CHAPTER – 12

ADVANCED CAPITAL BUDGETING

PART 1: INFLATION IN CAPITAL BUDGETING

Question – 01

A firm has projected the following cash flows from a project under evaluation:

Year	₹ lakhs
0	(70)
1	30
2	40
3	30

The above cash flows have been made at expected prices after recognizing inflation. The firm's cost of capital is 10%. The expected annual rate of inflation is 5%.

Show how the viability of the project is to be evaluated.

(SM TYK – 17)

Solution:

Nominal Cash Flows & Nominal Discounting Rate

NDR = $[(1.10 \times 1.05) - 1] \times 100$

= 15.5%

$$NPV = \frac{30}{(1.155)^1} + \frac{40}{(1.155)^2} + \frac{30}{(1.155)^3} - 70$$

= 5.429 lakh

Since NPV is positive hence project is viable.

Question – 02

KLM Ltd. requires ₹ 15,00,000 for a new project.

Useful life of project is 3 years.

Salvage value - NIL. Depreciation is ₹ 5,00,000 p.a.

Given below are projected revenues and costs (excluding depreciation) ignoring inflation:

Year	1	2	3
Revenues in ₹	10,00,000	13,00,000	14,00,000
Costs in ₹	5,00,000	6,00,000	6,50,000

Applicable tax rate is 35%. Assume nominal cost of capital to be 14% (after tax). The inflation rates for revenues and costs are as under:

Year	Revenues %	Costs %
1	9	10
2	8	9
3	6	7

PVF at 14%, for 3 years = 0.877, 0.769 and 0.675

Show amount to the nearest rupee in calculations.

You are required to calculate net present value of the project.

(SM TYK – 19)

Solution:

अगर Revenue & Cost का Inflation rate अलग अलग है तो NCF & NDR ही हमें लेना होगा।

Nominal CF

	1	2	3
Revenue	10,00,000 (1.09) =10,90,000	13,00,000 (1.09) (1.08) = 15,30,360	14,00,000 (1.09) (1.08) (1.06) = 17,46,965
(-) Cost	5,00,000 (1.10) 5,50,000	6,00,000 (1.10) (1.09) 7,19,400	6,50,000 (1.10) (1.09) (1.07) 8,33,905
CFBT – (i)	5,40,000	8,10,960	9,13,060
(-) Depreciation	5,00,000	5,00,000	5,00,000
PBT	40,000	3,10,960	4,13,060
Tax @ 35% – (ii)	14,000	1,08,836	1,44,571

CFAT (i – ii) (x) PVF (14%)	5,26,000 0.877	7,02,124 0.769	7,68,489 0.675

PVCI = ₹ 15,19,965

(-) PVCO = ₹ 15,00,000

NPV = ₹ 19,965

Since NPV is positive hence project should be accepted.

Question – 03

Determine NPV of the project with the following information:

Initial Outlay of project	₹ 40,000
Annual revenues (Without inflation)	₹ 30,000
Annual costs excluding depreciation (Without inflation)	₹ 10,000
Useful life	4 years
Salvage value	Nil
Tax Rate	50%
Cost of Capital (Including inflation premium of 10%)	12%

Solution:

Alternative 1: RCF & RDR

CFAT

Sales = 30,000

(-) cost = 10,000

CFBT (i) = 20,000

(-) Dep. $\left(\frac{40,000}{4}\right)$ = 10,000

PBT = 10,000

Tax @ 50% (ii) = 5,000

CFAT (i – ii) = 15,000

RDR $= \left[\frac{1.12}{1.10} - 1\right] \times 100 = 1.82\%$

NPV = (15000 × 3.824) = 40,000

= 17,360

Alternative 2: NCF & NDR

Since inflation rate is 10% a year, real cash flows may be stated in nominal cash flows as follows:

