BCCA – SFM Chapter Wise Categorization & Weightage

CHAPTER NAME	MCQS (MARKS)	DESCRIPTIVE (MARKS)	WEIGHTAGE (MARKS)
A Category (High priority)			
Securitization	0-2	4	4-6
Security valuation	2-4	14	16-18
Portfolio management	6-8	14	20-22
Mutual funds	2-4	7	9-11
Derivatives	6-8	14	20-22
Digital finance	2-4	5	7-9
A Category total			**78-88**
B Category (Moderate priority)			
Evaluation of risky proposals for investment decisions	0-2	7	7-9
Forex	2-4	14	16-18
International financial management (IFM)	0-2	5	5-7
Interest rate risk management	0-2	0-7	0-9
B Category total			**28-34**
C Category (Low priority)			
Investments decisions	2	7	9
Leasing decisions	0-2	7	7-9
Security analysis	4	-	4
C Category total			**20-22**

BCCA – SFM Question Paper Analysis

QUESTION NO		CHAPTER NAME	MARKS
1	MCQs		2x15=30
2A		Investments decisions	7
2B		Leasing decisions	7
3A		Evaluation of risky proposals for investment decisions	7
3B		Security valuation (Equity)	7
4A		Security valuation (Bonds)	7
4B		Mutual funds	7
5A		Portfolio management	7
5B		Portfolio management	7
6A		Derivatives	7
6B		Derivatives	7
7A		Forex	7
7B		Forex	7
8A		Digital finance	5
8B		International financial management (IFM)	5
8C		Securitization	4
			128 Marks

BCCA – 100% ENGLISH COURSE DETAILS

CHAPTER NAME	NUMBER OF LECTURES	DURATION (Hours)
1. Introduction	1	1
2. Time Value of Money	2	2.5
3. Investment Decisions	7	9
4. Leasing Decisions	4	6
5. Evaluation of risky proposals for investment decisions	7	10.5
6. Securitization	2	1.5
7. portfolio management	14	16
8. Forex	12	**12**
9. Derivatives	9	13
10. Mutual funds	6	9
11. Security valuation	NA	9
12. International financial management (IFM)	NA	2
13. Interest rate risk management	NA	2
14.Digital finance	NA	2
15. Security analysis	NA	4
Total Duration		**100 (approx.)**

BCCA – SFM FASTRACK COURSE DETAILS

CHAPTER NAME	NUMBER OF LECTURES	DURATION (Hours)
1. Securitization	2	1.5
2. Portfolio management	14	15
3. Derivatives	9	13
4. Mutual funds	6	8
5. Forex	6	9
6. Security valuation	NA	9 (Approx.)
7. Digital finance	NA	2
Total Duration		**57(Approx.)**

BCCA – SFM 100% ENGLISH MCQs COURSE DETAILS

CHAPTER NAME	NUMBER OF LECTURES	DURATION (Hours)
1. Derivatives	3	2
2. Forex	3	2
3. Investments decisions	2	1.5
4. Evaluation of risky proposals for investment decisions	1	0.5
5. Portfolio management	3	2
6. Leasing decisions & Securitization	1	6Min
7. Security valuation	1	1
8. Mutual funds	1	**1**
9. Security analysis	2	1.5
Total Duration	**17**	**11.5 (approx.)**

SFM SUPER 50 - DURATION -APPROX. (15 HOURS)

INDEX

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Illustration 1

A firm is considering a project requiring ₹50 lakh of investment. Expected cash flow is ₹10 lakh per annum for 8 years. The rate of return required by the equity investors from the project is 15%. The firm is able to raise ₹24 lakh of debt finance carrying 14% interest for the project. The principal amount of debt is repayable in equal annual instalments over the eight-year period – the first to be paid at the end of the first year. The tax rate is 40%. Calculate ANPV and advise.

Solution:

Calculation of Base Case NPV:

Base case NPV = 10,00,000 × PVIFA (15%, 8) – 50,00,000

= 10,00,000 × 4.4873 – 50,00,000 = (–) ₹5,12,700

Equity Finance ₹ 26 lakh, Debt Finance ₹ 24 lakhs.

Calculation of PV of tax savings from debt financing: (₹ in lakhs)

Year	O/S Debt at the beginning	Interest @ 14%	Tax Shield = Interest × 40%	PVIF @ 14%	PV of Tax Shield
1	24	3.36	1.344	0.877	1.179
2	21	2.94	1.176	0.769	0.9043
3	18	2.52	1.008	0.675	0.6804
4	15	2.1	0.840	0.592	0.497
5	12	1.68	0.672	0.519	0.349
6	9	1.26	0.504	0.456	0.230
7	6	0.84	0.336	0.399	0.134
8	3	0.42	0.168	0.351	0.059
Total					**4.0327**

Equity Issue Cost is assumed to be 5%. Therefore, to get ₹ 26 lakh, Total equity issue = ₹26/0.95 = ₹27.37 lakh

So, floatation cost representing the cost of underwriting, brokerage, etc. for the issue = 27.37 – 26 = ₹1.37 lakhs

Adjusted NPV = (–) 5,12,700 + 4,03,270 –1,37,000 = (–) ₹2,46,430

Since the ANPV is negative the project is not acceptable.

Illustration 2

X Ltd. is considering a capital project with the following characteristics:

The initial outlay is ₹5,00,000.

Project life is 6 years.

Annual after-tax operating cash flows have a 50 percent probability of being ₹80,000 for the four years and a 50 percent probability of being ₹1,40,000.

Salvage value at project termination is 0.

The required rate of return is 12 percent.

In one year, after realizing the first-year cash flow, the company has the option to abandon the project and receive the salvage value of ₹4,00,000.

a. Compute the project NPV assuming no abandonment.

b. What is the optimal abandonment strategy? Compute the project NPV using that strategy.

Solution:

a. NPV assuming no abandonment

NPV (Low Cash Flow) = -500000 + 80000 × PVIFA (12%, 6)

= -5,00,000 + 80,000 × 4.111 = (-) ₹1,71,120

NPV (High Cash Flow) = -500000 + 140000 × PVIFA (12%, 6)

= -5,00,000 + 1,40,000 × 4.111 = ₹75,540

NPV of the project without abandonment option = 0.50 × (-) 171120 + 0.50 × 75540 = (-) ₹47,790

Since, NPV is negative, the project should be rejected.

b. NPV assuming abandonment option

Low cash flow and abandonment after 1 year:

NPV = -500000 + 80000 × PVIF (12%, 1) + 400000 × PVIF (12%, 1)

= -500000 + 80000 × 0.893 + 400000 × 0.893

= (-) ₹71,360

Whereas, NPV for Low cash flow and continue = (-) ₹1,71,120

This is the preferred option as NPV without abandonment leads to an NPV of (-) ₹1,71,120.

High cash flow and abandonment after 1 year:

NPV = -500000 + 140000 × PVIF (12%, 1) + 400000 × PVIF (12%, 1)

= -500000 + 140000 × 0.893 + 400000 × 0.893 = (-) ₹17,780

Whereas, NPV for High cash flow and Continue = ₹75,540

So, the latter is the preferred option.

Hence, NPV with abandonment option = (-) 17780 × 0.50 + 75540 × 0.50 = ₹28,880

Since NPV is higher with abandonment option, the project should be accepted.

Illustration 3

Following are the data on a capital project being evaluated by the management of X Ltd.

	Project M (₹)
Annual cost saving	4,00,000
Useful life	4 years
I.R.R.	15%
Profitability Index (PI)	1.064
NPV	?

Cost of capital	?
Cost of project	?
Payback	?
Salvage value	0

Find the missing values considering the following table of discount factor only:

Discount factor	15%	14%	13%	12%
1 year	0.869	0.877	0.885	0.893
2 years	0.756	0.769	0.783	0.797
3 years	0.658	0.675	0.693	0.712
4 years	0.572	0.592	0.613	0.636
	2.855	2.913	2.974	3.038

Solution:

Annual Cash Inflow: ₹400000

Useful life = 4 years IRR =15%

Profitability Index = 1.064

(a) Cost of Capital project M :-

At IRR, Sum of discounted cash outflow = Sum of discounted cash inflow

= Annual cash inflow x PVAF @ IRR

= ₹ 4,00,000 x PVAF@ 15%

Sum of discounted cash outflow = ₹ 4,00,000 x 2.855

(Or) = ₹ 11,42,000

Cost of project

(b) Payback period

Payback period $\frac{\text{Intial Investment}}{\text{Annual cash inflow}}$

$= \frac{11,42,000}{4,00,000} = 2.8555$ years.

(c) Net Present Value (NPV):

Profitability Index =1.064

NPV = Initial investment x (P.I – 1)

= 11,42,000 X (1.064 – 1)

NPV = ₹ 73,088

(d) Cost of a Capital

Year	Cash Flow	PVAF @ 12%	DCF
1-4	4,00,000	3.03772	12,15,088
(-) SDCOF			**(11,42,000)**
NPV			**73,088**

PVAF 3.038 lies at 12%, Hence Cost of Capital is 12%.

Illustration 4

A & Co. is contemplating whether to replace an existing machine or to spend money on overhauling it. A & Co. currently pays no taxes. The replacement machine costs ₹ 1,00,000 now and requires maintenance of ₹ 10,000 at the end of every year for eight years. At the end of eight years it would have a salvage value of ₹ 20,000 and would be sold. The existing machine requires increasing amounts of maintenance each year and its salvage value falls each year as follows:

Year	Maintenance (₹)	Salvage (₹)
Present	0	40,000
1	10,000	25,000
2	20,000	15,000
3	30,000	10,000
4	40,000	0

The opportunity cost of capital for A & Co. is 15%. When should the company replace the machine? (Notes: Present value of an annuity of ₹ 1 per period for 8 years at interest rate of 15% : 4.4873; present value of ₹ 1 to be received after 8 years at interest rate of 15% : 0.3269).

Solution:

Calculation of EAC of New Machine

Particulars	Year	CF	PVF/PVAF @ 15%	DCF
Cost of machine	0	1,00,000	1	1,00,000
Machine Cost	1-8	10,000	4.4873	44,873
Salvage Value	8	(20,000)	0.3269	(6,538)
SDCOF				**1,38,335**

EAC = $= \frac{SDCOF}{PVAF} = \frac{1,38,335}{4,4873} =$₹30.828

Calculation of EAC of New Machine

Particulars	Yr	PVAF @15%	Year 1		Year 2	
			CF	DCF	CF	DCF
Beginning Salvage Value	0	1	40,000	40,000	25,000	25,000
Maintenance Cost	1	0.8695	10,000	8,695	20,000	17,390
(-) Ending Salvage Value	1	0.8695	(25,000)	(21,737)	(15,000)	(13,042)
SDCOF			**26,958**		**29,348**	
EAC = $\frac{SDCOF}{PVF}$			$\frac{26,958}{0.8695} = 31,000$		$\frac{29,348}{0.8695} = 33,753$	

Particulars	Yr	PVAF @15%	Year 3		Year 4	
			CF	DCF	CF	DCF

Beginning Salvage Value	0	1	15,000	15,000	10,000	10,000
Maintenance Cost	1	0.8695	30,000	26,025	40,000	34,780
(-) Ending Salvage Value	1	0.8695	(10,000)	(8,695)	0	0
SDCOF			**32,390**		**44,780**	
EAC = $\frac{SDCOF}{PVF}$			$\frac{32,390}{0.8695} = 37,251$		$\frac{44,780}{0.8695} = 51,500$	

Calculation of Equated Annual Cost of Existing Machine

Year	Particulars	PVAF @15%	Year 1		Year 2	
			CF	DCF	CF	DCF
0	Purchase Price	1	40000	40000	25000	25000
1	Running Cost	0.8695	10000	8696	20000	17391
1	Salvage Value	0.8695	(25000)	(21739)	(15000)	(13043)
Sum of Discounted Cash Outflows				26957		29348
Equated Annual Cost				31000		33750

Year	Particulars	PVAF @15%	Year 3		Year 4	
			CF	DCF	CF	DCF
0	Purchase Price	1	15000	15000	10000	10000
1	Running Cost	0.8695	30000	26087	40000	34783
1	Salvage Value	0.8695	(10000)	(8696)		
Sum of Discounted Cash Outflows				**32391**		**44783**
Equated Annual Cost				**37250**		**51500**

Conclusion: Since the equivalent annual cost of new machine is lesser than that of the existing machine (in all the 4 years), it is suggested to replace it with the new machine.

ADDITIONAL QUESTIONS

Illustration 1

Techtronics Ltd., an existing company, is considering a new project for manufacture of pocket video games involvinga capital expenditure of ₹ 600 lakhs and working capital of ₹150 lakhs. The capacity of the plant is for an annual production of 12 lakh units and capacity utilisation during the 6-year working life of the project is expected to be as indicated below.

Year	Capacity Utilization (%)
1	33.33 %
2	66.66 %
3	90 %
4-6	100 %

The average price per unit of the product is expected to be ₹200 netting a contribution of 40%. Annual fixed costs, excluding depreciation, are estimated to be ₹480 lakhs per annum from the third year onwards; for the first and second year it would be ₹240lakhs and ₹360 lakhs respectively. The average rate of depreciation for tax purposes is 33 1/3% on the capital assets. No other tax reliefs are anticipated. The rate of income-tax may be taken at 50%.

At the end of the third year, an additional investment of ₹100 lakhs would be required for working capital. The company, without taking into account the effects of financial leverage, has targeted for a rate of return of 15%. You are required to indicate whether the proposal is viable, giving your working notes and analysis.

Terminal value for the fixed assets may be taken at 10% and for the current assets at 100%. Calculation may be rounded off to lakhs of rupees. For the purpose of your calculations, the recent amendments to tax laws with regard to balancing charge may be ignored.

Solution:

(a) Sum of discounted cash out flows

Particulars	Amount (₹)
Cost of capital expenditure	600,00,000
(+) Working capital	150,00,000
SDCOF	750,00,000

(b) Calculation of SDCIF (₹ in Lakhs)

Particulars	Y-1	Y-2	Y-3	Y-4	Y-5	Y-6
Contribution	320	640	864	960	960	960
	(12L x 33.33% x 200 × 40%)	(12L x 66.66% X 200 × 40%)	(12L x 90% x 200×40 %)	(12L x 100%x 200 × 40%)	(12L x 100%x 200 × 40%)	(12L x 100% x200 × 40%)
(-) fixed cost	(240)	(360)	(480)	(480)	(480)	(480)
PBDT	80	280	384	480	480	480
(-) Depreciation	(200)	(133)	(89)	(59)	(40)	(26)
PBT	(120)	147	295	421	440	454
(-)Tax @50%	(60)	73.5	147.5	210.5	220	227
PAT	60	(73.5)	(147.5)	(210.5)	(220)	(227)

(+) Depreciation	200	133	89	59	40	26
	140	207	237	270	260	253
(-) Additional Working Capital ****	-	-	(100)	-	-	-
Cash Inflows	140	207	137	270	260	253

(c) Sum of a discounted Cash Inflows and Calculation of NPV **₹ In Lakhs**

Year	Cash Inflow	PVF @ 15 %	DCF
1	140	0.869	121.66
2	207	0.756	156.492
3	137	0.657	90.009
4	270	0.571	154.17
5	260	0.497	129.22
6	559.5 (253 + 56.5 + 250)	0.432	241.704
Sum of Discounted Cash Inflow			**893.255**
Less: Sum of Discounted Cash Outflow			**(750)**
Net Present Value			**143.255**

WN 1 CALCULATION OF DEPRECIATION

Year	OPN. WDV	DEP	CLS. WDV
1	600	200 (600*1/3)	400
2	400	133 (400*1/3)	267
3	267	89 (267*1/3)	178
4	178	59 (178*1/3)	119
5	119	40 (119*1/3)	79
6	79	26 (79*1/3)	53

WN 2: CALCULATION OF NET SALVAGE VALUE

Particulars	Amount (₹)
Sale Value	60L (600 X 10%)
(-) Book Value	53L
Capital Gain	**7L**
Capital Gain Tax @ 50%	(3.5L)
NET SALVAGE VALUE	**56.5L (60-3.5)**

Illustration 2

Nine Gems Ltd. has just installed Machine – R at a cost of ₹ 2,00,000. The machine has a five year life with no residual value. The annual volume of production is estimated

at 1,50,000 units, which can be sold at ₹ 6 per unit. Annual operating costs are estimated at ₹ 2,00,000 (excluding depreciation) at this output level. Fixed costs are estimated at ₹ 3 per unit for the same level of production.

Nine Gems Ltd. has just come across another model called Machine – S capable of giving the same output at an annual operating cost of ₹ 1,80,000 (exclusive of depreciation). There will be no change in fixed costs. Capital cost of this machine is ₹ 2,50,000 and the estimated life is for five years with nil residual value.

The company has an offer for sale of Machine – R at ₹ 1,00,000. But the cost of dismantling and removal will amount to ₹ 30,000. As the company has not yet commenced operations, it wants to sell Machine – R and purchase Machine –S.

Nine Gems Ltd. will be a zero-tax company for seven years in view of several incentives and allowances available. The cost of capital may be assumed at 15%.

