calculated Expected NPV

Years	Exp. CF	Df @ 15%	PV
0	(900)	1	(900)
1	670	0.8696	583
2	810	0.7561	612
Expected NPV			295

Example

The following table provides NPV distribution of a project.

NPV	Probability
-600	0.2
700	0.1
1000	0.4
1500	0.3

Calculate expected NPV

Answer :

NPV(X)	Probability(P)	PX
-600	0.2	-120
700	0.1	70
1000	0.4	400
1500	0.3	450
Expected NPV		800

b. Variance or Standard Deviation

$\text{Variance}\left(\sigma_n^2\right) =$ Expected value of squared deviation

$\sum P\left(x-\bar{x}\right)^2$ (Difficult to interpret)

Standard Deviation (σ_x) = $\sqrt{\text{Variance}}$ = $\sqrt{\sum P\left(X-\bar{X}\right)^2}$

Example

Following table provides NPV distribution of a project

NPV	Probability
-200	0.2
100	0.5
300	0.3

Calculate expected NPV $\sum$ its SD

Answer :

NPV (X)	Probability(P)	PX	$P\left(X-\bar{X}\right)$
-200	0.2	-40	18,000
100	0.5	50	0
300	0.3	90	12,000
Expected NPV $\left(\bar{X}\right)$			30,000

$\sigma_x^2 = \sum P\left(X-\bar{X}\right)^2 = 30,000$

SD i.e., $\sigma x = \sqrt{30,000} = 173.21$

Example

Following table provides CF distribution of a 2 years project.

Year 1		Year 2	
CF	**Probability**	**CF**	**Probability**
200	0.4	300	0.3
400	0.4	700	0.4
500	0.2	800	0.3

Calculate expected CF $\sum$SD of CF for each year.

Answer :

Year 1

CF(X)	Probability(P)	PX	$\sum P(X-\bar{X})^2$
200	0.4	80	7,840
400	0.4	160	1,440
500	0.2	100	5,120
Expected $\overline{CF_1}$		340	14,400

Year 2

CF(X)	Probability(P)	PX	$\sum P(X-\bar{X})^2$
300	0.3	90	28,830
700	0.4	280	3,240
800	0.3	240	10,830
Expected $\overline{CF_2}$		610	42,900

$\sigma x^2 = 42,900$

$\sigma x(SD) = 207.123$

c. Coefficient of Variation (CV)

- Obviously, we prefer a project with higher expected NPV
- Obviously, we prefer a project with lower risk (SD)(σ)
- However, if there is a fight between the two i.e. project with higher expected NPV also has higher risk(σ). We compute coefficient of variation (CU)

$$CV = \frac{SD}{Mean} \times 100$$

(Risk, return ka kya % hai?) obviously, lower the better.

Example

Consider the following 2 mutually exclusive projects

Particulars	Project A	Project B
Expected NPV	300cr	500cr
SD of NPV	100cr	150cr

1. Which project should be selected based on expected NPV.
2. Which project should be selected based on risk alone.
3. Considering both risk and return, which project should be selected.

Answer :

1. Project B - Higher NPV
2. Project A - Lower SD
3. We Should compute CV.

$$CV_A = \frac{100}{300} \times 100 = 33.33\%$$

$$CV_B = \frac{150}{500} \times 100 = 30\%$$

So, Project B should selected.

Question

Shivam Ltd. is considering two mutually exclusive projects A and B. Project A costs ₹ 36,000 and project B ₹ 30,000. You have been given below the net present value probability distribution for each project.

Project A		Project B	
NPV estimates (₹)	**Probability**	**NPV estimates (₹)**	**Probability**
15,000	0.2	15,000	0.1
12,000	0.3	12,000	0.4
6,000	0.3	6,000	0.4
3,000	0.2	3,000	0.1

i. Compute the expected net present values of projects A and B.

ii. Compute the risk attached to each project i.e. standard deviation of each probability distribution.

iii. Compute the profitability index of each project.

iv. Which project do you recommend? State with reasons.

Answer :

i. Statement showing computation of expected net present value of Projects A and B:

Project A			Project B		
NPV Estimate (₹)	**Probability**	**Expected Value**	**NPV Estimate**	**Probability**	**Expected Value**
15,000	0.2	3,000	15,000	0.1	1,500
12,000	0.3	3,600	12,000	0.4	4,800
6,000	0.3	1,800	6,000	0.4	2,400
3,000	0.2	600	3,000	0.1	300
	1.0	EV = 9,000		1.0	EV = 9,000

ii. Computation of Standard deviation of each project

Project A

P	X	(X – EV)	P (X- EV)²
0.2	15,000	6,000	72,00,000
0.3	12,000	3,000	27,00,000
0.3	6,000	- 3,000	27,00,000
0.2	3,000	- 6,000	72,00,000
		Variance = 1,98,00,000	