Nominal Cash Flow = (1 + Inflation Rate) Real Cash Flows

Year	Real Cash Flows	Nominal Cash Flows
1	15,000	15,000 × 1.10 = 16,500
2	15,000	15,000 × $(1.10)^2$ = 18,150
3	15,000	15,000 × $(1.10)^3$ = 19,965
4	15,000	15,000 × $(1.10)^4$ = 21,962

NPV using nominal discounting rate 12%

$$\frac{16,500}{(1.12)^1} + \frac{18,150}{(1.12)^2} + \frac{19,965}{(1.12)^3} + \frac{21,962}{(1.12)^4} - 40,000$$

= ₹ 14,732 + ₹ 14,469 + ₹ 14,211 + ₹ 13,957 – ₹40,000

= ₹ 17,369 (Approx)

PART 2: RISK IN CAPITAL BUDGETING

(I) STATISTICAL TECHNIQUES

Question – 04

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 3,000	0.3 0.2	6,000 3,000	0.4 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.

(SM TYK – 06)

Solution:

(i) Expected NPV

Project A

= (15,000 × 0.2) + (12,000 × 0.3) + (6,000 × 0.3) + (3,000 × 0.2)

= 9,000

Project B

= (15,000 × 0.1) + (12,000 × 0.4) + (6,000 × 0.4) + (3,000 × 0.1)

= 9,000

(ii) Standard Deviation

Project A

$$\sigma_x = \sqrt{(15,000 - 9,000)^2\ 0.2 + (12,000 - 9,000)^2\ 0.3 + (6,000 - 9,000)^2\ 0.3 + (3,000 - 9,000)^2\ 0.2}$$

= 4,450

Project B

$$\sigma_B = \sqrt{(15,000 - 9,000)^2\ 0.1 + (12,000 - 9,000)^2\ 0.4 + (6,000 - 9,000)^2\ 0.4 + (3,000 - 9,000)^2\ 0.1}$$

σ_B = 3,795

	A	B
NPV	9,000	9,000
S.D.	4,450	3,795

(iii) Profitability Index

$$PI = \frac{PVCI}{PVCO}$$

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

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

(iv) Coefficient of Variation = $\frac{\sigma}{\bar{x}}$

$$A = \frac{4,450}{9,000} = 0.49$$

$$B = \frac{3,795}{9,000} = 0.42$$

Project B should be accepted due to lower risk (C.V.)

Question – 05

KLM Ltd., is considering taking up one of the two projects-Project-K and Project-So Both the projects having same life require equal investment of ₹ 80 lakhs each. Both are estimated to have almost the same yield. As the company is new to this type of business, the cash flow arising from the projects cannot be estimated with certainty. An attempt was therefore, made to use probability to analyze the pattern of cash flow from other projects during the first year of operations. This pattern is likely to continue during the life of these projects. The results of the analysis are as follows:

Project K		Project S	
Cash Flow (in ₹)	Probability	Cash Flow (in ₹)	Probability
11	0.10	09	0.10
13	0.20	13	0.25

15 17 19	0.40 0.20 0.10	17 21 25	0.30 0.25 0.10

Required:

(i) Calculate variance, standard deviation and co-efficient of variance for both the projects.

(ii) Which of the two projects is riskier?

(SM TYK – 04)

Solution:

Calculation of Variance & SD, EV.

Project K

Expected Cash Flows

$= (11 \times 0.10) + (13 \times 0.20) + (15 \times 0.40) + (17 \times 0.20) + (19 \times 0.10)$

$= 15$

$\sigma^2 = (11-15)^2\ 0.10 + (13-15)^2\ 0.20 + (15-15)^2\ 0.4 + (17-15)^2\ 0.20 + (19-15)^2\ 0.10$

$= 4.8$

$\sigma = \sqrt{4.8} = 2.19.$

$C.V. = \frac{\sigma}{\bar{x}} = \frac{2.19}{15} = 0.146$

Project S

Expected Cash Flows

$= (9 \times 0.10) + (13 \times 0.25) + (17 \times 0.30) + (21 \times 0.25) + (25 \times 0.10)$

$= 17$

$\sigma^2 = (9-17)^2 0.10 + (13-17)^2 0.25 + (17-17)^2 0.3 + (21-17)^2 0.25 + (25-17)^2\ 0.10$

$= 20.8$

$\sigma = \sqrt{20.8} = 4.56$

$C.V. = \frac{\sigma}{\bar{x}} = \frac{4.56}{17} = 0.268$

Project S is riskier as it has higher Coefficient of Variation.