P.V. factors for five years are as follows:

Year	V. Factors
1	0.8696
2	0.7561
3	0.6575
4	0.5717
5	0.4972

i. Advise whether the company should opt for the replacement.

ii. Will there be any change in your view, if Machine-R has not been installed but the company is in the process of selecting one or the other machine?

Support your view with necessary workings.

Solution:

(i) (a) Incremental Cash Outflow on purchase of Machine 'S', if machine 'R' is already installed

Particulars	Amount ₹
Cost of Machine 'S'	2,50,000
Cost of Dismantling Machine 'R'	30,000
Less: Sale value of Machine 'R'	(1,00,000)
Incremental Cash Out Flow	1,80,000

(b) Incremental NPV on purchase of Machine 'S', if machine 'R' is already installed

Year	Incremental Cash Inflow	PVAF @ 15%	DCIF
1 – 5	20,000 (2,00,000 – 1,80,000)	3.3521	67,042
Less: Sum of Discounted Cash Outflow			**1,80,000**
Incremental Net Present Value			**(1,12,958)**

(ii) a) Incremental Cash Outflow on purchase of Machine 'S', if machine 'R' is not yet installed

Particulars	Amount ₹
Cost of Machine 'S'	2,50,000
Less: Cost of Machine 'R'	2,00,000
Incremental Cash Out Flow	50,000

(b) Incremental NPV on purchase of Machine 'S', if machine 'R' is not yet installed

Year	Incremental Cash Inflow	PVAF @ 15%	DCIF
1 – 5	20,000 (2,00,000 – 1,80,000)	3.3521	67,042
Less: Sum of Discounted Cash Outflow			**50,000**
Incremental Net Present Value			**17,042**

Conclusion: Since the Incremental NPV is +ve, Management should go for Machine's'.

Calculation of Incremental Annual Cash Inflow (Alternative)

Particulars	Machine 'R' (₹)	Machine 'S' (₹)
Sales	9,00,000 (1,50,000 x 6)	9,00,000 (1,50,000 x 6)
Less: Operating Cost	(2,00,000)	(1,80,000)
Fixed Cost	(4,50,000) (1,50,000 x 3)	(4,50,000) (1,50,000 x 3)
Annual Cash Inflow	**2,50,000**	**2,70,000**
Incremental Cash Inflow on buying Machine 'S' = 2,70,000 – 2,50,000 = ₹ 20,000		

Illustration 3

S Engineering Company is considering to replace or repair a particular machine, which has just broken down. Last year this machine costed ₹ 2,00,000 to run and maintain. These costs have been increasing in real terms in recent years with the age of the machine. A further useful life of 5 years is expected, if immediate repairs of ₹ 1,90,000 are carried out. If the machine is not repaired it can be sold immediately to realize about ₹ 50,000 (Ignore loss/gain on such disposal).

Alternatively, the company can buy a new machine for ₹ 4,90,000 with an expected life of 10 years with no salvage value after providing depreciation on straight line basis. In this case, running and maintenance costs.

In this case running and maintaining cost will be reduced to 1,40,000 each year and are not expected to increase much in real term for a few years at least. S engineering company regard a normal return of 10% p.a after tax as a minimum requirement on any new investment Considering capital budgeting techniques which alternative will you

choose? take corporate tax rate of 15% and assume that depreciation on straight line basis will be accepted for tax purposes also .Given cumulative PRESENT VALUE OF Rs 1 p.a 10% for 5 yr =3.791, Present value Rs.1 p.a 10% for 10 years = 6.145

Solution:

Calculation of Equated Annual Cost

(i) Old Machine:-

Particulars	Year	CF	PVF/PVAF @10%	DCF
Repair cost	0	1,90,000	1	1,90,000
Running & machine costs	1-5	1,00,000 (2,00,000 x 50%)	3.791	3,79,100
Tax savings on depreciation	1-5	19,000 1,90,000 (5 X 50%)	3.791	(72,029)
Sum of discounted cash outflow				**4,97,071**

Equated Annual cost = $\frac{SDCOF}{PVAF} = \frac{4,97,071}{3,791}$

= 1,31,118.70

(ii) New Machine:-

Particulars	Year	CF	PVF/PVAF @10%	DCF
Cost of machine Initial cash outflow	0	4,40,000 (4,90,000 – 50,000)	1	4,40,000
Repair costs	1-10	70,000 (1,40,000 x 50%)	6.145	4,30,150
Tax savings on depreciation	1-10	24,500 4,90,000 (10 X 50%)	6.145	(1,50,552)
Sum of discounted cash outflow				**7,19,598**

Equated Annual cost = $\frac{SDCOF}{PVAF} = \frac{7,19,598}{6,145}$

= 1,17,103

DECISION: - The Company should go for buying new machine because of less equated cost. Note: - It is assumed that repair cost of old machine resulted in increase of a life of a machine, hence it is capitalized.

Alternatively repair cost can be treated as revenue expenditure, then

Calculated Equated Annual cost – old machine

Particulars	Year	CF	PVF/PVAF @15%	DCF
Repair cost	0	95,000(1,90,000 x 50%)	1	95,000
Running & maintenance	1-5	1,00,000	3.791	3,79,100
Sum of discounted cash outflow				**4,74,100**

Equated annual cost = $\frac{4,74,100}{3,791} = 1,25,059$

New machine as stated before same in this method also.

Illustration 4

From the following information determine the optimal combination of projects assuming that the projects are divisible and indivisible. Amount allocated for capital budgeting purposes ₹ 3,00,000.

Project	Required Initial Investment	NPV at appropriate cost of capital
A1	1,00,000	20,000
A2	3,00,000	35,000
A3	50,000	16,000
A4	2,00,000	25,000
A5	1,00,000	30,000

Solution:

Calculation of profitability index

Project	SODCOF	SODCIF (NPV +SODCOF)	Profitability index SODCOF/SODCIF
A1	1,00,000	1,20,000	1.2
A2	3,00,000	3,35,000	1.116
A3	50,000	66,000	1.32
A4	2,00,000	2,25,000	1.125
A5	1,00,000	1,30,000	1.3

When projects are divisible:

The projects can be selected on the basics of profitability Index

Therefore, the optimal combination of projects is A3, A5, A1 and 1/4th of A4 NPV OF THIS COMBINATION = 66,000 + 30,000 + 20,000 + (25,000 x $\frac{1}{4}$)

= ₹ 72,250

IF THE PROJECTS ARE INDIVISIBLE, then we should select a combination which gives maximum NPV.

Combination	Investment	NPV
A1 , A3	1,50,000	36,000
A1 , A4	3,00,000	45,000
A1 , A5	2,00,000	50,000
A1 , A3 , A5	2,50,000	66,000
A3 , A4	2,50,000	41,000
A4 , A5	3,00,000	55,000
A2	3,00,000	35,000

If a projects are indivisible the company should select A1, A3, A5.

Illustration 1

A company is considering two mutually exclusive projects X and Y. Project X costs ₹ 3,00,000 andProject Y ₹ 3,60,000. You have been given below the net present value, probability distribution for each project:

Project X		Project Y	
NPV estimate (₹)	Probability	NPV estimate (₹)	Probability
30,000	0.1	30,000	0.2
60,000	0.4	60,000	0.3
1,20,000	0.4	1,20,000	0.3
1,50,000	0.1	1,50,000	0.2

i. **Compute the expected net present value of Projects X and Y.**

ii. **Compute the risk attached to each project i.e., Standard Deviation of each probabilitydistribution.**

iii. **Which project do you consider more risky and why?**

iv. **Compute the profitability index of each project.**

Solution

(i) Calculation of expected NPV of Project X and Y:

Project X			Project Y		
NPV Estimated (₹)	Prob.	Expected NPV	NPV Estimated (₹)	Prob.	Expected NPV
30,000	0.1	3,000	30,000	0.2	6,000
60,000	0.4	24,000	60,000	0.3	18,000
1,20,000	0.4	48,000	1,20,000	0.3	36,000
1,50,000	0.1	15,000	1,50,000	0.2	30,000
		90,000			90,000

(ii) Calculation of standard deviation : [Project X]

NPV estimate(x)	Expected NPV $\bar{x}$	X - $\bar{x}$	Probability (P)	P$(x-\bar{x})^2$
30,000	90,000	(60,000)	0.1	36,00,00,000
60,000	90,000	(30,000)	0.4	36,00,00,000
1,20,000	90,000	30,000	0.4	36,00,00,000
1,50,000	90,000	60,000	0.1	36,00,00,000
Variance = (σ^2) $E^P(x-\bar{x})^2$				**1,44,00,00,000**

Variance =$(\sigma)^2$ = $\sum P(x-\bar{x})^2$ = 1,44,00,00,000

Standard deviation =$\sqrt{P(x-\bar{x})^2}$ = $\sqrt{\sigma}$ = $\sqrt{1,44,00,00,000}$ = 37,947

Calculation of standard deviation: [Project Y]

NPV estimate(Y)	Expected NPV ($\bar{Y}$)	Y - $\bar{Y}$	Probability(P)	P (Y - $\bar{Y}$)²
30,000	90,000	(60,000)	0.2	72,00,00,000
60,000	90,000	(30,000)	0.3	27,00,00,000
1,20,000	90,000	30,000	0.3	27,00,00,000
1,50,000	90,000	60,000	0.2	72,00,00,000
Variance = (σ^2) $E^P(Y - \bar{Y})^2$				**1,98,00,00,000**

Variance =$(\sigma)^2$ = $\sum P(Y - \bar{Y})^2$= 198,00,00,000

Standard deviation = $\sqrt{P(Y - \bar{Y})^2}$ = $\sqrt{\sigma}$ = $\sqrt{198,00,00,000}$ = 44,497

(iii) Project Y is having more risk as compared to Project x.

Coefficient variation of Project x = $\frac{SD}{\text{Expected NPV}} = \frac{37,947}{90,000}$ =0.42

Coefficient variation of Project y = $\frac{SD}{\text{Expected NPV}} = \frac{44,497}{90,000}$ =0.49 (or)0.50

(iv) PI of Project X = $\frac{SDCIF}{SDCOF} = \frac{3,00,000+90,000}{30,00,000} = 1.3$

PI of Project Y = $\frac{SDCIF}{SDCOF} = \frac{3,60,000+90,000}{3,60,000}$ = 1.25

Illustration 2

PNR Ltd. is considering a project with the following Cash Flows:

Year	Cost of Plant (₹)	Running Cost (₹)	Savings (₹)
0	12,00,00,000	-	-
1	-	4,00,00,000	12,00,00,000
2	-	5,00,00,000	14,00,00,000
3	-	6,00,00,000	11,00,00,000

The cost of capital is 12%. Measure the sensitivity of the project to changes in the levels of plant cost, running cost and savings (considering each factor at a time) such that the NPV becomes zero. The P.V. factors at 12% are as under:

Year	0	1	2	3
PV factor @12%	1	0.892	0.797	0.711

DETERMINE the factor which is the most sensitive to affect the acceptability of the project?

Solution

Calculation of NPV:

Particulars	Year 1	Year 2	Year 3
Running Cost	(4,00,00,000)	(5,00,00,000)	(6,00,00,000)
Savings	12,00,00,000	14,00,00,000	11,00,00,000
Net Cash Flow	8,00,00,000	9,00,00,000	5,00,00,000
PV factor	0.892	0.797	0.711

PV of cash flow	7,13,60,000	7,17,30,000	3,55,50,000
Sum of Discounted Cash Inflow (7,13,60,000 + 7,17,30,000 + 3,55,50,000)			**17,86,40,000**
(-) Sum of Discounted Cash Outflow (Cost of Plant) (12,00,00,000 x 1)			**(12,00,00,000)**
NPV			**5,86,40,000**

i. Cost of plant:

NPV of the project would be zero when the cost of the plant is increased by ₹ 5,86,40,000.

∴ % change in plant cost = $\frac{5,86,40,000}{12,00,00,000} \times 100 = 48.86\%$

ii. Running cost:

NPV of the project would be zero when the Running cost is increased by ₹ 5,86,40,000.

∴ % change in Running cost = $\frac{5,86,40,000}{(0.892 \times 4,00,00,000)+(0.797 \times 5,00,00,000) + (0.711 \times 6,00,00,000)} \times 100$

$= \frac{5,86,40,000}{3,56,80,000+3,98,50,000+4,26,60,000} \times 100$

$= \frac{5,86,40,000}{11,81,90,000} \times 100$

$= 49.61\%$

iii. Savings:

NPV of the project would be zero when the savings is decreased by ₹ 5,86,40,000.

∴ % change in savings

$= \frac{5,86,40,000}{(0.892 \times 12,00,00,000)+(0.797 \times 14,00,00,000) + (0.711 \times 11,00,00,000)} \times 100$

$= \frac{5,86,40,000}{10,70,40,000+11,15,80,000+7,82,10,000} \times 100$

$= \frac{5,86,40,000}{29,68,30,000} \times 100$

$= 19,75\%$

The Savings factor is the most sensitive as only a change beyond 19.75% in savings makes the projectunacceptable.

Illustration 3

a) A firm has an investment proposal, requiring an outlay of ₹ 40,000. The investment proposalis expected to have 2 years' economic life with no salvage value. In year 1, there is a 0.4 probability that cash inflow after tax will be ₹ 25,000 and 0.6 probability that cash inflow after tax will be ₹ 30,000. The probabilities assigned to cash inflows after tax for the year2 are as follows:

The cash inflow 1st year	₹ 25,000		₹ 30,000	
The cash inflow 2nd year		Probability		Probability
	₹ 12,000	0.2	₹ 20,000	0.4
	₹ 16,000	0.3	₹ 25,000	0.5
	₹ 22,000	0.5	₹ 30,000	0.1

The firm uses a 12% discount rate for this type of investment. Required:

i. Construct a decision tree for the proposed investment project.

ii. What net present value will the project yield if worst outcome is realized? What is theprobability of occurrence of this NPV?

iii. What will be the best and the probability of that occurrence?

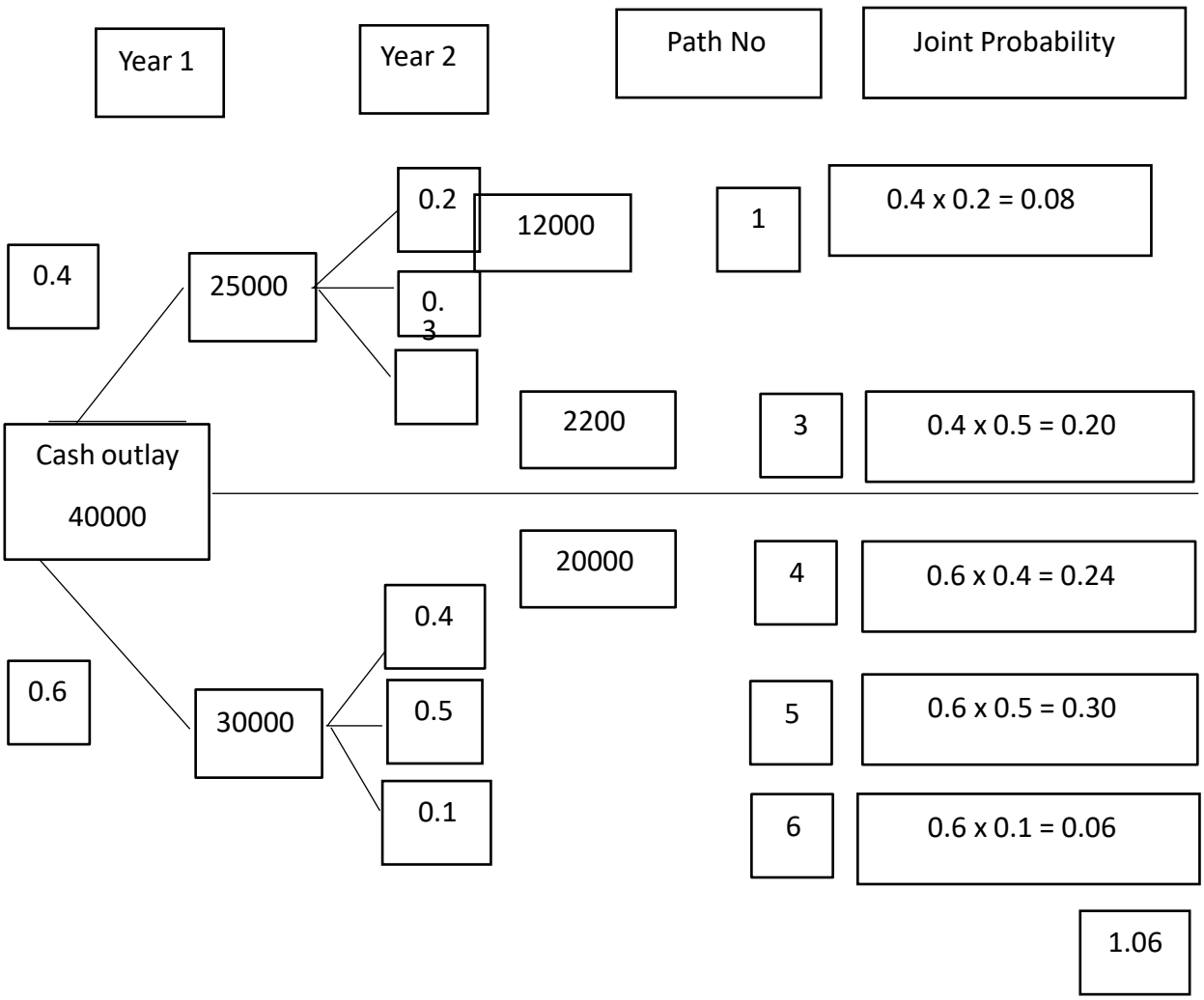
iv. Will the project be accepted?