Standard Deviation of Project A = $\sqrt{1,98,00,000}$ = ₹4,450

Project B

P	X	(X – EV)	P (X- EV)²
0.1	15,000	6,000	36,00,000
0.4	12,000	3,000	36,00,000
0.4	6,000	- 3,000	36,00,000
0.1	3,000	- 6,000	36,00,000
		Variance = 1,44,00,000	

Standard Deviation of Project B = $\sqrt{1,44,00,000}$ = ₹ 3,795

iii. Computation of profitability of each project

Profitability index = Discount cash inflow / Initial outlay

In case of Project A : PI

$$= \frac{9,000+36,000}{36,000} = \frac{45,000}{36,000} = 1.25$$

In case of Project B : PI

$$= \frac{9,000+30,000}{30,000} = \frac{39,000}{30,000} = 1.30$$

iv. Measurement of risk is made by the possible variation of outcomes around the expected value and the decision will be taken in view of the variation in the expected value where two projects have the same expected value, the decision will be the project which has smaller variation in expected value. In the selection of one of the two projects A and B, Project B is preferable because the possible profit which may occur is subject to less variation (or dispersion). Much higher risk is lying with project A.

Question

Possible net cash flows of Projects A and B and their probabilities are given as below. Discount rate is 10 per cent for both the project initially investment is ₹ 10,000. Calculate the expected net present value for each project. Which project is preferable?

Project A			Project B	
Possible Event	Cash Flow (₹)	Probability	Cash Flow (₹)	Probability
A	8,000	0.10	4,000	0.10
B	10,000	0.20	20,000	0.15
C	12,000	0.40	16,000	0.50
D	14,000	0.20	12,000	0.15
E	16,000	0.10	8,0,000	0.10

Answer :

Calculation of Expected Value for Project A and Project B

Project A				Project B		
Possible Event	Net Cash Flow (₹)	Probability	Expected Value (₹)	Cash Flow (₹)	Probability	Expected Value (₹)
A	8,000	0.10	800	4,000	0.10	400
B	10,000	0.20	2,000	20,000	0.15	3,000
C	12,000	0.40	4,800	16,000	0.50	8,000
D	14,000	0.20	2,800	12,000	0.15	1,800
E	16,000	0.10	1,600	80,000	0.10	800
ENCF			12,000			16,000

The net present value for Project A is (0.909 × ₹ 12,000 – ₹ 10,000) = ₹ 908

The net present value for Project B is (0.909 × ₹ 16,000 – ₹10,000) = ₹ 4,544.

Self Note

Calculate SD of the CF for each project - *(Ye ek saal ka project hai)*

Solution :

Project A

X	P	$P(X-\bar{X})^2$
8,000	0.1	16,00,000
10,000	0.2	8,00,000
12,000	0.4	0

14,000	0.2	8,00,000
16,000	0.1	16,00,000
Variance		48,00,000

$\sigma x = \sqrt{48,00,000} = 2190.89$

Project B

X	P	
4,000	0.1	2,95,84,000
20,000	0.15	2,16,000
16,000	0.5	1,35,20,000
12,000	0.15	1,26,96,000
80,000	0.1	34,57,44,000
		40,17,60,000

$\sigma x = \sqrt{401760000} = 20043.95$

Based on SD alone, project A is less risky & preferred.

Self Note

State your final decision and considering both risk and return.

Solution :

$$COV = \frac{SD}{Mean} \times 100$$

	Project A	Project B
COV	$\frac{2190.89}{12000} \times 100 = 18.26\%$	$\frac{20044}{21200} \times 100 = 94.55$

So, project A is preferred.

Calculation of Risk via Statistical Techniques

Example

The following table provides a probability Distribution of NPV of a project

NPV	Probability
-10	0.3
5	0.5
20	0.2

Calculate expected NPV, Standard Deviation of NPV, Coefficient of variation of NPV

Answer :

NPV(x)	Probability (P)	Px	$p\left(x-\bar{x}\right)^2$
-10	0.3	-3	54.675
5	0.5	2.5	1.125
20	0.2	4	54.45
Expected NPV		3.5	110.25