Question – 06

A company is considering Projects X and Y with following information:

Project	Expected NPV (₹)	Standard Deviation
X	1,22,000	90,000
Y	2,25,000	1,20,000

(i) Which project will you recommend based on the above data?

(ii) Explain whether your opinion will change, if you use coefficient of variation as a measure of risk.

(iii) Which measure is more appropriate in this situation and why?

(SM TYK – 03)

Solution:

(i) On the basis of NFV project Y is better due to higher NPV.

On the basis of standard deviation, project x is better due to lower standard deviation.

(ii) Coefficient of Variation = $\frac{\sigma}{x}$

$X = \frac{90,000}{1,22,000} = 0.738$

$Y = \frac{1,20,000}{2,25,000} = 0.533$

Project Y is better due to lower (C.V.)

(iii) However, the NPV method in such conflicting situation is best because the NPV method is in compatibility of the objective of wealth maximization in terms of time value.

(II) CONVENTIONAL TECHNIQUES

(i) Risk Adjusted Discounting Rate

Question – 07

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

(SM TYK – 15)

Solution:

Risk adjusting NPV

Project X

RADR = 16%

RANPV = (70,000 × 3.274) – 2,10,000

= 19,180

Project Y

RADR = 14%

= (42,000 × 3.433) – 1,20,000

= 24,186

Project Z

RADR = (30,000 × 3.605) – 1,00,000

= 8,150

Question – 08

New Projects Ltd. is evaluating 3 projects, P-I, P-II, P-III. Following information is available in respect of these projects:

	P-I	P-II	P-III
Cost	₹ 15,00,000	₹ 11,00,000	₹ 19,00,000
Inflow-Year 1	6,00,000	6,00,000	4,00,000
Year 2	6,00,000	4,00,000	6,00,000
Year 3	6,00,000	5,00,000	8,00,000
Year 4	6,00,000	2,00,000	12,00,000
Risk Index	1.80	1.00	0.60

Minimum required rate of return of the firm is 15% and applicable tax rate is 40%. The risk free interest rate is 10%.

Required:

(i) Find out the risk-adjusted discount rate (RADR) for these projects.

(ii) Which project is the best?

(SM TYK – 16)

Solution:

(i) The risk free rate of interest and risk factor for each of the projects are given. The risk adjusted discount rate (RADR) for different projects can be found on the basis of CAPM as follows:

Required Rate of Return = I_{Rf} + (K_0 – I_{RF}) Risk Factor

For P-I : RADR = 0.10 + (0.15 – 0.10) 1.80 = 19%

For P-II : RADR = 0.10 + (0.15 – 0.10) 1.00 = 15 %

For P-III : RADR = 0.10 + (0.15 – 0.10) 0.60 = 13 %

(ii) The three projects can now be evaluated at 19%, 15% and 13% discount rate as follows:

Project P-I

Annual Inflows	₹ 6,00,000
PVAF (19%, 4)	2.639
PV of Inflows (₹ 6,00,000 × 2.639)	₹ 15,83,400
Less: Cost of Investment	₹ 15,00,000
Net Present Value	**₹ 83,400**

Project P-II

Year	Cash Inflow (₹)	PVF (15%,n)	PV (₹)
1	6,00,000	0.870	5,22,000
2	4,00,000	0.756	3,02,400
3	5,00,000	0.658	3,29,000
4	2,00,000	0.572	1,14,400
Total Present Value			12,67,800
Less: Cost of Investment			11,00,000
Net Present Value			1,67,800

Project P-III

Year	Cash Inflow (₹)	PVF (15%,n)	PV (₹)
1	4,00,000	0.885	3,54,000
2	6,00,000	0.783	4,69,800
3	8,00,000	0.693	5,54,400
4	12,00,000	0.613	7,35,600
Total Present Value			21,13,800
Less: Cost of Investment			19,00,000
Net Present Value			2,13,800

Project P-III has highest NPV. So, it should be accepted by the firm.