(12% Discount factor 1st year 0.8929 2nd year 0.7972)

b) Do the profitability index and the NPV criterion of evaluating investment proposals lead to the same acceptance – rejection and ranking decisions? In what situations will they give conflicting results?

Solution

(i) Decision tree:



Calculation of NPV of all outcomes:

Yr.	PVF @12%	Outcome I		Outcome II		Outcome III	
		CF	DCF	CF	DCF	CF	DCF
1	0.8929	25,000	22,323	25,000	22,323	25,000	22,323
2	0.7972	12,000	9,566	16,000	12,755	22,000	17,538
SDCIF			**31,889**		**35,078**		**39,861**
(-)SDCOF			**(40,000)**		**(40,000)**		**(40,000)**
NPV			**(8,111)**		**(4,922)**		**(139)**

Outcome IV		Outcome V		Outcome VI	
CF	DCF	CF	DCF	CF	DCF
30,000	26,787	30,000	26,787	30,000	26,787
20,000	15,944	25,000	19,930	30,000	23,916
SDCIF	**42,731**		**46,717**		**50,703**
(-) SDCOF	**(40,000)**		**(40,000)**		**(40,000)**
NPV	**2,731**		**6,717**		**10,703**

(ii) NPV of a project if worst outcome is realized = ₹ (8111)

% of occurrence = 8%

(iii) NPV of a project if best outcome is realized = ₹ 10,703

% of occurrence = 6%

(iv) **Expected NPV of the project:**

= (8,111)(0.08)+(4,992) (0.12)+(139)(0.2)+(2,731 x 0.24)+(6,717x 0.3)+(10,703 x 0.06)

= (648.88) + (599.04) + (27.8) + (655.44) + (2,015.1) + (642.18)

= ₹ 2,045.40

∴ Project is accepted since NPV is positive

b. No the profitability index and the NPV methods of evaluating the investment proposaldoesnot lead to same acceptance or rejection and ranking decision .

Reason: Size disparity

Illustration 4

A project has expected NPV value of ₹800 and S.D. of NPV of ₹400. The management wants to determine the probability of the NPV under the following ranges.

(i) Zero or less

(ii) Greater than zero

(iii) Between the range of ₹500 and ₹900

(iv) Between the range of ₹300 and ₹600

Solution:

(i) P (NPV ≤ 0)

= P $\left[\frac{\text{NPV-expected NPV}}{\text{S.D. of NPV}} \leq \frac{0-800}{400}\right]$

= P (Z ≤ - 2) = (-2) = 1 – (2) = 1- (0.50 + 0.4772) = 0.0228 or 2.28%

(ii) P (NPV ≥ 0)

= P $\left[\frac{\text{NPV-expected NPV}}{\text{S.D. of NPV}} \geq \frac{0-800}{400}\right]$

= P (Z ≥ - 2) =1 - P (Z ≤ - 2) = 1 - $\frac{Profit}{\frac{P}{V}Ratio}(-2) = \frac{Profit}{\frac{P}{V}Ratio}(2)$ = (0.50 + 0.4772) = 0.9772 or 97.72%

(iii) When NPV = 500; Z = (500 – 800) / 400 = - 300/400 = - 3/ 4 = - 0.75

When NPV = 900; Z = (900 – 800) / 400 = 100/400 = 1/ 4 = 0.25

Table Value of 0.75 = .2734 and 0.25 = .0987; so, $\frac{Profit}{\frac{P}{V}Ratio}(0.25) = 0.5987$ and $\frac{Profit}{\frac{P}{V}Ratio}$ (0.75) = 0.7734

P (NPV between 500 & 900)

= P (500 ≤ NPV ≤ 800)

= P (-0.75 ≤ Z ≤ 0.25)

$= \frac{Profit}{\frac{P}{V}Ratio}(0.25) - (-0.75)$

$= \frac{Profit}{\frac{P}{V}Ratio}(0.25) - [1 - (0.75)]$

= 0.5987 – [1 – 0.7734]

= 0.5987 – 0.2266 = 0.3721 = 37.21%

(iv) Table Value of 1.25 = 0.3944 and 0.50 = 0.1915; so, $\frac{Profit}{\frac{P}{V}Ratio}(1.25) = 0.8944$ and $\frac{Profit}{\frac{P}{V}Ratio}$ (0.50) = 0.6915

P (NPV between 300 & 600)

= P (300 ≤ NPV ≤ 600)

= P (-1.25 ≤ Z ≤ -0.50)

$= \frac{Profit}{\frac{P}{V}Ratio}(-0.5) - \frac{Profit}{\frac{P}{V}Ratio}(-1.25)$

$= [1 - \frac{Profit}{\frac{P}{V}Ratio}(-0.5)] - [1 - \frac{Profit}{\frac{P}{V}Ratio}(1.25)]$

= 0.3085 – 0.1056

= 0.2029 = 20.29%

Additional Questions

Illustration 1

Skylark Airways is planning to acquire a light commercial aircraft for flying class clients at an investment of ₹ 50,00,000. The expected cash flow after tax for the next three years is as follows:

Year 1		Year 2		Year 3	
CFAT	Probability	CFAT	Probability	CFAT	Probability
14,00,000	0.1	15,00,000	0.1	18,00,000	0.2
18,00,000	0.2	20,00,000	0.3	25,00,000	0.5
25,00,000	0.4	32,00,000	0.4	35,00,000	0.2
40,00,000	0.3	45,00,000	0.2	48,00,000	0.1

The Company wishes to take into consideration all possible risk factors relating to an airlineoperation. The company wants to know:

i. **The expected NPV of this venture assuming independent probability distribution with 8 %risk free rate of interest.**

ii. **The possible deviation in the expected value.**

iii. **State the importance of standard deviation of the present value distribution in CapitalBudgeting decisions?**

Solution

I) a. Calculation of expected cash flow: (₹ in lakhs)

Year 1			Year 2			Year 3		
CFAT	Probability(P)	CFAT XP	CFAT	Probability (P)	CFAT XP	CFAT	Probability (P)	CFAT XP
14L	0.1	1.4L	15L	0.1	1.5L	18L	0.2	3.6L
18L	0.2	3.6L	20L	0.3	6L	25L	0.5	12.5L
25L	0.4	10L	32L	0.4	1.28L	35L	0.2	7L
40L	0.3	12L	45L	0.2	9L	48L	0.1	4.8L
		27L			**29.3L**			**27.9L**

Calculation of NPV:

Year	Expected Cash Flow	PVF @ 8%	Discounted Cash Flow
1	27,00,000	0.9259	24,99,930
2	29,30,000	0.8573	25,11,889
3	27,90,000	0.7938	22,14,702
Sum of Discounted Cash Inflow			72,26,521
(-)Sum of Discounted Cash Outflow			(50,00,000)
NPV			22,26,521

II) Possible deviation in the expected value:

YEAR 1 (₹ in lakhs)

CFAT (x)	x	$\bar{x}-x$	Probability(P)	$(\bar{x}-x)^2$	$P(\bar{x}-x)^2$
14	27	(13)	0.1	169	16.9
18	27	(9)	0.2	81	16.2
25	27	(2)	0.4	4	1.6
40	27	13	0.3	169	50.7
					85.4

Variance $=(\sigma)^2 = \sum P(x-x)^2 = 85.4$

Standard deviation $=\sum \sqrt{P(x-\bar{x})^2} = \sqrt{\sigma} = \sqrt{85.4} = 9.241$

YEAR 2 (₹ in lakhs)

CFAT (x)	x	$\bar{x}-x$	Probability(P)	$(\bar{x}-x)^2$	$P(\bar{x}-x)^2$
15	29.3	(14.3)	0.1	204.49	20.449
20	29.3	(9.3)	0.3	86.49	25.947
32	29.3	2.7	0.4	7.29	2.916
45	29.3	15.7	0.2	246.49	49.298
					98.61

Variance $=(\sigma)^2 = \sum P(x-\bar{x})^2 = 98.61$

Standard deviation $=\sum \sqrt{P(\bar{x}-x)^2} = \sqrt{\sigma} = \sqrt{98.61} = 9.93L$

YEAR 3: (₹ in lakhs)

CFAT (x)	x	$\bar{x}-x$	Probability(P)	$(x-\bar{x})^2$	$P(x-\bar{x})^2$
18	27.9	(9.9)	0.2	98.01	19.602
25	27.9	(2.9)	0.5	8.41	4.205
35	27.9	7.1	0.2	50.41	10.082
48	27.9	20.1	0.1	404.01	40.401
					74.29

Variance $= (\sigma)^2 = \sum P(x-x)^2 = 74.29$

Standard deviation $= \sum \sqrt{P(x-\bar{x})^2} = \sqrt{\sigma} = \sqrt{74.29} = 8.62L$

Standard deviation of expected value $= \sqrt{\frac{8.54}{(1.08)^2} \cdot \frac{98.61}{(1.08)^4} \cdot \frac{74.29}{(1.08)^2}} = 13.874$

Illustration 2

The management of Power Tech. Ltd. must choose whether to go ahead with either of two mutuallyexclusive projects A and B. The expected profits are as follows:

Particulars	Profit if there is strong demand	Profit/loss if there is weak demand
Option A(₹)	4,000	(1,000)

Option B(₹)	1,500	500
Probability of demand	0.3	0.7

a. What would be the decision based on expected values. If no information about demands were available?

b. What is the value of perfect information about demand?

Solution

a) If there is no information the project with higher expected profit would be selected:
Expectedprofit option A = 0.3 x 4,000 + 0.7(1,000) = ₹ 500
Expected profit option B = 0.3 x 1,500 + 0.7 x 500 = ₹ 800.

b) Perfect information indicates we have a clear idea that demand will be strong or weak If demand forecasted is weak Project B would be selected.
If demand forecasted is strong then Project A would be selected. Expected profit with perfect information = 0.7 x 500 + 0.3 x 4,000 = 1,550Expected profit without perfect information = (800)
Value of perfect information = 750

Illustration 3

A manager is trying to decide which of the three mutually exclusive project X, Y or Z to undertake. Each of the projects could lead to varying net profits which are classified as outcomesI, II and III. The manager has constructed the following pay-off table or matrix (a conditionalprofit table).

Outcomes	Probability	Project		
		X	Y	z
		Net Profit (₹)		
I (Worst)	0.2	5,00,000	7,00,000	9,00,000
II (Most likely)	0.5	8,50,000	7,50,000	10,00,000
III (Best)	0.3	13,00,000	14,00,000	11,00,000

(i) **Which project should be undertaken using Expected Value Criterion?**

(ii) **Which project should be chosen, if minimax regret rule is applicable?**

Solution

(i)

Outcome	Probability	EVx (₹)	EVY (₹)	EVz (₹)
I (Worst)	0.2	1,00,000	1,40,000	1,80,000
II (Most Likely)	0.5	4,25,000	3,75,000	5,00,000
III (Best)	0.3	3,90,000	4,20,000	3,30,000
Total	1.0	9,15,000	9,35,000	10,10,000

If the project with the highest EV of profit is chosen, this would be product Z.

(ii) A table of regrets can be compiled, as follows, showing the amount of profit that might be foregonefor each project, depending on whether the outcome is I, II or III.

Outcome	X (₹)	Y (₹)	Z (Rs)
I (Worst)	[9,00,000 - 5,00,000] = 4,00,000	[9,00,000-7,00,000] = 2,00,000	[9,00,000- 9,00,000] = 0
II (Most likely)	[10,00,000-8,50,000] = 1,50,000	[10,00,000-7,50,000] = 2,50,000	[10,00,000 10,00,000] = 0
III (Best)	[14,00,000 -13,00,000] = 1,00,000	[14,00,000-14,00,000] = 0	[14,00,000-11,00,000] = 3,00,000

Analysis: The maximum regret is ₹ 4,00,000 with project X, ₹ 2,50,000 with Y and ₹ 3,00,000 with Z.The lowest of these three maximum regrets is ₹ 2,50,000 with Y and so project Y would be selected,if the minimax regret rule is used.

Illustration 4

Spark Ltd. is a company that specializes in building tracks for high-speed trains. The company is the process of bidding for a new interstate train project. The chief bidding engineer has come up with a net present value estimate of ₹814.5 Crore. His inputs include the company's weighted average cost of capital of 8%, cash inflows of ₹2,000 crore which are expected at the end of 3rd year, annual expenditures for year 1, 2 and 3 of ₹300 crore per year. As the chief investment officer, you have made the following predictions: For the best-case scenario, you predicted a WACC of 6.5%, cash inflows of ₹2,100 crore at the end of 2nd year and cash outflows of ₹400 crore at the end of 1st year and ₹500 crore at the end of second year. For the worst-case scenario, you predicted a WACC of 9%, cash inflows of ₹1,200 crore at the end of 4th year and cash outflows of ₹200 crore at the end of each year for 4 years. The initial investment is 0 in all scenarios. Find the best-case scenario and worst-case scenario.

Solution:

The summary of different scenarios are as follows:

Particulars	Base-Case	Best Case	Worst Case
WACC	8%	6.5%	9%
Cash Inflow	₹2000 crore at the end of 3rd year	₹2100 crore at the end of 2nd year	₹1,200 crore at the end of 4th year
Cash Outflow	₹300 crore per year for first 3 years	₹400 crore at the end of 1st year and ₹500 crore at the end of 2nd year	₹200 crore at the end of each year for 4 years

NPV with the most likely figure (base-case) = ₹814.5 Crore (given)

NPV under best-case scenario = $\frac{-400}{(1+6.5\%)^1} + \frac{2100-500}{(1+6.5\%)^2} - 0 = ₹1{,}035$

NPV under worst-case scenario = - 200 × PVIFA (9%, 4) + $\frac{1200}{(1+9\%)^4} - 0 = ₹202\ Crore$

From this scenario analysis, we find that the net present value of the project is expected to be between ₹202 crore and ₹1,035 crore with the most likely figure to be ₹814.5 crore.

Thus, NPV is likely to vary within the range ₹202 crores to ₹1,035 crore.

Illustration 1

Fair finance, a leasing company, has been approached by a prospective customer intending to acquire a machine whose Cash Down price is Rs. 3 crores. The customer, to leverage his tax position, has requested a quote for a three-year lease with rentals payable at the end of each year but in a diminishing manner such that they are in the ratio of 3: 2: 1. Depreciation can be assumed to be on straight line basis and Fair Finance's marginal tax rate is 35%. The target rate of return for Fair Finance on the transaction is12%. Calculate the lease rents to be quoted for the lease for three years.

Solution

SDCOF under Buy Option

Cost of Machine = ₹ 3 crores

(-) PV of tax savings on depreciation (3cr/3 x 35% x2.4018) = ₹ (84,06,300)

Sum of discounted cash outflow = ₹ 2,15,93,700

Lease Option

Let lease rent to be charged for 3rd year = X

Year	Lease rent after tax	PVAF @ 12%	DCOF
1	3x (0.65)	0.8928	1.7409x
2	2x (0.7971)	0.7971	1.03623x
3	X (0.65)	0.7117	0.462605x
Sum of discounted cash outflow			**3.239795x**

Lease rent for 3rd year = ₹ 2,15,93,700 / 3.239795x = ₹ 66,65,144

Lease rent for 2nd year =₹ 2 (66,65,144) = ₹ 1,33,30,288

Lease rent for 1st year = ₹ 3 (66,65,144) = ₹ 1, 99,95,432

Illustration 2

ABC Company Ltd. is faced with two options as under in respect of acquisition of an asset valued Rs.1,00,000/- EITHER

a) To acquire the asset directly by taking a Bank Loan of ₹ 1,00,000/- repayable in 5 year-end instalments at an interest of 15%. Or

b) To lease in the asset at yearly rentals of Rs.320 per ₹ 1,000 of the asset value for 5 years payable at year end.

The following additional information are available.

i) The rate of depreciation of the asset is 15% W.D.V. The company has an effective tax rate of 50%.

ii) The company employs a discounting rate of 16%.

You are to indicate in your report which option is more preferable to the Company. Restrict calculation over a period of ten years.