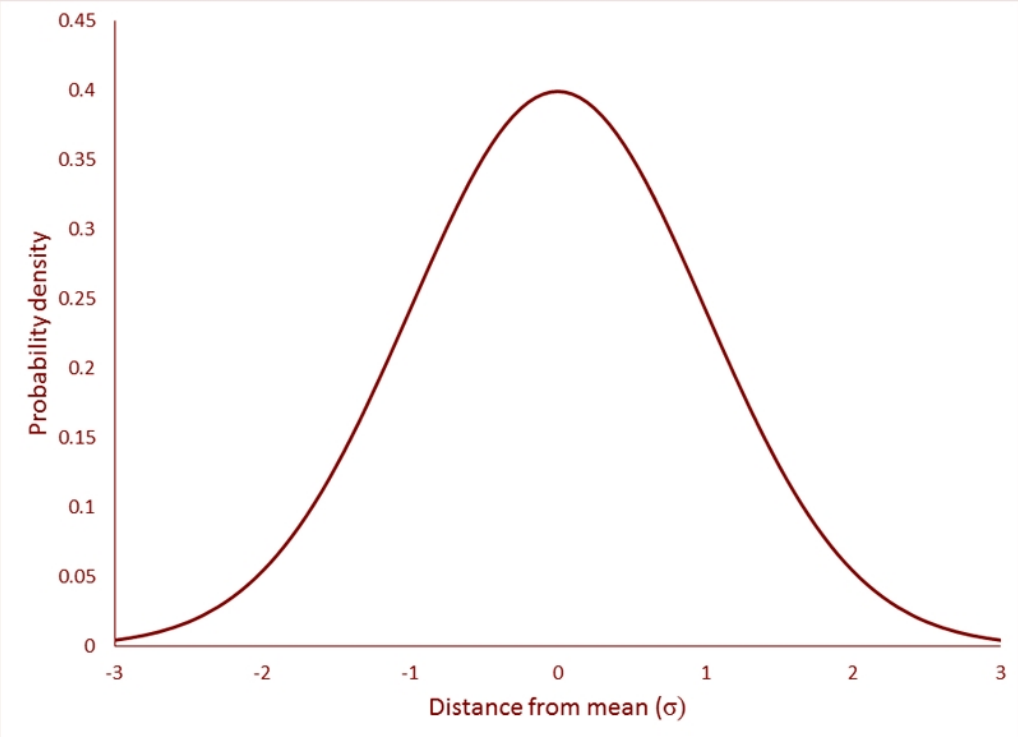
σ of NPV = $\sqrt{110.25} = 10.5$

Coefficient of Variation = $\frac{SD}{Mean} \times 100 = \frac{10.5}{3.5} \times 100 = 300\%$

This is compared to firm's risk appetite.

Application of normal distribution

Normal distribution, is a probability distribution that is symmetric about the mean, showing that data near the mean are more frequent in occurrence than data far from the mean. In graph form, normal distribution will appear as a bell curve.



Since, Normal Distribution has 2 parameters i.e. Mean and SD , and these Parameters will be different in different situations, we use Standard Normal Distribution with a mean of 0 and SD of 1. The process of converting x into z is known as Standardization given by –

$$z = \frac{x - \mu}{\sigma}$$

Example

In the previous sum, what is the probability of Negative NPV if :

Case 1 : You have the Probability Distribution as given

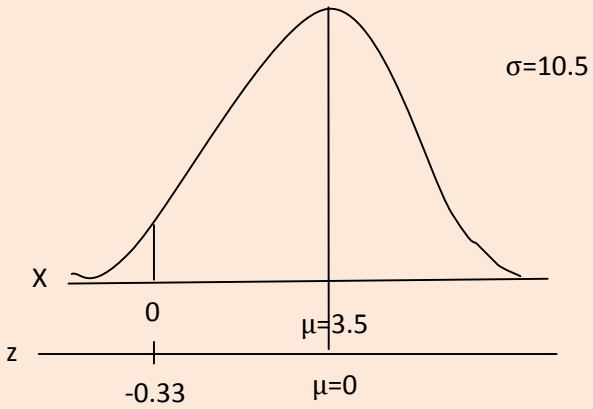
NPV	Probability
-10	0.3
5	0.5
20	0.2

Case 2 : NPV follows a Normal Distribution with Mean = 3.5 and SD = 10.5.

Answer :

Case 1 : Probability of Negative NPV = 30%

Case 2 :



$$z = \frac{x - \mu}{\sigma} = \frac{0 - 3.5}{10.5} = -0.33$$

Probability = 0.3707 (calculated from Excel Sheet command : Normsdist(-0.33))

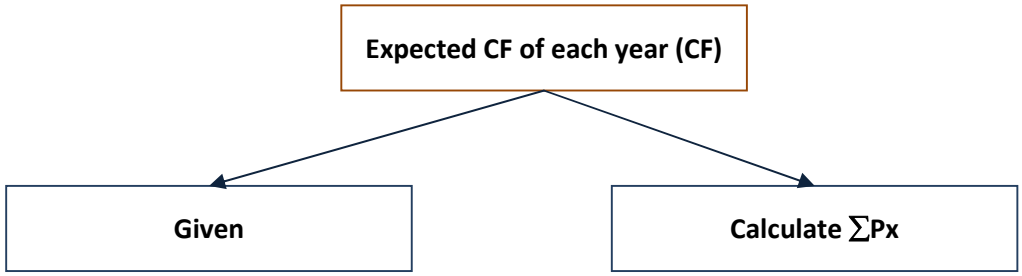
Conventional Techniques

Project risky hai..... I don't like it because I am fattu. I will penalize the project..... *Agni Pariksha*. If it still provides positive NPV, it is accepted.