(ii) Certainty Equivalent Approach

Question – 09

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?

(SM TYK – 14)

Solution:

(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	5,00,000	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 analyzed with a higher rate.

RADR is based on the premise that riskiness of a proposal may be taken care of, by adjusting the discount rate. The cash flows from a more risky proposal should be discounted at a relatively higher discount rate as compared to other proposals whose cash flows are less risky. Any investor is basically risk averse. However, he may be ready to take risk provided he is rewarded for undertaking risk by higher returns. So, more risky the investment is, the greater would be the expected return. The expected return is expressed in terms of discount rate which is also the minimum required rate of return generated by a proposal if it is to be accepted. Therefore, there is a positive correlation between risk of a proposal and the discount rate.

(III) OTHER TECHNIQUES

(i) Sensitivity Analysis

Question – 10

From the following details relating to a project, analyze 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? (Use annuity factors: for 10% 3.169 and 11% 3.103).

(SM TYK – 10)

Solution:

Calculation of NPV

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

If initial project cost is varied adversely by 10%*

NPV (Revised) (₹ 1,42,605 – ₹ 1,32,000)	₹ 10,605
Change in NPV (₹ 22,605 – ₹ 10,605)/₹ 22,605 i.e.	53.08 %

If annual cash inflow is varied adversely by 10%*

Revised annual inflow	₹ 40,500
NPV (Revised) (₹ 40,500 × 3.169) – (₹ 1,20,000)	(+)₹ 8,345
Change in NPV (₹ 22,605 – ₹ 8,345)/₹ 22,605	63.08 %

If cost of capital is varied adversely by 10%*

NPV (Revised) (₹ 45,000 × 3.103) – ₹ 1,20,000 (+) ₹19,635

Change in NPV (₹ 22,605 – ₹19,635)/₹ 22,605 13.14 %

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

*Note: Students may please note that they may assume any other percentage rate other than 10 % say 15%, 20 % 25 % etc.

Question – 11

XYZ Ltd. is considering a project for which the following estimates are available:

	₹
Initial Cost of the project	10,00,000
Sales price/unit	60
Cost/unit	40
Sales volumes	
Year 1	20000 units
Year 2	30000 units
Year 3	30000 units

Discount rate is 10% p.a.

You are required to measure the sensitivity of the project in relation to each of the following parameters:

(a) Sales Price/unit

(b) Unit cost

(c) Sales volume

(d) Initial outlay and

(e) Project lifetime Taxation may be ignored.

(SM TYK – 09)

Solution:

Approach I

NPV = PVCI – PVCO

$$= 20 \times \left[\frac{20,000}{(1.10)^1} + \frac{30,000}{(1.10)^2} + \frac{30,000}{(1.10)^3}\right] - 10,00,000$$

$$= 20 \times 65,514.65 - 10,00,000$$

$$= ₹\ 3,10,293$$

(a) Selling Price = 10% ↓ [60 × 10% = 6]

$$= 14 \times \left[\frac{20,000}{(1.10)^1} + \frac{30,000}{(1.10)^2} + \frac{30,000}{(1.10)^3}\right] - 10,00,000$$

$$= -\ 82,795$$

$$\text{Sensitivity} = \frac{3,10,293 - (-82,795)}{3,10,293} \times 100$$

$$= 126.68\%$$

(b) Unit Cost 10% ↑

$$= 40 \times 10\% = 4$$

$$= 16 \times 65,514.65 - 10,00,000 = 48,234$$

$$\text{Sensitivity} = \frac{3,10,293 - 48,234}{3,10,293} \times 100$$

$$= 84.46\%$$

(c) Sales Volume 10% ↓

$$= 20 \times \left[\frac{18,000}{(1.10)^1} + \frac{27,000}{(1.10)^2} + \frac{27,000}{(1.10)^3}\right] - 10,00,000$$