The present value of one Rupee due at the end of each year is:

End of the year	1	2	3	4	5	6	7	8	9	10
Present Value	0.862	0.743	0.640	0.552	0.476	0.410	0.353	0.305	0.263	0.227

Solution

Working note 1 – Calculation of tax savings on depreciation

Year	Opening WDV	Depreciation	Closing WDV	Tax savings on Depn.
1	1,00,000	15,000	85,000	7,500
2	85,000	12,750	72,250	6,375
3	72,250	10,837	61,413	5,419
4	61,413	9,212	52,201	4,606
5	52,201	7,830	44,371	3,915
6	44,371	6,656	37,715	3,328
7	37,715	5,657	32,058	2,829
8	32,058	4,809	27,249	2,405
9	27,249	4,087	23,162	2,043
10	23,162	3,474	19,688	1,737

Option 1 – Acquisition of asset

Calculation of Sum of discounted cash outflow:

Year	Principal	Interest	P + I	Tax Savingson Interest	Tax savingson Dep.	Net Cash Outflow	PVF @ 16%	DCF
1	20,000	15,000	35,000	(7,500)	(7,500)	20,000	0.862	17,241
2	20,000	12,000	32,000	(6,000)	(6,375)	19,625	0.743	14,581
3	20,000	9,000	29,000	(4,500)	(5,419)	19,080	0.640	12,211
4	20,000	6,000	26,000	(3,000)	(4,606)	18,394	0.552	10,153
5	20,000	3,000	23,000	(1,500)	(3,915)	17,585	0.476	8,370
6	-	-	-	-	(3,328)	(3,328)	0.410	(1,364)
7	-	-	-	-	(2,829)	(2,829)	0.353	(998)
8	-	-	-	-	(2,404)	(2,404)	0.305	(733)
9	-	-	-	-	(2,043)	(2,043)	0.263	(537)
10	-	-	-	-	(1,737)	(1,737)	0.227	(394)
Sum of Discounted Cash Outflows								**58,530**

Option 2 – Lease

Sum of Discounted Cash Outflow

Year	Lease rent	Tax saving	Net outflow	PVAF @ 16%	DFC
1-5	32,000	16,000	16,000	3.2742	52,387

Equated annual cost under Buy option $= \frac{Sum\ of\ discounted\ cash\ outflow}{PVAF\ @\ 16\%\ for\ 10\ years}$

$= \frac{₹58,530}{4,8332} = ₹\ 12,110$

Equated annual cost under Lease option $= \frac{Sum\ of\ discounted\ cash\ outflow}{PVAF\ @\ 16\%\ for\ 5\ years}$

$$= \frac{₹52,387}{3.2742} = ₹\ 16,000$$

Decision – Since the SDCOF is lower under lease, company should opt for lease. However, it is not wise to compare the two proposals SDCOF with different life periods. Hence EAC should be considered for decision making. **Company should buy an asset as equated annual cost is lowerunder buy option.**

ADDITIONAL QUESTIONS

Question 1

Your company is considering to acquire an additional computer to supplement its time share computer services to its clients. It has two option:

i) **To purchase the computer for ₹ 22Lakhs.**

ii) **To lease the computer for 3 years from a leasing company for ₹ 5,00,000 as annual lease rent plus 10% of gross time share services revenue .The agreement also requires an additional payment of ₹ 6,00,000 at the end of 3rd year . Lease rents are payable at the year end and the computer reverts to the lessor after the contract period.**

The company estimates that the computer under review will be worth ₹ 10Lakhs at the end of 3rd year.

Forecast Revenue are:

YEAR	1	2	3
AMOUNT (₹ in Lakhs)	22.5	25	27.5

Annual operating cost excluding depreciation / lease rent of computer are estimated at ₹ 9 Lakhs. With additional ₹ 1 Lakhs for startup and training costs at the beginning of the 1st year. These costs are to be borne by the lessee. Your company will borrow at 16% interest to finance the acquisition of the company. Repayments are to be made according to the following schedule:

Year end	1	2	3
Principal (₹ 000)	500	850	850
Interest (₹ 000)	352	272	136

The company uses straight line method (SLM) to depreciate its assets and pays 50% tax on its income. The management approaches you to advice. Which alternative would be recommended and why?

NOTE: The PV factor at 8% and 16% rate of discount are:

Year	1	2	3
8%	0.926	0.857	0.794

16%	0.862	0.743	0.641

Solution

Option 1 – Purchase of Computer

Calculation of Sum of discounted cash outflow:

Particulars	**Year 1**	**Year 2**	**Year 3**
Principle	5,00,000	8,50,000	8,50,000
Interest after tax	1,76,000 3,52,000 (1 - 50%)	1,36,000 2,72,000 (1 – 50%)	68,000 1,36,000 (1 - 50%)
(-) Tax Savings on Depreciation $\left(\frac{22L-10L}{3}\right)$ x **50%**	(2,00,000)	(2,00,000)	(2,00,000)
(-) Salvage Value			(10,00,000)
Net Cash Outflow	4,76,000	7,86,000	(2,82,000)
PVF @8%	0.926	0.857	0.794
Discounted Cash Outflow	4,40,776	6,73,602	(2,23,908)

Sum of Discounted Cash Outflow = ₹ 4,40,776 + 6,73,602 – 2,23,908 = ₹ 8,90,470

Option 2 – Leasing

Yr	**PVF @ 8%**	**Lease rent (fixed)**	**Lease rent (variable)**	**Additional payment**	**Total**	**Cash outflow after tax @50%**	**PVF @ 8%**	**Disc Cash Outflows**
1	0.926	5,00,000	2,25,000	-	7,25,000	3,62,500	0.926	3,35,675
2	0.857	5,00,000	2,50,000	-	7,50,000	3,75,000	0.857	3,21,375
3	0.794	5,00,000	2,75,000	6,00,000	13,75,000	6,87,500	0.794	5,45,875
Sum of Discounted Cash Outflows								**12,02,925**

Decision: Since the Sum of discounted cash outflow under alternative 1 is lower, the companyshould purchase computer.

Illustration 1

Following Financial data are available for PQR Ltd. for the year 2008:

	(₹ in lakh)
8% debentures	125
10% bonds (2007)	50
Equity shares (Rs 10 each)	100
Reserves and Surplus	300
Total Assets	600
Assets Turnovers ratio	1.1
Effective interest rate	8%
Effective tax rate	40%
Operating margin	10%
Dividend payout ratio	16.67%
Current market Price of Share	₹ 14
Required rate of return of investors	15%

You are required to:

i) Draw income statement for the year

ii) Calculate its sustainable growth rate

iii) Calculate the fair price of the Company's share using dividend discount model, and

iv) What is your opinion on investment in the company's share at current price?

Solution

Total assets = 600 lakhs

Asset turnover ratio = 1.1

Sales/ Assets = 1.1

Sales = (600 x 1.1) = 660 lakhs

Operating profit (EBIT) = (660 x 10%) = 66 lakhs

i) Income statement for the year:

Particulars	Amt (in lakhs)
EBIT	66
Less: Interest [(125 + 50) x 8%]	(14)
EBT	52
Less: Tax @ 40%	(20.8)
EAT/EAES	31.2
Less: dividend (31.2 x 16.67%)	(5.2)
Retained Earnings	26

No. of shares (100 lakhs/ 10 lakhs) = 10 lakh shares

EPS (31.2/10) = 3.12

DPS (5.2/10) = 0.52

ii) Growth rate (g) = b x r

b = retention ratio

r = return on equity

Retention ratio (1 – 16.67%) = 83.33%

Return on equity [31.2/ (100+300)] = 7.8%

Growth rate (g) = 83.33% x 7.8% = 6.49%

iii) Fair price of a share = (0.52 + 6.49%)/ (15% - 6.49%) = 6.507/-

iv) Investor should not invest in the Co because share is overpriced in the market.

Illustration 2

The earnings and dividend on equity share of RAXON Ltd., have been growing at a rate of 10% per annum for 4 years. After four years the growing rate of dividend is expected to decline linearly to 7%. After six years, the growing rate will fall and stabilize at 7% forever (infinitely). The last dividend per share was ₹3 and the investors required rate of return on the stock of RAXON Ltd. is ₹16%.

Required:

Analyze and assess how much the value per share of RAXON Ltd.'s equity stock should be. (using Three-Phase Model)

P.V. Factor:

Year	1	2	3	4	5	6	7	8	9	10
PVIF (16%, Yrs.)	0.862	0.743	0.641	0.552	0.476	0.410	0.354	0.305	0.263	0.227

Solution

The present value per share of Raxon Ltd's equity will be D 40.13

Illustration 3

On the basis of the following information:

Current Dividend (D_0) = Rs. 2.50

Discount Rate (k) = 10.5%

Growth Rate (g) = 2%

i) Calculate the present value of stock of ABC Ltd

ii) Is its stock overvalued if stock price is Rs. 35, ROE = 9% and EPS = Rs. 2.25? Show detailed calculation. Using PE Multiple approach and Earning Growth Model

Solution

Given, Current Dividend (D_0) = Rs 2.50

Growth Rate (g) = 2%

Cost of equity (K_e) = 10.5%

(i) Present Value of Stock under Dividend Growth Model

$$P_0 = \frac{D_1}{K_e - g}$$

$$P_0 = \frac{2.50(1 + 2\%)}{10.5\% - 2\%} = \frac{2.55}{8.5\%} = \text{Rs. } 30$$

(ii) a) Value of Stock under PE Multiple Approach

Given,

Return on Equity = 9%

EPS = Rs. 2.25

PE Ratio = $\frac{1}{Ke} = \frac{1}{9\%}$ = 11.11

Value of Share = 2.25 x 11.11 = Rs. 25

Actual Stock Price = Rs. 35

Value of Share = Rs. 25

Actual Stock Price is higher than the value, hence the share is OVERVALUED

b) Value of Stock under Earnings Growth Model

Given,

Return on Equity = 9%

EPS = Rs. 2.25

Growth Rate = 2%

Value of Share = $\frac{E_1}{(Ke - g)}$

= $\frac{2.25(1+2\%)}{9\% - 2\%}$ = Rs. 32.79

Actual Stock Price = Rs. 35

Value of Share = Rs. 32.79

Actual Stock Price is higher than the value, hence the share is OVERVALUED

Illustration 4

Calculate the value of share from the following information:

Profit of the company	₹ 290 crores
Equity capital of company	₹ 1,300 crores
Par value of share	₹ 40 each
Debt ratio of company (Debt/ Debt + Equity)	27%
Long run growth rate of the company	8%
Beta 0.1; risk free interest rate	8.7%
Market returns	10.3%
Capital expenditure per share	₹ 47
Depreciation per share	₹ 39
Change in Working capital	₹ 3.45 per share

Solution

Profit = 290 Cr

ESC = 1300 Cr

Face Value = 40/-

No. of equity shares (1300/40) = 32.5 Cr shares

EPS = (290/ 32.5) = 8.923/-

Free Cash Flow to Equity (FCFE):

FCFE = Net Income – [(Cap Exp – Dep) + Δ WC] x Equity ratio

Cap Exp – Dep = Capital exp investment

Δ WC = working capital investment

FCFE = 8.923 – [(47 – 39) + 3.45] x 73% = 0.5645

Cost of equity K_e = 8.7 + 0.1(10.3 – 8.7) = 8.86%

Value of a share = (FCFE/ K_e – g) = (0.5645 + 8%)/ (8.86% - 8%) = 70.89/-

Illustration 5

PALSON Ltd. has issued a convertible bond with a face value of₹ 1,00,000. The bond pays a coupon rate of 6% per annum, with interest payments made semi-annually. The bond has a term of 3 years and will be redeemed at ₹1,10,000 at maturity. Alternatively, the bondholder has the option to convert the bond into 50 shares at the end of the 3-year term. The required rate of return for the bond is 12% per annum.

Currently, the share price of PALSON Ltd is ₹ 2,000, and the shares are expected to grow at an annual rate of 8%. The shares also pay an annual dividend of ₹50 each.

Given: PV Factor:

Year	1	2	3	4	5	6
PVIF (3%)	0.971	0.943	0.915	0.888	0.863	0.837
PVIF (6%)	0.943	0.89	0.84	0.792	0.747	0.705
PVIF (8%)	0.926	0.857	0.794	0.735	0.681	0.630
PVIF (12%)	0.893	0.797	0.712	0.636	0.567	0.507

Required:

i) **Analyze the value of the bond if it redeems at maturity.**

ii) **Assess the value of share at conversion.**

iii) **Assess the value of conversion option.**

iv) **Advise which option is more advantageous for the bondholder.**

Solution

(i) Interest payment = 100000 x 6% / 2 = D 3000 semi annually Present value of interest = 3000 x 4.917 = D 14751

Present value of redemption value = 110000 x 0.705= D 77550 Value of Bond = 14751 + 77550 = D 92301

(ii) Expected Share Price at Maturity:

Price at the end of 3 year = 2000 x $(1 + 0.08)^3$ = 2000 x 1.26 = D 2520

Value of Shares at conversion:

= 50 x 2520 = D 126000

(iii) Value of conversion option:

Present value of dividend incomes = 50 x 50 x 2.402 = D 6005 Present value of shares at conversion = 126000 x 0.712 = D 89712 Value of conversion option = 6005 + 89712= D 95717

Advise:

The bondholder should choose to convert the bond into shares, as the value of conversion option (D 95717) is higher than that of the current bond value (D 92301)

Illustration 6

The following is the parameter pertaining to 8% fully convertible (into equity shares) debentures issued by DAZIN Ltd. at₹ 1,000:

Market Price of 8% Debenture (₹)	1,200
Conversion Ratio (No. of shares)	25
Straight Value of 8% Debentures (₹)	1,000
Market Price of equity shares on the date of conversion (₹)	40
Expected Dividend per share (₹)	1

Required:

(i) Analyse and assess the following:

(ii) Conversion Value of Debenture

(iii) Market Conversion Price

(iv) Conversion Premium per share

(v) Ratio of Conversion Premium

(vi) Premium over Straight Value of Debenture

(vii) Favourable Income Differential per share

Solution

(i) Conversion Value of Debenture = D 1,000

(ii) Market Conversion Price = D 48

(iii) Conversion Premium per share = D 8

(iv) Ratio of Conversion Premium = 0.2 i.e. 20 %

(v) Premium over Straight Value of Debenture = 20 %

(vi) Favourable Income Differential per share = D 2.20

Illustration 7

Following information is related to the Convertible Bond of SONTA Ltd. which is currently priced at 1060 per Bond:

- **Conversion Parity Price = ₹53**
- **Conversion Premium = 10.41667%**
- **Percentage of Downside Risk with respect to Straight Value of Bond = 12.766%**

Required:

(i) Calculate No. of shares on Conversion.

(ii) Analyse Current Market Price Per Share of SONTA Ltd.

(iii) Assess the Straight Value of Bond.

Solution

(i) No. of Shares on Conversion = 20

(ii) The current market price of Share of SONTA Ltd. shall be = D 48 per share

(iii) Straight Value of Bond = D 940 per Bond

Illustration 8

An investor is considering the purchase of the following Bond:

Face value	**₹ 100**
Coupon rate	**11%**
Maturity	**3 years**

i) If he wants a yield of 13% what is the maximum price he should be ready to pay for?

ii) If the Bond is selling for ₹ 97.60, what would be his yield?

Solution

i) Calculation of value of bond:

Year	CF	PVF/PVAF @ 13%	DCF
1-3	11	2.361	25.971
3	100	0.693	69.3
			95.271

The max price he should be ready to pay for is 95.271/-

ii) Yield – When the bond is selling for 97.6

Trial 1 – Yield @ 10%

Year	CF	PVF/PVAF @ 10%	DCF
1-3	11	2.487	27.36
3	100	0.751	75.1
			102.46

Yield = 10% + [(102.46 – 97.6)/ (102.46 – 95.271)] x 3

= 10% + (4.86/ 7.189) x 3

= **12.03%**

ADDITIONAL QUESTIONS

Illustration 1

TEXTON Ltd. is a major player in the textile industry of the country. The industry is expected to maintain high growth for a period of 5 years after which it is expected to drop down. Currently the company is distributing 40% of its profit as dividend to Shareholders. The dividend payout ratio of the company is expected to remain at the current level for a period of next 5 years after which it is expected to increase to 55%. The net profit margin of the company is currently 8% and is expected to remain at the same level for next 5 years, after which it is expected to decrease to 5.7%. Currently

the company is able to generate sales of ₹2.50 for every 1 rupee of assets employed and it is expected to remain the same for the next 5 years, and after that the company is expected to generate sales of ₹3.50 for every 1 rupee of assets employed. 50% of the assets of the company are financed with equity capital, and it is expected to remain same in the future. At present the risk free rate of return is 7% and market risk premium is 15.5%. The Beta of the company is currently 1.2. Current net worth of the company is ₹250 lakhs and numbers of shares outstanding is 2 Lakhs. Assuming that the market is in equilibrium.

(Calculation to be rounded off to 3 dizimals)

Given PVI Factors:

Year	1	2	3	4	5
PVIF (20%)	0.833	0.694	0.579	0.482	0.402
PVIF (24%)	0.806	0.650	0.524	0.423	0.341
PVIF (25%)	0.800	0.640	0.512	0.410	0.328
PVIF (25.6%)	0.796	0.634	0.505	0.402	0.320

Required:

Analyze and assess the price per share of Texton Ltd., using Dividend Discount Model (DDM).