Method I

Certainty Equivalent Approach(α)

Step 1 :



Step 2:

Certain Equivalent CF = $\alpha \times \overline{CF}$

Where, α = certainty equivalent coefficient

(Ek rupiya jo uncertain hai uske badle kitna rupya certain chahiye) $\Rightarrow$ Say α = 0.9

Step 3 :

Agni pariksha Step 2 me hogaya $\Rightarrow$ *Aab NPV nikalo. Rf (Risk free) discount rate use karke*

Years	Expected CF	$\alpha \times$ Expected CF	Df @ Rf	PV
				××
			(-) II	(××)
			Expected NPV	××

Example

Consider a 3 year project with II = 500 cr. CFs each year are uncertain and have the following distribution :

Year 1		Year 2		Year 3	
CF	Probability	CF	Probability	CF	Probability
100	0.4	200	0.2	300	0.1
120	0.5	240	0.5	390	0.4
200	0.1	300	0.3	420	0.5

Firm decided to use certainty equivalent method. The Certainty equivalent coefficients are given by

$\alpha_t = 1 - 0.1t$ (t = 1,2,and 3)

Rf = 7% and Kc = 15%.

Show the process of evaluation of the project.

Answer :

Step 1 : Calculation of expected CF each year.

$$\overline{CF_1} = 0.4 \times 100 + 0.5 \times 120 + 0.1 \times 200 = 120$$
$$\overline{CF_2} = 0.2 \times 200 + 0.5 \times 240 + 0.3 \times 300 = 250$$
$$\overline{CF_3} = 300 \times 0.1 + 0.4 \times 390 + 0.5 \times 420 = 396$$

Step 2 : Calculation of α

$\alpha_1 = 1 - 0.1 \times 1 = 0.9$
$\alpha_2 = 1 - 0.1 \times 2 = 0.8$
$\alpha_3 = 1 - 0.1 \times 3 = 0.7$

Step 3 : Expected NPV using Rf = 7% as discuss

Year	Expected CF	$\alpha \times$ Expected CF	PV	df@Rf
	120	108	100.9	0.93
	250	200	174.68	0.8734
	396	277.2	226.27	0.8163
			501.88	0.8163
		(-)II	(500)	
			₹ 1.88 cr.	

Since NPV is positive, project is viable.

Self Note

Bujho/Samjho to Jane

- **Higher the risk - lower the α**
- **Higher the level of risk aversion (mein high level ka fattu hu) - lower the α**

Method 2

Risk Adequate Discount Rate (RADR)

Step 1 : Expected CF

Student Comment - Aur kitna baar?

Step 2 : *RADR se tangee*

Case I : RADR given.

Case II : RADR = Kc + Differential Risk Premium *(Co mein already normal risk hai... is project mein perhaps differential risk hai)*

Case III : RADR = Rf + Risk Premium

Case IV : RADR = Based on Cov

Case V : RADR = Rf + (Kc - Rf) RI = 7% + (15% - 7%) RI

where RI - Risk index of the project i.e. *project risk co ke risk ka kitna times hai (0.8 ya 12. times)*

Example

Ignore the information on α Use RADR method to evaluate the project:

Case I : RADR = 19%

Case II : This project has higher risk compared to normal risk of the firm. So a differential risk premium of 2% should be used.

Case III : Risk premium on the project = 11%

Case IV : Projects COV is 0.25

Management has provided the following table for RADR

COV	RADR
0	7
0.25	14
0.5	19
0.75	28

Case V : Risk Index of the project = 1.2

Answer :

Case I

Step 1 : Expected CF already Calculated

Step 2 : Expected NPV using RADR = 19%

Year	Expected CF	Df @ 19%	PV
1	120	0.8403	100.836
2	250	0.7062	176.5
3	396	0.5934	234.99
			512.386
		(-) II	(500)
		NPV	12.38 cr.

Project is accepted

Case II

RADR = 15% + 2% (Kc + 2%) = 17%

Year	Expected CF	df@17%	PV
1	120	0.8547	103
2	250	0.7305	183
3	396	0.6244	247
			533

		(-)II	(500)
		NPV	33cr.

Project is accepted.

Case III

RADR = 7% + 11% (Rf + 11%) = 18%

Year	Expected CF	df@18%	PV
1	120	0.8475	101
2	250	0.7182	180
3	396	0.6086	241
			522
		(-)II	(500)
		NPV	22 cr

Project is Accepted.