$$= 1,79,264$$

$$\text{Sensitivity} = \frac{3,10,293 - 1,79,264}{3,10,293} \times 100$$

$$= 42.23\%$$

(d) Initial Outlays 10% ↑

$$= 10,00,000 + 10\% = 11,00,000$$

NPV = 20 × 65,514.65 – 11,00,000

= 2,10,293

$$\text{Sensitivity} = \frac{3,10,293 - 2,10,293}{3,10,293} \times 100$$

= 32.22%

Project life 33.33% ↓

Life = 3 Years

Life = 3 – 33.33%

= 2 years

$$\text{NPV} = 20 \times \frac{20,000}{(1.10)^1} + \frac{30,000}{(1.10)^2} - 10,00,000$$

= -1,40,496

$$\text{Sensitivity} = \frac{3,10,293 - (-1,40,496)}{3,10,293} \times 100$$

= 145.28%

$$= \frac{145.28}{33.33} \times 10 = 43.59\%$$

Approach II

(a) Selling Price

$$0 = X \times \frac{20,000}{(1.10)^1} + \frac{30,000}{(1.10)^2} + \frac{30,000}{(1.10)^3} - 10,00,000$$

$$65,514.65\ x = 10,00,000$$

$$x = \frac{10,00,000}{65,514.65}$$

= ₹ 15.26

Contribution = S.P. – VC

15.26 = x – 40

x = 55.26

Sensitivity in selling price $= \frac{60 - 55.26}{60} \times 100$

$= 7.90\%$

(b) Sensitivity in Unit Cost

Contribution = 15.26

Contribution = S.P. – VC

15.26 = 60 – x

x = 44.74

Sensitivity in unit cost $= \frac{44.74 - 40}{40} \times 100$

$= 11.85\%$

(c) Sensitivity in Sales Volume

Alternative 1

Let assume no. of units be x

$= 20 \times \frac{2x}{(1.10)^1} + \frac{3x}{(1.10)^2} + \frac{3x}{(1.10)^3} - 10,00,000 = 0$

$= 20 \times 6.5515\ x = 10,00,000$

$x = \frac{10,00,000}{20 \times 6.5515} = 7,631.84$ units

1 Year = 7,631.84 × 2 = 15,263.68

2 Year = 7,631.84 × 3 = 22,895.52

1 Year = 7,631.84 × 3 = 22,895.52

= 61,054.72

Sensitivity in units $= \frac{80,000 - 61,054.72}{80,000} \times 100$

$= 23.68\%$

Alternative II (Best)

Assume P.V. of units be x

$= 20 \times x - 10,00,000 = 0$

x $= 50,000$ units

Sensitivity in units $= \frac{65,514.65 - 50,000}{65,514.65} \times 100$

$= 23.68\%$

ICAI

$= \frac{3,10,293}{13,10,293} \times 100 = 23.68\%$

(d) Initial Outlays

Sensitivity in project cost $= \frac{NPV}{\text{Initial Outlays}} \times 100$

$= \frac{3,10,293}{10,00,000} \times 100$

$= 31.03\%$

(e) Project Life

Life 3 years NPV = 3,10,293

Life 2 years NPV = -1,40,496

2 years	----------	(1,40,496)
3 years	----------	3,10,293
1 year		(4,50,789)

2 years + $\left(\frac{1}{4,50,789} \times 1,40,496\right)$

2.31 years

$$\text{Sensitivity in life} = \frac{3 - 2.31}{3} \times 100$$

$$= 22.97\%$$

Question – 12

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?

(SM TYK – 11)

Solution:

P.V. of Cash Flows

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