Solution

Particulars	Next 5 Years	After 5 Years
Pay-out ratio	40 %	55 %
Net profit margin	8 %	5.70%
Asset turnover ratio	2.50	3.50
N W / T A	50 %	50 %
ROE	40 %	39.9 % = 40%
Growth rate	24 %	17.955% or18 %

Calculation of price per share :

Year	Growth Rate%	DPR %	EPS	DPS %
0	24	40	50	
1	24	40	62	24.8
2	24	40	76.88	30.752
3	24	40	95.33	38.132
4	24	40	118.21	47.284
5	24	40	146.58	58.632
6	18	55	172.97	95.134

Current EPS of the Company = $\frac{100}{2}$ =D 50

Cost of equity (Ke) = 7 + 1.2 (15.5) = 25.6%

Terminal value at the end of 5th year = 95.134 / (0.256 – 0.18) = 1251.76

Alternatively: = 69.19/ (0.256 – 0.18) = 910.34

Assessment of Price per Share at time 'O':

= [19.7408+19.4967+19.2566+19.0081+419.325 or 310.07] =D 496.83 Or = D 387.57

Illustration 2

The risk free rate of return RF is 9 percent. The expected rate of return on the market portfolio RM is 13 percent. The expected rate of growth for the dividend of Platinum Ltd. is 7 percent.

The last dividend paid on the equity stock of firm A was Rs 2.00. The beta of Platinum Ltd. equity stock is 1.2.

1. What is the equilibrium price of the equity stock of Platinum Ltd.?

2. How would the equilibrium price change when

- **The inflation premium increases by 2 percent?**
- **The expected growth rate increases by 3 percent?**
- **The beta of Platinum Ltd. equity rises to 1.3?**

Solution

1) Risk free rate of return (R_f) = 9%

Market Return (R_m) = 13%

Growth Rate (g) = 7%

Current Dividend (D_0) = 2

Beta (β) = 1.2

As per CAPM, $K_e = R_f + (R_m - R_f)$ = 9% + 1.2 (13% - 9%) = 13.8%

Equilibrium price = 2(1 + 7%)/ 13.8% - 7% = 31.47%

Inflation rate increases by 2%, growth rate increases by 3%, beta is 1.3

2) $K_e = R_f + (R_m - R_f)$ = 11 + 1.3 (15 – 11) = 16.2%

Equilibrium price = (2+10%)/ (16.2% - 10%) = 35.483/-

Illustration 1

An investor has decided to invest 1,00,000 in the shares of two companies, namely, ABC and XYZ. The projections of returns from the shares of the two companies along with their probabilities are as follows:

Probability	ABC (%)	XYZ (%)
0.20	12	16
0.25	14	10
0.25	-7	28
0.30	28	-2

You are required to:

(i) Comment on return and risk of investment in individual shares.

(ii) Compare the risk and return of these two shares with a Portfolio of these shares in equal proportions.

(iii) Find out the proportion of each of the above shares to formulate a minimum risk portfolio

Solution

a) Calculation of Risk and Return of ABC:

Return: A

ER_A = [(0.2 X 12) + (0.25 X 14) + (0.25 X -7) + (0.3 X 28)]

ER_A = 12.55%

Risk A

GR_A	ER_A	Probability	$GR_A - ER_A$	$P(GR_A-ER_A)^2$
12%	12.55%	0.20	(0.55)	0.0605
14%	12.55%	0.25	1.45	0.526
-7%	12.55%	0.25	(19.55)	95.55
28%	12.55%	0.30	15.45	71.61
			$P\Sigma(GR_A-ER_A)^2$	167.75

$\sigma_A = \sqrt{\Sigma P(GRA - ERA)^2} = \sqrt{167.75} = 12.95\%$

Return: B

ER_B = [(0.2 X 16) + (0.25 X 10) + (0.25 X 28) + (0.3 X -2)]

ER_B = 12.1%

Risk B

GR_B	ER_B	Probability	$GR_B - ER_B$	$P(GR_B-ER_B)^2$
16%	12.1%	0.20	3.9	3.042
10%	12.1%	0.25	(2.1)	1.1025
28%	12.1%	0.25	15.9	63.2025
-2%	12.1%	0.30	(14.1)	59.643
			$P\Sigma(GR_B-ER_B)^2$	**126.99**

$\sigma_B = \sqrt{\sum P(GR_B - ER_B)^2} = \sqrt{126.99} = 11.27\%$

Conclusion:

	ABC	XYZ
Return	12.55%	12.1%
Risk	12.95%	11.27%

Security XYZ – Less Return and less Risk Security

ABC – High Risk and high Return

b) Return and Risk of a port-folio:

$W_A = 0.5$, $W_B = 0.5$

Return of Portfolio:

$ER_p = W_A ER_A + W_B ER_B = (0.5 \times 12.55) + (0.5 \times 12.1) = 12.325\%$

Risk of Portfolio:

$$\sigma_P = \sqrt{W_A^2\sigma_A^2 + W_B^2\sigma_B^2 + 2W_A W_B \sigma_A \sigma_B \sigma_{AB}}$$

$Cov_{(A,B)} = \sum P(GR_A - ER_A)(GR_B - ER_B)$

$GR_A - ER_A$	$GR_B - ER_B$	Probability	$P(GR_A - ER_A)(GR_B - ER_B)$
(0.55)	3.9	0.20	(0.429)
1.45	(2.1)	0.25	(0.76125)
(19.55)	15.9	0.25	(77.711)
15.45	(14.1)	0.30	(65.3535)
			(144.254)

$\sigma(A,B) = \frac{Cov_{(A,B)}}{\sigma_A \sigma_B} = -144.254 / (12.95 \times 11.27) = -0.98$

$\sigma_p = \sqrt{(0.5)^2 (12.95)^2 + (0.5)^2 (11.27)^2 + 2(0.5)(0.5)(12.95)(11.27)(-0.98)}$

$= \sqrt{41.93 + 31.75 - 72.098}$

$\sigma_p = 1.25\%$

	ABC	XYZ	Portfolio
Return	12.55%	12.1%	12.325%
Risk	12.95%	11.27%	1.25%

c) Calculation of proportion of above shares for construction of minimum risk portfolio:

$W_A = \frac{\sigma_B^2 - Cov_{(A,B)}}{\sigma_A^2 + \sigma_B^2 - 2Cov_{(A,B)}} = \frac{(11.27)^2 - (-144.254)}{(12.95)^2 + (11.27)^2 - 2(-144.254)} = 46\%$

$W_B = 1 - WA = 1 - 0.46 = 54\%$

Illustration 2

The following information are available with respect of Krishna Ltd.

Year	Krishna Ltd. Average share price	Dividend per Share	Average Market Index	Dividend Yield	Return on Govt. bonds
2012	245	20	2013	4%	7%

2013	253	22	2130	5%	6%
2014	310	25	2350	6%	6%
2015	330	30	2580	7%	6%

Compute Beta Value of the Krishna Ltd. at the end of 2015 and state your observation.

Solution

$$\beta = \frac{Cov_{(S,M)}}{\sigma_M^2}$$

$$Cov_{(A,B)} = \frac{\Sigma(GR_A - AR_A)(GR_B - AR_B)}{n}$$

Calculation of Return and Risk of Security

Year	Calculation of GR_S	GR_S	AR_S	$GR_S - AR_S$
2012-13	$\frac{253 - 245 + 22}{245}$	12.24%	20.26%	(8.02)
2013-14	$\frac{310 - 253 + 25}{253}$	32.41%	20.26%	12.15
2014-15	$\frac{330 - 310 + 30}{310}$	16.13%	20.26%	(4.13)

Calculation of Return and Risk of Market:

Year	Calculation of GR_M	GR_M	AR_M	$GR_M - AR_M$	$(GR_M - AR_M)^2$
2012-13	$\frac{2130 - 2013}{2013}$ +5%	10.81%	14.64%	(3.83)	14.67
2013-14	$\frac{2350 - 2130}{2130}$ +6%	16.33%	14.64%	1.69	2.86
2014-15	$\frac{2580 - 2350}{2350}$ +7%	16.73%	14.64%	2.15	4.62
					22.15

Calculation of Cov_{SM}

GRS-ARS	GRM-ARM	(GRS-ARS)(GRM-ARM)
(8.02)	(3.83)	30.72
12.15	1.69	20.53
(4.13)	2.15	(8.8)
		42.37

$Cov_{(SM)} = (42.37/3) = 14.12$

Variance $(\sigma_M^2) = \frac{\Sigma(GR_M - AR_M)^2}{n} = (22.15/3) = 7.38\%$

$\beta = \frac{Cov_{(S,M)}}{\sigma_M^2} = \frac{14.12\%}{7.38\%} = 1.913$

Calculation of CAPM return and Statement showing Observation:

Year	CAPM return	Actual return	Over/under priced	Action
2012-13	6% +(10.81 - 6%) 1.913 = 15.19%	12.24%	Over	Sell
2013-14	6% +(16.33 - 6%) 1.913 = 25.76%	32.41%	Under	Buy
2014-15	6% +(16.79 - 6%)1.913 = 26.65%	16.13%	Over	Sell

CAPM = Rf + (Rm -Rf) β = 6% +(10.81 - 6%) 1.913 = 15.19%

Illustration 3

A Ltd. has an expected return of 22% and Standard deviation of 40%. B Ltd. has an expected return of 24% and Standard deviation of 38%. A Ltd. has a beta of 0.86 and B Ltd. a beta of 1.24. The correlation coefficient between the return of A Ltd. and B Ltd. is 0.72. The Standard deviation of the market return is 20%. Suggest:

(i) Is investing in B Ltd. better than investing in A Ltd.?

(ii) If you invest 30% in B Ltd. and 70% in A Ltd., what is your expected rate of return and portfolio Standard deviation?

(iii) What is the market portfolios expected rate of return and how much is the risk - free rate?

(iv) What is the beta of Portfolio if A Ltd.'s weight is 70% and B Ltd.'s weight is 30%?

Solution

Given data:

	A Ltd	B Ltd	Market
Expected Return ER_A	22%	24%	
Standard deviation σ	40%	38%	20%
Beta β	0.86	1.24	

σ_{AB} = 0.72

(i) Investing in 'B' ltd is better than investing 'A' ltd because 'B' Ltd gives higher return with lower risk.

(ii) WA = 0.7, WA = 0.3

ERp = $W_A ER_A + W_B ER_B$

= (0.7 X 22%) + (0.3 X 24%)

ERp = 22.6%

$$\sigma_p = \sqrt{W_A^2\sigma_A^2+W_B^2\sigma_B^2+2W_A W_B\sigma_A\sigma_B\sigma_{AB}}$$

$$\sigma_p = \sqrt{0.7)^2\ (0.4)^2 + (0.3)^2\ (0.38)^2 + 2\ (0.7)(0.3)(0.4)(0.38)(0.72)}$$

σ_p = 37.06%

(iii) **Security A**

CAPM Return = Rf + (Rm – Rf) β

22% = Rf + 0.86(Rm – Rf)

Security B

CAPM Return = Rf + (Rm – Rf)β

24% = Rf + 1.24(Rm – Rf)

22% = Rf + 0.86(Rm – Rf) – equation 1

24% = Rf + 1.24(Rm – Rf) – equation 2

\- - -

-2% = (Rm – Rf)(0.86 – 1.24)

Rm – Rf = 5.26

Substitute Rm – Rf = 5.26 in equation 1

22% = Rf + 0.86 (5.26)

Rf = 17.47%

We know that, Rm – Rf = 5.26

Rm – 17.47= 5.26

Rm = 22.73%

(iv) **βp = WA βA + WB βB** = (0.7 x 0.86) + (0.3 x 1.24)

βp = 0.97

Illustration 4

An investor holds two stocks A and B. An analyst prepared ex-ante probability distribution for the possible economic scenarios and the conditional returns for two stocks and the market index as shown below:

Economic scenario	Probability	Conditional Returns %		
		A	B	Market
Growth	0.40	25	20	18
Stagnation	0.30	10	15	13
Recession	0.30	-5	-8	-3

The risk-free rate during the next year is expected to be around 11%. Determine whether the investor should liquidate his holdings in stocks A and B or on the contrary make fresh investments in them. CAPM assumptions are holding true.

Solution

Calculation of Expected Return:

Expected Return of Stock – A = [(0.4 x 25) + (0.3 x 10) + (0.3 x -5)] = 11.5%

Expected Return of Stock – B = [(0.4 x 20) + (0.3 x 15) + (0.3 x -8)] = 10.1%

Expected Return of Market = [(0.4 x 18) + (0.3 x 13) + (0.3 x -3)] = 10.2%

Security A

Calculation of Co-variance $Cov_{(A,M)}$ and variance of market σ_M^2:

Economic Scenario	$GR_A - AR_A$	$GR_M - AR_M$	Probability	$P(GR_A - AR_A)(GR_M - AR_M)$	$P(GR_M - AR_M)^2$
Growth	13.5	7.8	0.4	42.12	24.34
Stagnation	(1.5)	2.8	0.3	(1.26)	2.35
Recession	(16.5)	(13.2)	0.3	65.34	52.27
				106.2	**78.96**

$Cov_{(A,M)} = \sum P(GR_A - ER_A)(GR_M - ER_M)$

$Cov_{(A,M)} = 106.2$

$\sigma_M^2 = \sum P(GR_M - ER_M)$

$\sigma_M^2 = 78.96$

$\beta = \frac{Cov_{(S,M)}}{\sigma_M^2} = \frac{106.2}{78.96} = 1.345$

SECURITY B

Calculation of Co-variance $Cov_{(B,M)}$ and variance of market σ_M^2:

Economic Scenario	$GR_A - AR_A$	$GR_M - AR_M$	Probability	$P(GR_A - AR_A)(GR_M - AR_M)$
Growth	9.9	7.8	0.4	30.89
Stagnation	4.9	2.8	0.3	4.12
Recession	(18.1)	(13.2)	0.3	71.68
				106.69

Required Return of A:

Return = $R_f + \beta(R_m - R_f)$

$R_A = 11\% + 1.345\ (10.2 - 11) =$ **9.924%**

Required Return of B:

Return = $R_f + \beta(R_m - R_f)$

$R_B = 11\% + 1.351\ (10.2 - 11) = 9.92\%$

Alpha of Stock – A:

Expected Return – Required Return = (11.5% - 9.924%)

Alpha of Stock – A = 1.576%

Alpha of Stock – B:

Expected Return – Required Return = (10.1% - 9.92%)

Alpha of Stock – A = 0.18%

Since stock A and B both have positive Alpha, therefore, they are UNDERPRICED. The investor should make fresh investment in them.

Illustration 5

Mr. Nirmal Kumar has categorized all the available stock in the market into the following types:

a) Small cap growth stocks

b) Small cap value stocks

c) Large cap growth stocks

d) Large cap value stocks

Mr. Nirmal Kumar also estimated the weights of the above categories of stocks in the market index. Further, more the sensitivity of returns on these categories of stocks to the three important factor are estimated to be:

Category of Stocks	Weight in the Market Index	Factor I (Beta)	Factor II (Book Price)	Factor III (Inflation)
Small cap growth	25%	0.80	1.39	1.35
Small cap value	10%	0.90	0.75	1.25
Large cap growth	50%	1.165	2.75	8.65
Large cap value	15%	0.85	2.05	6.75
Risk Premium		6.85%	-3.5%	0.65%

The rate of return on treasury bonds is 4.5%

Required:

a) Using Arbitrage Pricing Theory, determination the expected return on the market index.

b) Using Capital Asset Pricing Model (CAPM), determine the expected return on the market index.

c) Mr. Nirmal Kumar wants to construct a portfolio constituting only the 'small cap value' and 'large cap growth' stocks. If the target beta for the desired portfolio is 1, determine the composition of his portfolio.

Solution

As per Arbitrage pricing theory:

Small Cap Growth = [4.5% + (6.85 x 0.8) + (-3.5 x 1.39) + (0.65 x 1.35)] = 5.99%

Small Cap Value = [4.5% + (6.85 x 0.9) + (-3.5 x 0.75) + (0.65 x 1.25)] = 8.85%

Large Cap Growth = [4.5% + (6.85 x 1.165) + (-3.5 x 2.75) + (0.65 x 8.65)] = 8.48%

Large Cap Value= [4.5% + (6.85 x 0.85) + (-3.5 x 2.05) + (0.65 x 6.75)] = 7.53%

Total Expected Return = [(0.25 x 5.99) + (0.1 x 8.85) + (0.5 x 8.48)+ (0.15 x 7.53)] = 7.752%

a) CAPM

β = [(0.8 x 25) + (0.9 x 0.1) + (1.165 x 0.5) +(0.85 x 0.15)]

β = 1

b) Expected Return = Rf + (Rm – Rf)β = 4.5% + 1(6.85) = 11.35%

c) Target β of desired portfolio = 1

β of small cap value = 0.9

β of large cap growth = 1.165

Let the proportion of small cap value = x Proportion of large cap growth = 1 – x

β p = WA β A + WB β B

1 = (x x 0.9) + (1 – x)(1.165)

1 = 0.9 x + 1.165 – 1.165 x

x = 62.3%

Proportion of small cap value = 62.3%

Proportion of large cap growth = 37.7%

Illustration 6

Suppose that economy A is growing rapidly and you are managing a global equity fund and so far you have invested only in developed-country stocks only. Now you have decided to add stocks of economy A to your portfolio. The table below shows the expected rates of return, standard deviations, and correlation coefficients (all estimates are for aggregate stock market of developed countries and stock market of Economy A).