Case IV

RADR = 14% (Since Cov = 0.25 RADR = 14%)

Year	Expected CF	Df @ 14%	PV
1	120	0.8772	105
2	250	0.7695	192
3	390	0.6750	263
			560
		(-)II	(500)
		NPV	60cr.

Project is Accepted

Case V

RADR = Rf + (Kc - Rf) RI = 7 + (15-7)1.2=16.6%

Year	Expected CF	df@16.6%	PV
1	120	0.8576	103
2	250	0.7355	183
3	396	0.6308	250
			536
		(-II)	(500)
		NPV	36 cr.

Project is Accepted

Example

	Project A	Project B
Year	α	α
1	0.9	0.85
2	0.8	0.75
3	0.7	0.65

Which project should be analysed with a higher RADR?

Answer :

Since project B has lower α, it is more risky. So, higher RADR should be used in Project B.

Question

Probabilities for net cash flows for 3 years a project are as follows:

Year 1		Year 2		Year 3	
Cash Flow (₹)	Probability	Cash Flow (₹)	Probability	Cash Flow (₹)	Probability
2,000	0.1	2,000	0.2	2,000	0.3
4,000	0.2	4,000	0.3	4,000	0.4
6,000	0.3	6,000	0.4	6,000	0.2
8,000	0.4	8,000	0.1	8,000	0.1

Calculate the expected net cash flows. Also calculate the present value of the expected cash flow, using 10 per cent discount rate. Initial Investment is ₹ 10,000.

Answer :

Year 1			Year 2			Year 3		
Cash Flow (₹)	Probability	Expected Value (₹)	Cash Flow (₹)	Probability	Expected Value (₹)	Cash Flow (₹)	Probability	Expected Value (₹)
2,000	0.1	200	2,000	0.2	400	2,000	0.3	600
4,000	0.2	800	4,000	0.3	1200	4,000	0.4	1,600
6,000	0.3	1,800	6,000	0.4	2400	6,000	0.2	1,200
8,000	0.4	3,200	8,000	0.1	800	8,000	0.1	800
ENCF		6,000			4,800			4,200

The present value of the expected value of cash flow at 10 per cent discount rate has been determined as follows:

Present Value of cash flow : $\frac{ENCF_1}{(1+K)^1} + \frac{ENCF_2}{(1+K)^2} + \frac{ENCF_3}{(1+K)^3}$

$$= \frac{6,000}{(1.1)^2} + \frac{4,800}{(1.1)^2} + \frac{4,200}{(1.1)^3}$$

= (6,000 × 0.909) + (4,800 × 0.826) + (4,200 + 0.751) = 12,573

Expected Net Present value = Present Value of cash flow - Initial Investment

= ₹ 12,573 – ₹10,000 = ₹2,573.

Question

An enterprise is investing ₹ 100 lakhs in a project. The risk-free rate of return is 7%. Risk premium expected by the Management is 7%. The life of the project is 5 years. Following are the cash flows that are estimated over the life of the project.

Year	Cash flows (₹ in lakhs)
1	25
2	60
3	75
4	80
5	65

Calculate Net Present Value of the project based on Risk free rate and also on the basis of Risks adjusted discount rate.

Answer :

		At rf		At RADR	
Year	**CF**	**df@7%**	**PV**	**df@14%**	**PV**
1	25	0.9346	23	0.8772	20
2	60	0.8734	52	0.7695	40
3	75	0.8163	61	0.6750	41
4	80	0.7629	61	0.5921	36
5	65	0.7129	46	0.5193	24
			243		161
	(-) II		(100)	(-)II	(100)
	NPV		143 lacs	NPV	61 lacs

Self

Risk free rate = 7%

Risk premium = 7%

∴ RADR = 7 + 7 = 14%

Question

If Investment Proposal is ₹ 45,00,000 and risk free rate is 5%, calculate Net present value under certainty equivalent technique.

Year	Expected cash flow (₹)	Certainty Equivalent coefficient
1	10,00,000	0.90

2	15,00,000	0.85
3	20,00,000	0.82
4	25,00,000	0.78

Answer :

Year	Expected CF	α	α × Expected CF	Df @ 5%	PV
1	1000	0.9	900	0.9524	857.16
2	1500	0.85	1275	0.9070	1156.425
3	2000	0.82	1640	0.8638	1416.632
4	2500	0.78	1950	0.8227	1604.265
					5034.482

∴ PV = 50,34,482
(-) II = 45,00,000
NPV = 5,34,482

Question

The Textile Manufacturing Company Ltd., is considering one of two mutually exclusive proposals, Projects M and N, which require cash outlays of ₹ 8,50,000 and ₹ 8,25,000 respectively. The certainty-equivalent (C.E) approach is used in incorporating risk in capital budgeting decisions. The current yield on government bonds is 6% and this is used as the risk free rate. The expected net cash flows and their certainty equivalents are as follows:

	Project M		Project N	
Year end	Cash Flow (₹)	C.E.	Cash Flow (₹)	C.E.
1	4,50,000	0.8	4,50,000	0.9
2	5,00,000	0.7	4,50,000	0.8
3	5,00,000	0.5	5,00,000	0.7

Present value factors of ₹ 1 discounted at 6% at the end of year 1, 2 and 3 are 0.943, 0.890 and 0.840 respectively.