	Developed Country Stocks	Stocks of Economy A
Expected rate of return (annualized percentage)	10	15
Risk [Annualized Standard Deviation (%)]	16	30
Correlation Coefficient (r)	0.30	

Assuming the risk-free interest rate to be 3%, you are required to determine:

a) What percentage of your portfolio should you allocate to stocks of Economy A if you want to increase the expected rate of return on your portfolio by 0.5%?

b) What will be the standard deviation of your portfolio assuming that stocks of Economy A are included in the portfolio as calculated above?

Also show how well the Fund will be compensated for the risk undertaken due to inclusion of stocks of Economy A in the portfolio?

Solution

a) Let the weight of stocks of Economy A is expressed as w, then ((1- w) x 10.0) + (w x 15.0) = 10.5

10 – 10w + 15w = 10.5

w = 10%

b) $\sigma_p = \sqrt{W_A^2\sigma_A^2+W_B^2\sigma_B^2+W_C^2\sigma_C^2+2W_AW_B\sigma_A\sigma_B\sigma_{(AB)}}$

$= \sqrt{(0.9)^2\ (0.16)^2 + (0.1)^2\ (0.3)^2 + 2(0.9)(0.1)(0.16)(0.3)(0.3)}$

= 15.6%

Sharpe Ratio:

Sharpe Ratio = $\frac{R_p - R_f}{\sigma_p}$

When Investment is only in developed countries = (10% - 3%)/ 16% = 0.437

With inclusion of stocks in Economy A = (10.5% - 3%)/ 15.6% = 0.481

The Sharpe ratio will improve by approximately 0.04.

Illustration 7

Following are the details of a portfolio consisting of three shares:

Share	Portfolio weight	Beta	Expected return in %	Total variance
A	0.20	0.40	14	0.015
B	0.50	0.50	15	0.025
C	0.30	1.10	21	0.100

Standard Deviation of Market Portfolio Returns = 10% You are given the following additional data:

Covariance (A, B) = 0.030

Covariance (A, C) = 0.020

Covariance (B, C) = 0.040

Calculate the following:

(i) The Portfolio Beta

(ii) Residual variance of each of the three shares

(iii) Portfolio variance using Sharpe Index Model

(iv) Portfolio variance (on the basis of modern portfolio theory given by Markowitz)

Solution

(i) Portfolio Beta:

$\beta_p = W_A \beta_A + W_B \beta_B + \ldots\ldots = (0.2 \times 0.4) + (0.5 \times 0.5) + (0.3 \times 1.1) = 0.66$

(ii) Residual Variance of each share:

Total Variance – Systematic risk

Systematic risk $= \beta_s^2 \times \sigma_m^2$

A – $(0.4)^2 \times (0.1)^2 = 0.0016$

B – $(0.5)^2 \times (0.1)^2 = 0.0025$

C – $(1.1)^2 \times (0.1)^2 = 0.0121$

Residual Variance:

A – 0.015 - 0.0016 = 0.0134

B – 0.025 – 0.0025 = 0.0225

C –0.100 – 0.0121 = 0.0879

(iii) Portfolio – Variance – Sharpe Index Model:

Systematic risk $= \beta_p^2 \times \sigma_m^2 = (0.66)^2 \times (0.1)^2 = 0.004356$

Unsystematic risk $= W_A^2 USR_A + W_B^2 USR_B + W_C^2 USR_C$

$= [(0.2)^2 (0.0134) + (0.5)^2 (0.0225) + (0.3)^2 (0.0879)] = 0.014072$

Total Variance σ_p^2 = Systematic risk + Unsystematic risk

= 0.004356 + 0.014072 = 0.018428

(iv) Portfolio Variance – Markowitz Theory

$\sigma_p^2 = W_A^2 \sigma_A^2 + W_B^2 \sigma_B^2 + W_B^2 \sigma_C^2 + 2 W_A W_B cov_{(A,B)} + 2 W_B W_C cov_{(B,C)} + 2 W_C W_A cov_{(C,A)}$

$\sigma_p^2 = (0.2)^2 (0.015) + (0.5)^2 (0.025) + (0.3)^2 (0.100) + 2(0.2)(0.5)(0.030) + 2(0.5)(0.3)(0.040) + 2(0.3)(0.2)(0.020)$

$\sigma_p^2 = 0.0006 + 0.00625 + 0.009 + 0.006 + 0.012 + 0.0024$

$\sigma_p^2 = 0.03625$

Illustration 8

The returns on stock A and market portfolio for a period of 6 years are as follows

Year	Return on A (%)	Return on market portfolio (%)
1	12	8
2	15	12
3	11	11
4	2	-4

5	10	9.5
6	-12	-2

You are required to determine:

(i) Characteristic line for stock A

(ii) The systematic and unsystematic risk of stock A.

Solution

(i) Characteristic line for Stock – A:

Characteristic Line = $\propto + \beta R_m$

$\beta = \frac{Cov_{(S,M)}}{\sigma_m^2}$

Calculation of Covariance:

Year	GR_A	GR_M	$GR_A - AR_A$	$GR_M - AR_M$	$(GR_A - AR_A)(GR_M - AR_M)$
1	12	8	5.67	2.25	12.76
2	15	12	8.67	6.25	54.19
3	11	11	4.67	5.25	24.52
4	2	(4)	(4.33)	(9.75)	42.22
5	10	9.5	3.67	3.75	13.76
6	(12)	(2)	(18.33)	(7.75)	142.06
	38	34.5			289.51

$AR_A = (38/6) = 6.33\%$

$AR_M = (34.5/6) = 5.75\%$

$Cov_{(A,B)} = \frac{\Sigma(GR_A - AR_A)(GR_B - AR_B)}{n} = (289.51/6) = 48.25$

Calculation of σ_M^2:

Year	$GR_M - AR_M$	$(GR_M - AR_M)^2$
1	2.25	5.0625
2	6.25	39.062
3	5.25	27.563
4	(9.75)	95.063
5	3.75	14.063
6	(7.75)	60.063
		240.87

$\sigma_M^2 = \frac{\Sigma (GR_M - AR_M)^2}{n}$

$\sigma_M^2 = \frac{240.87}{6}$

$\sigma_M^2 = 40.145$

$\beta = \frac{Cov_{(S,M)}}{\sigma_m^2} = (48.25/40.145) = 1.202$

Characteristic Line = $\propto + \beta R_m$

$6.33 = \propto + (1.202)(5.75)$

$\propto = -0.58$

Characteristic Line = -0.58 + (1.202) R_m

(ii) Calculation of Systematic and Unsystematic Risk of Stock – A:

Calculation of σ_S^2:

Year	$(GR_A - AR_A)$	$(GR_A - AR_A)^2$
1	5.67	32.15
2	8.67	75.17
3	4.67	21.81
4	(4.33)	18.75
5	3.67	13.47
6	(18.33)	335.99
		497.34

$$\sigma_S^2 = \frac{\Sigma(GR_A - AR_A)^2}{n}$$

σ_S^2 = (497.34/ 6) = 82.89

Total Risk = σ_S^2 = 82.89

Systematic risk = $\beta_s^2 \times \sigma_m^2 = (1.202)^2 \times 40.145$ = 58%

Unsystematic risk = $\sigma_s^2 - (\beta_s^2 - \sigma_m^2)$ = 82.89 – 58 = 24.89%

ADDITIONAL QUESTIONS

Illustration 1

Expected returns on two stocks for particular market returns are given in the following table:

Market Return	Aggressive	Defensive
7%	4%	9%
25%	40%	18%

You are required to calculate:

(i) The Betas of the two stocks.

(ii) Expected return of each stock, if the market return is equally likely to be 7% or 25%.

(iii) The Security Market Line (SML), if the risk-free rate is 7.5% and market return is equally likely to be 7% or 25%.

(iv) The Alphas of the two stocks.

Solution

a) β of two stocks:

$$\beta = \frac{\text{Change in Security Return}}{\text{Change in market return}}$$

Aggressive: β = (40 - 4)/ (25 – 7) = 2

Defensive: β = (18 - 9)/ (25 – 7) = 0.5

b) Calculation of Expected Return:

Aggressive: (40 + 4)/ 2 = 22%

Defensive: (9 + 18)/ 2 = 13.5%

c) SML line

Aggressive: $R_f + (R_m - R_f)\ \beta = 7.5\% + (16\% - 7.5\%)\ (2) = 24.5\%$

SML Line = 7.5% + (16% – 7.5%) β

Defensive: $R_f + (R_m - R_f)\ \beta = 7.5\% + (16\% - 7.5\%)\ (0.5) = 11.75\%$

d) Calculation of Alpha:

Aggressive: $Rs = \alpha + \beta\ Rm$

$22\% = \alpha + (2)\ (16\%)$

$\alpha = -10$

Defensive: $Rs = \alpha + \beta\ Rm$

$13.5\% = \alpha + (0.5)\ (16\%)$

$\alpha = 5.5$

Illustration 2

A study by a Mutual fund has revealed the following data in respect of three securities:

Security	σ (%)	Correlation with Index, Pm
A	20	0.60
B	18	0.95
C	12	0.75

The standard deviation of market portfolio (BSE Sensex) is observed to be 15%.

a) What is the sensitivity of returns of each stock with respect to the market?

b) What are the covariances among the various stocks?

c) What would be the risk of portfolio consisting of all the three stocks equally?

d) What is the beta of the portfolio consisting of equal investment in each stock?

e) What is the total, systematic and unsystematic risk of the portfolio in (iv)?

Solution

a) Calculation of sensitivity of β of each stock:

$$\beta = \sigma_{SM} \times \frac{\sigma_S}{\sigma_M}$$

A – (0.6 x 20/ 15) = 0.8

B – (0.95 x 18/ 15) = 1.14 C – (0.75 x 12/15) = 0.60

b) Covariances among various stocks:

$Cov_{(A,B)} = \beta_A\ \beta_B\ \sigma_M^{\ 2}$

Stock	A	B	C
A	400	205.2	108
B	205.2	324	153.9
C	108	153.9	144

$Cov_{(A,A)} = \sigma_A^2 = 400$

$Cov_{(A,B)} = \beta_A \beta_B \sigma_M^2 = (0.8)(1.14)(15)^2 = 205.2$

$Cov_{(A,C)} = \beta_A \beta_C \sigma_M^2 = (0.8)(0.6)(15)^2 = 108$

$Cov_{(B,B)} = \sigma_B^2 = 324$

$Cov_{(B,C)} = \beta_B \beta_C \sigma_M^2 = (1.14)(0.6)(15)^2 = 153.9$

$Cov_{(C,C)} = \sigma_C^2 = 144$

c) Risk of Portfolio:

$$\sigma_p = \sqrt{W_A^2\sigma_A^2+W_B^2\sigma_B^2+W_C^2\sigma_C^2+2W_AW_B cov_{(A,B)}+2W_BW_C cov_{(B,C)}+2W_AW_C cov_{(C,A)}}$$

$$= \sqrt{\left(\frac{1}{3}\right)^2(400)+\left(\frac{1}{3}\right)^2(324)+\left(\frac{1}{3}\right)^2(144)+2\left(\frac{1}{3}\right)^2(205.2)+2\left(\frac{1}{3}\right)^2(153.9)+2\left(\frac{1}{3}\right)^2(108)}$$

$$= \sqrt{200.244} = 14.150\%$$

d) 'β' of Portfolio:

$\beta_p = (0.8 + 1.14 + 0.6)/3 = 0.8467$

e) Systematic risk = $\beta_P^2 \times \sigma_M^2 = (0.8467)^2 (15)^2 = 161.302$

Unsystematic risk = $\sigma^2 - (\beta^2 \times \sigma^2)$ = 200.244 – 161.302 = 38.942

Total Risk = (161.302 + 38.942) = 200.244

Illustration 3

An investor has categorized all the available stock in the market into the following types and the estimated weights of the categories of stocks in the market index are given below.

Further, the sensitivity of returns of these categories of stocks to two factors Inflation and Stock market are also given below:

Category	Weight in Market Index	Factor 1 (Inflation)			Factor 2 (Stock Market)		
		Beta 1	Expected Value in %	Actual Value in %	Beta 2	Expected Value in %	Actual Value in%
Small Cap	20%	1.20	6.70	6.70	0.80	10.00	10.50
Medium Cap	30%	1.75	4.50	6.00	0.90	7.00	8.00
Large Cap	15%	1.30	6.75	8.00	1.165	9.00	10.00
Flexi Cap	35%	1.70	7.00	6.50	0.85	8.85	9.75

Risk Free Rate of Interest is 7.50%. Round off to 2 decimal.

You are required to calculate:

(i) **Expected return on the market index for both the factors.**

(ii) **Expected return on the market index under Arbitrage Pricing Theory (Existing Scenario).**

(iii) **Expected return on the market index under Arbitrage Pricing Theory if the composition of the Portfolio is changed to 25% equally in all four categories.**

(iv) **Which alternative (Existing or Changed) will be more profitable?(8 Marks)**

Solution

i. Expected Return on Market Index for Both factors

Factor 1

= 0.20 x 6.70% + 0.30 x 4.50% + 0.15 x 6.75% + 0.35 x 7.00%

= 1.34% + 1.35% + 1.01% + 2.45% = 6.15%

Factor 2

= 0.20 x 10% + 0.30 x 7% + 0.15 x 9% + 0.35 x 8.85%

= 2% + 2.10% + 1.35% + 3.10%

= 8.55%

ii. Calculation of expected Return on the Market index under Arbitrage Pricing Theory (Existing Scenario):

	Factor 1 (Inflation)				
Category	**Beta**	**Actual value**	**Expected value**	**Difference**	**Beta x Diff.**
	(a)	(b) (%)	(c) (%)	(b) - (c) = (d) (%)	(e)
Small Cap	1.20	6.70	6.70	0.00	0.00
Medium Cap	1.75	6.00	4.50	1.50	2.63
Large Cap	1.30	8.00	6.75	1.25	1.63
Flexi cap	1.70	6.50	7.00	(0.50)	(0.85)

	Factor 2 (Stock Market)					
Category	**Beta**	**Actual value**	**Expected value**	**Difference**	**Beta x Diff.**	**Total**
	(f)	(g) (%)	(h) (%)	(g) – (h) = (i) (%)	(j)	(e) + (j) =(k)
Small Cap	0.80	10.50	10.00	0.50	0.40	0.40
Medium Cap	0.90	8.00	7.00	1.00	0.90	3.53
Large Cap	1.165	10.00	9.00	1.00	1.17	2.80
Flexi cap	0.85	9.75	8.85	0.90	0.77	(0.08)

Category	**Weight in market index (1)**	**Total Beta x Diff (2)**	**Expected Return (2 x 1 = 3)**
Small Cap	20%	0.40	0.08
Medium Cap	30%	3.53	1.06
Large Cap	15%	2.80	0.42
Flexi cap	35%	(0.08)	(0.03)
Total			1.53
Add: Risk Free Rate of Interest			7.50
Expected Return (%)			9.03

iii. **Expected Return on the Market Index under Arbitrage Pricing Theory under changed scenario:**

Category	Weight in market index (1)	Total Beta x Diff (2)	Expected Return (2 x 1 = 3)
Small Cap	25%	0.40	0.10
Medium Cap	25%	3.53	0.88
Large Cap	25%	2.80	0.70
Flexi cap	25%	(0.08)	(0.02)
Total			1.66
Add: Risk Free Rate of Interest			7.50
Expected Return (%)			9.16

iv. As per the above calculation, the investors by investing 25% equally in all four categories, is profitable compared to the existing composition. As the proposed composition gives rate of return of 9.16% per annuam when compared to the existing return of the present portfolio which is 9.03%.

Illustration 4

An investor has the following four stocks in his portfolio:

Security	No. of shares	Market Price per share (₹)	Beta (β)
A	6000	40	0.9
B	3000	20	1.0
C	5000	25	1.5
D	1000	225	1.1

(i) Compute the portfolio beta (β).

(ii) If the investor seeks to reduce the β to 0.8, how much risk-free investment should he bring in?

(iii) Independent of (ii), if the investor would like to have an overall weighted β of 1.02 without bringing in more money, by selling shares of C and buying A instead, How many shares of C should be sold?

(iv) Independent of (ii), if the investor would like to have an overall weighted β of 1.02 without bringing in more money, by selling shares of C and buying A instead, what would be the revised weighted β of A, B, C and D?

Solution:

(i) Portfolio Beta = 1.094 or 1.0938

(ii) ₹2,38,828

(iii) 3296.69 shares of C should be sold.

(iv) Revised weighted Beta = 1.01775 or 1.02

Illustration 5

An investor has the following constituent holdings in his portfolio:

Security	No. of shares	Price per share (₹)	Share Beta
A	400	500	1.4
B	500	750	1.2
C	200	250	1.6

i. **Find the market value weighted average beta of his portfolio.**

ii. **If the investor wants a target beta for his portfolio at 0.9, how would he dispose of his securities and replace them with Government securities if he want to sell in the order of risk? Present the revised tabulation of his holding and prove that the target beta has been achieved by your advice.**

iii.

iv. **If he is willing to invest further, how much investment should he make in G Sec to make his beta 0.9, without selling any share at all?**

Solution

i.

Security	Nos	Price(₹)	Value(₹)	Beta	Weight	Weight x Beta
A	400	500	2,00,000	1.4	0.32	0.448
B	500	750	3,75,000	1.2	0.6	0.72
C	200	250	50,000	1.6	0.08	0.128
Total	1100		625000			1.296

Portfolio's beta based on market value weights is = 1.296

ii. Target beta = 0.9.

We should first replace the riskiest of the securities with Govt. zero beta securities. Thenwe go for the next riskier one. Hence, C, being of lower market value should be fully replaced by Govt. securities.

If we assume full of A to be sold, then, b x 1.2 = .9 × 625000 = ₹ 562500. Then, solving, weget b = 468750 which is more than ₹ 3,75,000 . This means that any of B should not be sold and that A too should not be sold in full.

Hence, 375000 × 1.2 + a × 1.4 = 625000 × 0.9

450000 + 1.4 a = 562500 Or, a = 112500/1.4 = ₹ 80357.

₹ 80357 value of A should be retained in the portfolio. This amounts to 80357/500

= ₹160.714 shares, which is 161 shares.

Hence the new portfolio will consist of 161 shares of A, 500 shares of B and no share of C and Govt., securities worth ₹ 169500 (50,000 from C and 200000 – 80500 = ₹ 119500 from A)

Proof:

Security	Nos	Price (₹)	Value (₹)	Beta	Weight	Weight x Beta
A	161	500	80,500	1,4	0.1288 = 80500/625000	0.18032
B	500	750	3,75,000	1.2	0.6 = 375000/625000	0.72
C	0	250	0	1.6		0
Govt. Securities			169500	0		0
Total			625000			0.90032

Thus the new portfolio beta will be the targeted 0.9

iii. Without selling any share, if investment has to be made, say for value 'g' in govt,security, weighted beta

$= \frac{(6,25,000 \times 1.296)+(g \times 0)}{(6,25,000+g)} = 0.9$

= 6,25,000 (1.296 – 0.90) = 0.90 g

$g = \frac{625000 \times 0.396}{0.90}$ = ₹ 2,75,000 market value worth G Sec should be purchased.

Illustration 6

Sagar owns a portfolio in three stocks as detailed below:

Stock	No. of shares	Price (Rs./share)	Beta
X	400000	400	1.3
Y	800000	300	1.2
Z	1200000	100	1.1

The index futures is traded at Rs. 10,250. Assume that the index factor is 100.

(i) Compute the existing portfolio beta upto two decimals.

(ii) Find out the number of contracts (rounded off to the nearest integer) of stock index futures to be bought or sold in order to :

(A) Decrease the portfolio β to 0.8

(B) Increase the portfolio β to 1.5. What will be the proportion of market value of investments in X to the value of total investments plus 10% margin on futures?

Solution

Stock	No. of Shares	Price Rs/Share	Beta	Market Value	Weighted Value of beta
X	400000	400	1.3	16,00,00,000	20,80,00,000
Y	800000	300	1.2	24,00,00,000	28,80,00,000
Z	1200000	100	1.1	12,00,00,000	13,20,00,000
Total				52,00,00,000	62,80,00,000

Weighted Beta = 62,80/52,00 = 1.21

Futures Contract value = 10,250 x 100 = 10,25,000

No. of contracts = (1.21-0.8) x 52,00,00,000 / 10,25,000 = 0.41 x 507.32 = 208 contracts have to be sold in the futures market.

Margin money = 10% x 208 x 10,25,000 = 2,13,20,000

Total investments = 52,00,00,000 +2,13,20,000 = 54,13,20,000

Proportion of X= 16,00,00,000 / 54,13,20,000 = 29.55%, say 30%

To increase the beta on 1.5, no of futures to be purchased = (1.5 – 1.21) x 52,00,00,000 /10,25,000 = 0.29 x 507.32 = 147.1229 = 147 contracts.

Value of the futures contracts = 147 x 10,25,000 = 15,06,75,000

Initial Margin 10% = 1,50,67,500

Total value of investments

in shares = 52,00,00,000

Margin = $\frac{+1,50,67,500}{53,50,67,500}$

Proportion of X = $\frac{16,00,00,000}{53,50,67,500} = 29.$**90 or 30%**

Illustration 7

MR. ABHISHEK an analyst at ASHLEEN SECURITIES LTD. The projects of returns for the stocks of these two companies along with their probabilities are as follows:

Returns associated with (in%)		
Probability	**Spark Ltd.**	**Electra Ltd.**
0.2	90	11
0.1	75	29
0.3	60	33
0.25	20	60
0.15	30	55

You are required to:

Calculate the expected returns, standard deviations of returns and correlation co-efficient between the two stocks.

Compare the risk and return of these two stocks with a portfolio of these stocks in equal proportions.

Determine the expected rate of return of a ZERO RISK portfolio consisting of the above two stocks.

Illustration 8

An Investor is proposing to invest ₹ 10,000/- in two Portfolios A and B in the ratio of 3 : 2. The Portfolios have three securities each with following weights :

	WA	WB	WC
Portfolio X	**0.30**	**0.25**	**0.45**
Portfolio Y	**0.20**	**0.45**	**0.35**

You are required to

(i) **Calculate the weight of each stock.**

(ii) **Calculate the amount allocated to Y and Z if half of the funds are allocated to security X.**

Note: In question paper in sub part (ii) Y and Z mistakenly got typed as B and C.

Solution

(i) Investment committed to each security would be:

	X (₹)	Y (₹)	Z (₹)	Total (₹)
Portfolio A	1,800	1,500	2,700	6,000
Portfolio B	800	1,800	1,400	4,000
Combined Portfolio	2,600	3,300	4,100	10,000
Stock weights	0.26	0.33	0.41	

Alternatively, it can also be computed as follows:

Weight of Security X = 0.30 x 3/5 + 0.20 x 2/5 = 0.26

Weight of Security Y = 0.25 x 3/5 + 0.45 x 2/5 = 0.33

Weight of Security Z = 0.45 x 3/5 + 0.35 x 2/5 = 0.41

(ii) The equation of critical line takes the following form: WY = a + bWX Substituting the values of WX & WY from portfolio A and B in above equation, we get 0.25 = a + 0.30b, and 0.45 = a + 0.20b

Solving above equation we obtain the slope and intercept, a = 0.85 and b= -2 and thus, the critical line is

WY = 0.85 – 2WX

If half of the funds is invested in security X then, WY = 0.85 – 1.00 = - 0.15

Since WX + WY + WZ = 1 WZ = 1 - 0.50 + 0.15 = 0.65

Allocation of funds to Security Y = - 0.15 x 10,000 = - ₹ 1,500 and

Security Z = 0.65 x 10,000 = ₹ 6,500

Alternatively, it can also be solved as follows:

Amount to be allocated to Y & Z if half of the funds are allocated to X. The balance fund of ₹ 5,000 shall be allocated in the ratio of 33:41.

Illustration 1

Mr. X on 1.7.2012, during the initial public offer of a Mutual Fund (MF) invested1,00,000 at Face Value of ₹ 10. On 31.3.2013, the MF declared a dividend of 10% when Mr. X calculated that his holding period return was 115%. On 31.3.2014, MF again declared a dividend of 20%. On 31.3.2015, Mr. X redeemed all his investment which had accumulated to 11,296.11 units when his holding period return was 202.17%. Calculate the NAVs as on 31.03.2013, 31.03.2014 and 31.03.2015.

Solution

a) Calculation of NAV as on 31/03/2013:

Investment at the beginning - 1,00,000

Dividend (1,00,000 x 10%) - 10,000

Holding period yield - 115%

$$\text{Holding period Return \%} = \frac{NAV_1 - NAV_O + I + G}{NAV_O}$$

$$1.15 = \frac{NAV_1 - 1,00,000 + 10,000}{1,00,000}$$

NAV_1 = 2,05,000

NAV per unit as on 31/03/2013 = (2,05,000 / 10,000) = **20.5/-**

b) Calculation of NAV as on 31/03/2014:

No. of new units acquired on 31/03/2013 (10,000/20.5) = 487.8 units

Total units as on 31/03/2014 (10,000 + 487.8) = 10,487.8 units

Let NAV as on 31/03/2014 = x

Dividend received on 31/03/2014 = (10,487.8 x 10 x 20%) = 20,975.6/-

10,487.8 + (20,975.6/ x) = 11,296.11

x = 25.95

NAV p.u as on 31/03/2014= 25.95/-

c) Calculation NAV as on 31/03/2015:

Holding period return = 202.17%

2.0217 = NAV_1 – 1,00,000/1,00,000

NAV_1 = 3,02,170

NAV p.u as on 31/03/2015 = (3,02,180/11,296.11) = **26.75/-**

Illustration 2

M/S. Promising, an AMC, on 01.04.2018 has floated two schemes viz. Dividend Reinvestment Plan and Bonus Plan. Mr. X, an investor has invested in both the schemes. Mr. X, while submitting the tax papers, returned a capital loss on both the plans. Tax officials, suspicious on the claim of Mr. X, decided to launch an investigation and were able to collect the following details (except the issue price):

Date	Dividend (%)	Bonus Ratio	NAV (₹)	
			Dividend Reinvestment Plan	Bonus Plan
01.04.2018			?	?
31.12.2019		1:5	58	70
31.03.2020	12		60	72
31.03.2021	10		68	75
31.03.2022	15		75	66
31.12.2022*		1:3	70	60
31.03.2023			80	71

*** In question paper this row got typed before the row of values of 31.03.2022.**

Additional details	Dividend Reinvestment Plan	Bonus Plan
Investment (₹)	₹ 10,80,000	₹ 10,00,000
Average Profit (₹)	₹ 1,21,824	
Average Yield (%)		8.40%

Assume face value of unit as ₹ 10.

You are required to assist the tax officials to calculate the issue price of both the schemes as on 01.04.2018.

Solution

Dividend Plan

(a)	Average Annual gain over a period of 5 Years	₹ 1,21,824
(b)	Total gain over a period of 5 years (a*5)	₹ 6,09,120
(c)	Initial Investment	₹10,80,000
(d)	Total value of investment (b+c)	₹ 16,89,120
(e)	NAV as on 31.3.2023	₹ 80
(f)	Number of units at the end of the period as on 31.03.2022 (d/e)	21114

	1	2	3	4 = (2*3)	5	6 = [1/(4+5)]*4	7
Period	Units held	Rate	Unit value	Dividend	NAV	New Units*	Balance Units Pre Dividend
31.03.2022	21114	0.15	10	1.50	75	414	20700
31.03.2021	20700	0.10	10	1.00	68	300	20400
31.03.2020	20400	0.12	10	1.20	60	400	20000

Issue Price as on 01.04.2018

Investment 1080000/ Units purchased 20000 (c/i) = ₹ 54

* Let the units issued be X

X = (Closing Units/NAV + Dividend) x Dividend

Alternatively, it can also be computed as follows:

Illustration 3

On 1st April, an open-ended scheme of mutual fund had 300 lakh units outstanding with Net Assets Value (NAV) of ₹ 18.75. At the end of April, it issued 6 lakh units at opening NAV plus 2% load, adjusted for dividend equalization. At the end of May, 3 Lakh units were repurchased at opening NAV less 2% exit load adjusted for dividend equalization. At the end of June, 70% of its available income was distributed.

In respect of April-June quarter, the following additional information are available:

Particulars	₹ in lakh
Portfolio value appreciation	425.47
Income of April	22.950
Income for May	34.425
Income for June	45.450

You are required to calculate

i) Income available for distribution;

ii) Issue price at the end of April;

iii) Repurchase price at the end of May; and

iv) Net asset value (NAV) as on 30th June.

Solution

(i) Calculation of Income available for distribution:

Particulars	Units (Lakhs)	Per Unit (₹)	Total (₹ in lakhs)
Income from April	300	0.0765	22.95
Add: Dividend equalization collected on issue	6	0.0765	0.4590
	306	0.0765	23.4090
Add: Income from May		0.1125	34.4250
	306	0.1890	57.8340
Less: Dividend equalization paid on repurchase	(3)	0.1890	(0.5670)
	303	0.1890	57.2670
Add: Income from June		0.1500	45.4500
	303	0.3390	102.7170
Less: Dividend Paid (102.7170 x 70%)		0.2373	(71.9019)
	303	0.1017	30.8151

(ii) Calculation of issue price at the end of April:

Particulars	Amount (₹)
Opening NAV	18.750
Add: Entry Load (18.750 x 2%)	0.375
Add: Dividend Equalization paid on Issue Price	0.0765
Issue Price at the end of April	19.2015

(iii) Calculation of Repurchase Price at the end of May:

Particulars	Amount (₹)
Opening NAV	18.750
Less: Entry Load (18.750 x 2%)	(0.375)
Add: Dividend Equalization paid on Issue Price	0.1890
Repurchase Price at the end of April	18.564

(iv) Calculation of NAV as on 30th June:

Particulars	Amount (₹ in lakhs)
Opening NAV (18.75 x 300)	5625.00
Portfolio Value Appreciation	425.47
Issue of Fresh Units (6 x 19.2015)	115.209
Income Received (22.950 + 34.425 + 45.450)	102.825
Less: Units repurchased (3 x 18.564)	(55.692)
Less: Income Distributed	(71.9019)
Closing NAV	6140.9101
Closing Units (300 + 6 – 3) lakh	303 lakh
Closing NAV as on 30th June (6140.9101/ 303)	20.2670

Illustration 4

Ms. Sunidhi is working with an MNC at Mumbai. She is well versant with the portfolio management techniques and wants to test one of the techniques on an equity fund she has constructed and compare the gains and losses from the technique with those from a passive buy and hold strategy. The fund consists of equities only and the ending NAVs of the fund he constructed for the last 10 months are given below:

Month Ending	NAV (₹/unit)	Month Ending	NAV (₹/unit)
December 2008	40.00	May 2009	37.00
January 2009	25.00	June 2009	42.00
February 2009	36.00	July 2009	43.00
March 2009	32.00	August 2009	50.00
April 2009	38.00	September 2009	52.00

Assume Sunidhi had invested a notional amount of ₹ 2 lakhs equally in the equity fund and a conservative portfolio (of bonds) in the beginning of December 2008 and the total portfolio was being rebalanced each time the NAV of the fund increased or decreased by 15%.

You are required to determine the value of the portfolio for each level of NAV following the Constant Ratio Plan.

Solution

Constant Ratio Plan:

Stock Portfolio NAV (₹)	Value of Conservative Portfolio (₹)	Value of aggressive Portfolio (₹)	Total value of Constant Ratio Plan (₹)	Revaluation Action	Total No. of units in aggressive Portfolio
40	1,00,000	1,00,000	2,00,000	-	2500
25	1,00,000	62,500	1,62,500	-	2500
	81,250	81,250	1,62,500	Buy 750 units	3250
36	81,250	1,17,000	1,98,250	-	3250
	99,125	99,125	1,98,250	Sell 496.53 units	2753.47
32	99,125	88,111.04	1,87,236.04	-	2753.47
38	99,125	1,04,631.86	2,03,756.86	-	2753.47
	1,01,878.43	1,01,878.43	2,03,756.86	Sell 72.46 units	2681.01
37	1,01,878.50	99,197.37	2,01,075.87	-	2681.01
42	1,01,878.50	1,12,602.42	2,14,480.92	-	2681.01
43	1,01,878.50	1,15,283.43	2,17,161.93	-	2681.01
50	1,01,878.50	1,34,050.50	2,35,929	-	2681.01
	1,17,964.50	1,17,964.50	2,35,929	Sell 321.72 units	2359.29
52	1,17,964.50	1,22,683.08	2,40,647.58	-	2359.29

Hence, the ending value of the mechanical strategy is 2,40,647.58 and buy & hold strategy is 2,60,000.

Illustration 5

The following information is available regarding three Mutual Funds:

Mutual Fund	Average Return	Standard Deviation	Correlation with market
A	24%	8%	0.30
B	16%	4%	0.70
C	12%	3%	0.50

If the risk free return is 6%, return on market portfolio is 15% with a standard deviation of 4% ascertain:

(i) Total Gain and the Net Gain under Fama's Net Selectivity.

(ii) Systematic Risk and Unsystematic Risk.