Required :

i. Which project should be accepted?
ii. If risk adjusted discount rate method is used, which project would be appraised with a higher rate and why?

Answer :

i. Statement Showing the Net Present Value of Project M

Year end	Cash Flow (₹) (a)	C.E. (b)	Adjusted Cash flow (₹) (c) = (a) × (b)	Present value factor at 6%(d)	Total Present value (₹) (e) = (c) ×(d)
1	4,50,000	0.8	3,60,000	0.943	3,39,480
2	5,00,000	0.7	3,50,000	0.890	3,11,500

3	5,00,000	0.5	2,50,000	0.840	2,10,000
					8,60,980
Less: Initial Investment					8,50,000
Net Present Value					10,980

Statement Showing the Net Present Value of Project N

Year end	Cash Flow (₹) (a)	C.E. (b)	Adjusted Cash flow (₹) (c) = (a) × (b)	Present value factor at 6%(d)	Total Present value (₹) (e) = (c) ×(d)
1	4,50,000	0.9	4,05,000	0.943	3,81,915
2	4,50,000	0.8	3,60,000	0.890	3,20,400
3	5,00,000	0.7	3,50,000	0.840	2,94,000
					9,96,315
Less: Initial Investment					8,25,000
Net Present Value					1,71,315

Decision : Since the net present value of Project N is higher, so the project N should be accepted.

ii. Certainty - Equivalent (C.E.) Co-efficient of Project M (2.0) is lower than Project N (2.4). This means Project M is riskier than Project N as "higher the riskiness of a cash flow, the lower will be the CE factor". If risk adjusted discount rate (RADR) method is used, Project M would be analysed with a higher rate.

Question

Determine the risk adjusted net present value of the following projects:

	X	Y	Z
Net cash outlays (₹)	2,10,000	1,20,000	1,00,000
Project life	5 years	5 years	5 years
Annual Cash inflow (₹)	70,000	42,000	30,000
Coefficient of variation	1.2	0.8	0.4

The Company selects the risk-adjusted rate of discount on the basis of the coefficient of variation:

Coefficient of Variation	Risk-Adjusted Rate of Return	P.V. Factor 1 to 5 years At risk adjusted rate of discount
0.0	10%	3.791
0.4	12%	3.605
0.8	14%	3.433
1.2	16%	3.274
1.6	18%	3.127
2.0	22%	2.864
More than 2.0	25%	2.689

Answer :

Statement showing the determination of the risk adjusted net present value

Projects	Net cash outlays	Coefficient of variation	Risk adjusted discount rate	Annual cash inflow	PV factor 1-5 years	Discounted cash inflow	Net present value
	(₹)			(₹)		(₹)	(₹)
(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii) = (v) × (vi)	(viii) = (vii) – (ii)
X	2,10,000	1.20	16%	70,000	3.274	2,29,180	19,180
Y	1,20,000	0.80	14%	42,000	3.433	1,44,186	24,186
Z	1,00,000	0.40	12%	30,000	3.605	1,08,150	8,150

Question

Gauav Ltd. using certainty-equivalent approach in the evaluation of risky proposals. The following information regarding a new project is as follows:

Year	Expected Cash flow	Certainty-equivalent quotient
0	(4,00,000)	1.0
1	3,20,000	0.8
2	2,80,000	0.7
3	2,60,000	0.6
4	2,40,000	0.4
5	1,60,000	0.3

Riskless rate of interest on the government securities is 6 per cent. DETERMINE whether the project should be accepted?

Answer :

Determination of Net Present Value (NPV)

Year	Expected Cash flow (₹)	Certainty-equivalent (CE)	Adjusted Cash flow (Cash flow × CE) (₹)	PV factor (at 0.06)	Total PV (₹)
0	(4,00,000)	1.0	(4,00,000)	1.000	(4,00,000)
1	3,20,000	0.8	2,56,000	0.943	2,41,408
2	2,80,000	0.7	1,96,000	0.890	1,74,440
3	2,60,000	0.6	1,56,000	0.840	1,31,040
4	2,40,000	0.4	96,000	0.792	76,032
5	1,60,000	0.3	48,000	0.747	35,856
NPV = (6,58,776 – 4,00,000)					2,58,776

As the Net Present Value is positive the project should be accepted.

Question

Following information have been retrieved from the finance department of Corp Finance Ltd. relating to Projects X, Y and Z:

Particulars	X	Y	Z
Net cash outlays (₹)	42,00,000	24,00,000	20,00,000
Project life	5 years	5 years	5 years
Annual Cash inflow (₹)	14,00,000	8,40,000	6,00,000
Coefficient of variation	2.0	0.8	1.6

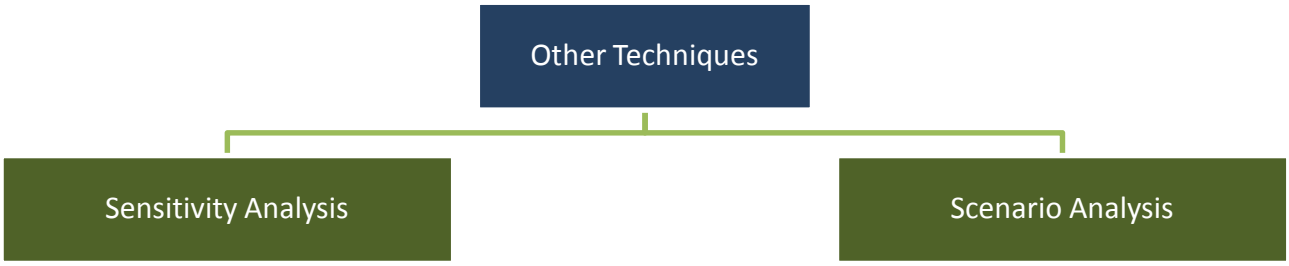
You are required to determine the risk adjusted net present value of the projects considering that the Company selects risk-adjusted rate of discount on the basis of the coefficient of variation:

Coefficient of Variation	Risk-Adjusted Rate of Return	P.V. Factor 1 to 5 years at risk adjusted rate of discount
0.0	8%	3.992
0.4	10%	3.790
0.8	12%	3.604
1.2	14%	3.433
1.6	16%	3.274
2.0	20%	2.990
More than 2.0	22%	2.863

Answer :

Statement showing the determination of the risk adjusted net present value

Projects	Net cash outlays	Coefficient of variation	Risk adjusted discount rate	Annual cash inflow	PV factor 1-5 years	Discounted cash inflow	Net present value
	(₹)			(₹)		(₹)	(₹)
(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii) = (v) × (vi)	(viii) = (vii)–(ii)
X	42,00,000	2.0	20%	14,00,000	2.990	41,86,000	-14,000
Y	24,00,000	0.8	12%	8,40,000	3.604	30,27,360	6,27,360
Z	20,00,000	1.6	16%	6,00,000	3.274	19,64,400	-35,600



Sensitivity Analysis (Most Important topic)

Part I Theory

1. It is a risk analysis tool
2. It involves finding out the sensitivity of NPV w.r.t. each risk factor, ceteris paribus
3. Steps in Sensitivity:
   Step 1 : Calculate expected NPV
   Step 2 : Now shock each risk factor in the adverse direction by a certain % and find out the percentage fall in NPV
   Step 3 : **Conclusion -** The factor which causes maximum percentage fall in NPV is critical factor.

Part II : Practical

Example

Annual CF = 40,000
Number of years = 5
K_c = 15%
Initial Investment = 1,20,000
Carry out Sensitivity analysis of NPV w.r.t -
a. Annual CF
b. K_c
c. Initial Investment
Take a shock of 20%. Which is the most critical factor

Answer :

Step 1 : Expected NPV = 40,000 × PVAF(15%,5) - II = 40,000 × 3.3522 - 1,20,000 = 14088
Step 2 : Sensitivity Analysis
a. w.r.t CF
CF ↓ 20%
∴ CF 40,000 × 0.8 = 32,000
∴ NPV = 32,000×3.3522 - 1,20,000 = -12,730
Percentage fall in NPV

$= \frac{14086-(-12730)}{14086} \times 100 = 190\%$ *(bhayanaak)*

b. w.r.t Kc

Kc ↑ 20%

∴ Kc = 15% × 1.2 = 18%

∴ NPV = 40,000 × PVAF (18%,5) - 1,20,000

= 40,000 × 3.1272 - 1,20,000 = 5088

Percentage fall in NPV = $\frac{14086-5088}{14086} \times 100 = 64\%$

c. w.r.t Initial Investment

II ↑ 20%

II = 1,44,000

∴ NPV = 40,000 × 3.3522 - 1,44,000 = -9912

Percentage fall in NPV = $\frac{14086-(-9912)}{14086} \times 100 = 170\%$

Conclusion : Cash flow is the most critical factor

Question

From the following details relating to a project, analyse the sensitivity of the project to changes in initial project cost, annual cash inflow and cost of capital :

Initial Project Cost (₹)	1,20,000
Annual Cash Inflow (₹)	45,000
Project Life (Years)	4
Cost of Capital	10%

To which of the three factors, the project is most sensitive if the variable is adversely affected by 10%? (Use annuity factors: for 10% 3.169 and 11% ... 3.103).

Answer :

Calculation of NPV through Sensitivity Analysis

	(₹)
PV of cash inflows (₹ 45,000 × 3.169)	1,42,605
Initial Project Cost	(1,20,000)
NPV	22,605

Situation	NPV	Changes in NPV
Base(present)	₹ 22,605	
If initial project cost is varied adversely by 10%	(₹ 1,42,605 - ₹ 1,32,000) = ₹ 10,605	(₹ 22,605 – ₹ 10,605)/₹22,605 = (53.08%)

If annual cash inflow is varied adversely by 10%	[₹40,500(revised cash flow) × 3.169) – (₹ 1,20,000)] = ₹ 8,345	(₹ 22,605 – ₹ 8,345) /₹ 22,605 =63.08%
If cost of capital is varied adversely by 10% i.e. it becomes 11%	(₹ 45,000 × 3.103) –₹ 1,20,000 = ₹ 19,635	(₹ 22,605 – ₹ 19,635) /₹22,605 = 13.14%

Conclusion : Project is most sensitive to 'annual cash inflow'

Question

XYZ Ltd. is considering a project "A" with an initial outlay of ₹ 14,00,000 and the possible three cash inflow attached with the project as follows :

Particular	Year 1	Year 2	Year 3
Worst case	450	400	700
Most likely	550	450	800
Best case	650	500	900

Assuming the cost of capital as 9%, determine NPV in each scenario. If XYZ Ltd is certain about the most likely result but uncertain about the third year's cash flow, what will be the NPV expecting worst scenario in the third year.

Answer :

The possible outcomes will be as follows :

Year	PVF @ 9%	Worst Case		Most likely		Best case	
		Cash Flow (₹ 000)	PV (₹ 000)	Cash Flow (₹ 000)	PV (₹ 000)	Cash Flow (₹ 000)	PV (₹ 000)
0	1	(1400)	(1400)	(1400)	(1400)	(1400)	(1400)
1	0.917	450	412.65	550	504.35	650	596.05
2	0.842	400	336.80	450	378.90	500	421.00
3	0.772	700	540.40	800	617.60	900	694.80
NPV			-110.15		100.85		311.85

Now suppose that CEO of XYZ Ltd. is bit confident about the estimates in the first two years, but not sure about the third year's high cash inflow. He is interested in knowing what will happen to traditional NPV if 3rd year turn out the bad contrary to his optimism.

The NPV in such case will be as follows:

$$= -₹14,00,000 + \frac{5,50,000}{(1+0.09)} + \frac{4,50,000}{(1+0.09)^2} + \frac{7,00,000}{(1+0.09)^3}$$

= –₹14,00,000 + ₹ 5,04,587 + ₹ 3,78,756 + ₹ 5,40,528 = ₹ 23,871

Self Note : Real life me shock kaise decide karte?

Elasticity Nikalo.

Life(n) ko sensitivity ke sum mein generally shock nahi dete - 4 ?

Kyunki lefe (n) integer hona zaruri hai. If n = 4, 10% shock means = 3.6 (solve kar nahi payenge)

of course agar 25% ↓ shock de, toh n = 3 (solve hoga)

Criticism of Sensitivity i.e. drawback of sensitivity

How can we shock one factor at a time keeping other constant?

Scenario Analysis - (*Isse chomu topic is dharti pe paida nahi hua)*

Imagine Different Scenarios

Particulars	Pessimistic Scenario	Most likely scenario	Optimistic Scenario
Annual CF	30,000	40,000	50,000
Life	4 years	5 years	7 years
Kc	18%	14%	12%
II	1,10,000	1,00,000	90,000

Calculate NPV under each scenario.

Pessimistic Scenario :

NPV = 30,000 × PVAF (18%, 4) - 1,10,000 = -29,298

Most likely scenario :

NPV = 40,000 × PVAF(14%,5) - 1,00,000 = 37,323

Optimistic Scenario :

NPV = 50,000 × PVAF(12%,7) - 90,000 = 1,38,188

Also suppose management feels that most likely scenario will occur but Kc will be that of Pessimist Scenario

Find NPV and advice

Annual CF = 40,000
Life = 5 years
Kc = 18%
II = 1,00,000
NPV = 40,000 × PVAF (18%, 5) - 1,00,000
= 25,087

Project is accepted