Solution

Working Note:

Risk Free Return (Rf) = 6%

Market Return (Rm) = 15% Market Standard Deviation (σm) = 4%

Market Risk Premium (Rm – Rf) = 15 % - 6% = 9%

Particulars	A	B	C
Average Return (Rp)	24%	16%	12%
Standard Deviation (σp) (Total Risk)	8%	4%	3%
Correlation with market (Ppm)	0.30	0.70	0.50
Portfolio Beta (Bp) = Ppm × (σp ÷ σm)	0.30 × 8 ÷4 = 0.60	0.70 × 4 ÷ 4 = 0.70	0.50 × 3 ÷ 4 = 0.375
Actual Risk Premium (Rp – Rf) (A)	24-6 = 18%	16-6 = 10%	12-6 = 6%
Computation of Net Gain			
Desired Risk Premium [(Rm – Rf) × σp ÷ σm] (B)	[9% × 8% ÷ 4%] 18%	[9% × 4% ÷ 4%] 9%	[9% × 3% ÷ 4%] 6.75%
Fama's Net Selectivity (Net gain) = (A - B)	0	1%	(0.75%)
Computation of Total Gain			
Desired Risk Premium [(Rm – Rf) × Ppm × σp ÷ σm] OR [Risk Premium in (B) × Ppm] (C)	18% × 0.30 = 5.4%	9% × 0.7 = 6.3%	6.75% × 0.5 = 3.375%
Total Gain [A – C]	(18% -5.4%) = 12.6%	(10%-6.3%) = 3.7%	(6% -3.375%) = 2.625%
(ii) Systematic Risk (σp × Bp)	8% × 0.6 = 4.8%	4% ×.70 = 2.8%	3% ×0.375 = 1.125%
Unsystematic Risk (Total Risk- Systematic Risk)	3.2%	1.2%	1.875%

Illustration 6

The following information is available for Mutual Fund A, Mutual Fund B and Market Portfolio (M) for six months:

Month (20210	April	May	June	July	August	September
Fund	Return (%)					
Fund A	3.00	1.75	(1.00)	3.50	1.50	0.00
Fund B	2.25	(1.25)	0.00	3.00	2.50	1.00
Market Portfolio (M)	1.00	(0.75)	2.00	1.50	0.25	3.50

Risk-free interest rate is 6% p.a.

(i) Compute Average Returns (AR), Risk of Losses (RL) of Funds A, B and M.

(ii) Compute the Morning Star Index of A, B and M.

(iii) Compute the standard deviation (s.d) of the returns of A, B and calculate the Sharpe Ratio of A.

Solution

(i) Average Returns:

Fund A = 1.46

Fund B = 1.25

Market Portfolio = 1.25

Risk of Losses:

Fund A = 0.33

Fund B = 0.38

Market Portfolio = 0.25

(ii) Morning Star Index:

Fund A = 1.13

Fund B = 0.87

Market Portfolio = 1.00

(iii) Standard Deviation of the Returns:

Fund A = 1.57

Fund B = 1.5

Sharpe Ratio:

Fund A = 0.611

Additional Questions

Illustration 1

A mutual fund made an issue of 10,00,000 units of ₹ 10 each on January 01, 2008. No entry load was charged. It made the following investments:

Particulars	₹
50,000 Equity shares of ₹ 100 each @ ₹ 160	80,00,000
7% Government Securities	8,00,000
9% Debentures (Unlisted)	5,00,000
10% Debentures (Listed)	5,00,000
	98,00,000

During the year, dividends of ₹ 12,00,000 were received on equity shares. Interest on all types of debt securities was received as and when due. At the end of the year equity

shares and 10% debentures are quoted at 175% and 90% respectively. Other investments are at par.

Find out the Net Asset Value (NAV) per unit given that operating expenses paid during the year amounted to ₹ 5,00,000. Also find out the NAV, if the Mutual fund had distributed a dividend of ₹ 0.80 per unit during the year to the unit holders.

Solution

Calculation of cash balance:

Particulars	Amount
Cash balance in the beginning (100 lakhs – 98 lakhs)	2,00,000
Dividend received	12,00,000
Interest on 7% Govt. Securities	56,000
Interest on 9% Debentures	45,000
Interest on 10% Debentures	50,000
Less: Operating Expenses	(5,00,000)
Net cash balance at the end	10,51,000

Calculation of NAV:

Particulars	Amount
Cash balance	10,51,000
7% Govt. Securities	8,00,000
50,000 equity shares @ **175% of the face value** each	87,50,000
9% Debentures (unlisted) at cost	5,00,000
10% Debentures (5,00,000 x 90%)	4,50,000
NAV before distribution of Dividend	**1,15,51,000**
Less: Dividend (10,00,000 x 0.8)	(8,00,000)
NAV after distribution of Dividend	**1,07,51,000**

WN:

NAV per unit without distribution of dividend

$$\frac{1,15,51,000}{10,00,000 \text{ units}} = ₹11.551$$

NAV per unit a distribution of dividend

$$\frac{1,07,51,000}{10,00,000 \text{ units}} = ₹10.751$$

Illustration 2

Mr. Y has invested in the three mutual funds (MF) as per the following details:

Particulars	MF 'X'	MF 'Y'	MF 'Z'
Amount of Investment (₹)	2,00,000	4,00,000	2,00,000
Net Assets Value (NAV) at the time of purchase (₹)	10.30	10.10	10
Dividend Received up to 31.03.2018 (₹)	6,000	0	5,000

NAV as on 31.03.2018 (₹)	10.25	10	10.20
Effective Yield per annum as on 31.03.2018 (percent)	9.66	-11.66	24.15

Assume 1 Year =365 days

Mr. Y has misplaced the documents of his investment. Help him in finding the date of his original investment after ascertaining the following:

i. **Number of units in each scheme;**
ii. **Total NAV;**
iii. **Total Yield; and**
iv. **Number of days investment held.**

Solution

(i) No. of units in each scheme:

MF 'X' = (2,00,000/ 10.3) = **19,417.48 units**

MF 'Y' = (4,00,000/ 10.10) = **39,603.96 units**

MF 'Z' = (2,00,000/ 10) = **20,000 units**

(ii) Total NAV:

MF 'X' = (19,417.48 x 10.25) = **1,99,029.17**

MF 'Y' = (39,603.96 x 10) = **3,96,039.60**

MF 'Z' = (20,000 x 10.2) = **2,04,000**

Total NAV = (1,99,029.17 + 3,96,039.60 + 2,04,000) = **₹ 7,99,068.77**

(iii) Total Return:

Particulars	Calculation	Capital (A)	Dividend(B)	Total (A + B)
MF X	(1,99,029.17 - 2,00,000)	(970.83)	6,000	5,029.17
MF Y	(3,96,039.60 – 4,00,000)	(3,960.40)	-	(3,960.40)
MF Z	(2,04,000 – 2,00,000)	4,000	5,000	9,000
				10,068.77

Total Yield = (10,068.77/ 8,00,000) x 100 = 1.2586%

(iv) Number of Days Investment held:

MF 'X'

Effective yield p.a. = 9.66%

Holding Period Return = 2.514%

No, of days = $\frac{2.514}{9.66}$x365= 95 days

MF 'Y'

Effective yield p.a. = -11.66%

Holding Period Return = -0.09%

No, of days = $\frac{-0.09}{-11.66}$x365= 28 days

MF 'Z'

Effective yield p.a. = 24.15%

Holding Period Return = 4.5%

No, of days = $\frac{4.5}{24.15}$x365= 68 days

Illustration 1

The following information pertaining to two securities is given:

	Securities	
	A Ltd.	B Ltd.
Spot Price (₹)	4,550	360
Dividend expected (₹)	50	20
Divided receivable in (months)	2	3
Recommended Action:	Sell Spot, Buy Futures	Buy Spot Sell Futures

Risk free interest rate may be taken as 9% p.a.

(i) Determine the 6 months' theoretical forward prices of securities of A Ltd. and B Ltd. For what values of futures contract rates will the above recommended action be appropriate?

(ii) What would your answer to (i) above be if there is no dividend expected for And B?

Solution

(i)

Securities of	A Ltd.	B Ltd.
Spot Price [Sx](₹)	4,550	360
Dividend Expected [DF](₹)	50	20
Dividend Receivable in [t]	2 months or 1/6 year or 0.1667	3 months or $\frac{1}{4}$ year or 0.25
Risk Free Interest Rate [r]	9% or 0.09	9% or 0.09
Present Value of Dividend [Dp]	DF ÷ e^{rt} = ₹ 50 ÷ $e^{0.09 \times 0.1667}$ = ₹ 50 ÷ $e^{0.015}$ = ₹ 50 ÷ 1.01511 = ₹ 49.256	DF ÷ e^{rt} = ₹ 20 ÷ $e^{0.09 \times 0.25}$ = ₹ 20 ÷ $e^{0.0225}$ = ₹ 20 ÷ 1.022755 = ₹ 19.555
Adjusted Spot Price [Sadj] Sx - DP (₹)	4,550 - 49.256 = 4,500.744	360 - 19.555 = 340.445
Theoretical Forward Price = [TFPx](₹)	= 4500.744 × $e^{0.09 \times 0.50}$ = 4,500.744 × $e^{0,045}$ = 4,500.744 × 1.04603 = 4,707.91	= 340.445 × $e^{0.09 \times 0.50}$ = 340.445 × $e^{0,045}$ = 340.445 × 1.04603 = 356.126
6 months Futures Contract Rate [AFPX] (₹)	Less than 4707	More than 356
Valuation in Futures Market	Undervalued	Overvalued
Recommended Action	Sell Spot. Buy Future.	Buy Spot. Sell Future.

(ii)

Adjusted spot price	4550	360
Theoretical Forward Price	$= 4550 \times e^{0.045}$ $= 4550 \times 1.04603$	$= 360 \times e^{0.045}$ $= 360 \times 1.04603$
	= 4759.4	= 376.57
6 months future rate for appropriateness of action	Less than 4759	More than 376

Illustration 2

On April 1, 2015, an investor has a portfolio consisting of eight securities as shown below:

Security	MarketPrice	No. ofShares	Value
A	29.40	400	0.59
B	318.70	800	1.32
C	660.20	150	0.87
D	5.20	300	0.35
E	281.90	400	1.16
F	275.40	750	1.24
G	514.60	300	1.05
H	170.50	900	0.76

The cost of capital for the investor is 20% p.a. continuously compounded. The investor fears afall in the prices of the shares in the near future. Accordingly, he approaches you for the advice to protect the interest of his portfolio.

You can make use of the following information:

a) The current NIFTY value is 8500.

b) NIFTY futures can be traded in units of 25 only.

c) Futures for May are currently quoted at 8700 and Futures for June are being quoted at 8850.

You are required to calculate:

1) The beta of his portfolio.

2) The theoretical value of the futures contract for contracts expiring in May and June. Given (e0.03 =1.03045, e0.04 = 1.04081, e0.05 =1.05127)

3) The number of NIFTY contracts that he would have to sell if he desires to hedge until Junein each of the following cases:

A. His total portfolio

B. 50% of his portfolio

C. 120% of his portfolio

Solution

Calculation of Portfolio β:

Security	Market Price	No. of Shares	MarketValue	Proportion	β	β x Proportion
A	29.40	400	₹ 11760	0.012	0.59	0.0071
B	318.70	800	₹ 254960	0.256	1.32	0.3379
C	660.20	150	₹ 99030	0.1	0.87	0.087
D	5.20	300	₹ 1560	0.002	0.35	0.0007
E	281.90	400	₹ 112760	0.113	1.16	0.1311
F	275.40	750	₹ 206550	0.208	1.24	0.2579
G	514.60	300	₹ 154380	0.155	1.05	0.1628
H	170.50	900	₹ 153450	0.154	0.76	0.117
Totals			**₹ 994450**			**1.1015**

Portfolio β = 1.1015 ~ 1.102

Calculation of theoretical fair future price:

FFP = spot price x e^{tr}

FFP of contract expiring in May = 8500 x $e^{(2/12 \times 20\%)}$ = 8500 x $e^{(0.0333)}$

= 8500 x 1.03386 = 8787.81

FFP of contract expiring in June = 8500 x $e^{(3/12 \times 20\%)}$ = 8500 x $e^{(0.05)}$

= 8500 x 1.05127 = 8935.8

Calculation of no. of nifty contracts to sell for hedging:

i) **Hedge his portfolio:**

Value of index to be sold for total hedge = **Portfolio value x β** = 9,94,450 x 1.102 = ₹ 10,95,884 Value of index to be sold for total hedge = ₹ 10,95,884

No of contracts = ₹ 10,95,884 / (8850 x 25) = 4.953

No of NIFTY Contracts to be sold to hedge his portfolio = 4.953 ~ 5 contracts

ii) **Hedge 50% of his portfolio:**

Value of index to be sold for 50% hedge = Portfolio value x 50% x β

= 9,94,450 x 50% x 1.102 = ₹ 5,47,942

Value of index to be sold for 50% hedge = ₹ 5,47,942 No of contracts = ₹ 5,47,942 / (8850 x 25) = 2.47

No of NIFTY Contracts to be sold to hedge 50% of his portfolio = 2.47 ~ 3 contracts.

iii) **Hedge 120% of his portfolio:**

Value of index to be sold for 120% hedge = Portfolio value x 120% x β

= 9,94,450 x 120% x 1.102

= ₹ 13,15,061

No of contracts = ₹ 13,15,061 / (8850 x 25) = 5.94

No of NIFTY Contracts to be sold to hedge 120% of his portfolio = 5.94 ~ 6 contracts.

Illustration 3

Details about portfolio of shares of an investor is as below:

Shares	No. of shares (Lakh)	Price per share	Beta
A Ltd.	3.00	Rs 500	1.40
B Ltd.	4.00	Rs 750	1.20
C Ltd.	2.00	Rs 250	1.60

The investor thinks that the risk of portfolio is very high and wants to reduce the portfolio beta to 0.91. He is considering two below mentioned alternative strategies:

(i) Dispose of a part of his existing portfolio to acquire risk free securities, or

(ii) Take appropriate position on Nifty Futures which are currently traded at Rs 8125 and each Nifty point is worth Rs200.

You are required to determine:

(1) Portfolio beta,

(2) The value of risk-free securities to be acquired,

(3) The number of shares of each company to be disposed of,

(4) The number of Nifty contracts to be bought/sold; and

(5) The value of portfolio beta for 2% rise in Nifty

Solution

a) Calculation of Portfolio β:

Shares	Market Value	Proportion	β	Prop x β
A	1500	0.3	1.4	0.42
B	3000	0.6	1.2	0.72
C	500	0.1	1.6	0.16
	5000		**βp**	1.3

Portfolio β = 1.3

b) Value of Risk-free securities to be acquired:

Present β = 1.3

Desired β = 0.91

Let the proportion of risk-free securities be x (0 x P) + ((1 – P) x 1.3) = 0.91

1.3 – 1.3 P = 0.91

P = 0.3

Proportion of risk-free securities = 30%

Hence, shares to be disposed off = (5000 x 30%) = 1500 lakhs

c) No. of shares of each Co to be disposed off:

A ltd = (1500 lakhs x 0.3 x 1/ 500) = **90,000 shares**

B ltd = (1500 lakhs x 0.6 x 1/ 750) = **1,20,000 shares**

C ltd = (1500 lakhs x 0.1 x 1/ 250) = **60,000 shares**

d) No. of NIFTY contracts to be sold/bought:

No. of NIFTY contracts to be sold/bought = $\frac{5000 \text{ lakhs} \times (1.3 - 0.91)}{(200 \times 8125)}$ = **120 contracts**

e) Value of portfolio β for 2% rise in Nifty:

1.3 x 2 = 2.6% shares

Particulars	Amount (in lakhs)
Increase in value of shares (5000*2.6%)	130
Margin Amount paid [(8125*200*120) (2%)]	(39)
Increase in value of portfolio	**91**

Total value = 5091 lakhs

% change = (5091 – 5000)/5000 = **1.82%**

Increase in NIFTY = 2%

β = 1.82/ 2% = **0.91**

Illustration 4

Mr. V is a commodity trader and specialized himself in trading of rice.

He has 24,000 Kg. of rice. The following details are available as on date:

Spot price	**₹/Kg.**	**70**
3 month's future is trading at	₹/Kg.	68
Expected Lower price after 3 months	₹/Kg.	64
Contract size	500 Kg./	contract
You are required to advise to Mr. V:		

(i) How to mitigate the risk of fall in price.

(ii) How to use the futures market.

What will be the effective realized price for his sales if, after 3 months, spot price is

₹ 69/ Kg. and the 3 months future contract price is

₹ 72/ Kg.

₹ 67/Kg.

Solution

(i) In order to hedge its position Mr. V (trader) should use Future Contracts.

Particulars	
(a) Quantity of Rice to be hedged	24000 kg.
(b) Contract Size	500 kg.
(c) No. of Contracts (a/b)	48
(d) Future Price	₹ 68/kg.
(e) Exposure in the future market (a x d)	₹16,32,000

(ii) Mr. V should short 48 Future contracts at the price ₹ 68/kg and cancel its position after 3 months by buying Future contract at prevailing Future price.

(iii) After 3 months, trader would cancel its position in the future by buying a future contract of same quantity and will sell Rice in the spot market and position shall be as follows:

Particulars	₹	₹
(a) Price of Future Contract	72/kg.	67/kg.
(b) Amount bought	17,28,000	16,08,000
(c) Exposure	16,32,000	16,32,000
(d) Gain/(Loss) on future position (b – c)	(96,000)	24,000
(e) Spot Price	69/kg	69/kg
(f) Amount realized by selling in the spot market	16,56,000	16,56,000
(g) Effective Selling Amount (f + d)	₹ 15,60,000	₹ 16,80,000
(g) Effective Selling Price	₹ 65/kg.	₹ 70/kg.

Illustration 5

Mr. X established the following spread on the Delta Corporation's stock :

a) Purchased one 3-month call option with a premium of Rs 30 and an exercise price of Rs 550.

b) Purchased one 3-month put option with a premium of Rs 5 and an exercise price of Rs 450. Delta Corporation's stock is currently selling at Rs 500. Determine profit or loss, if the price of Delta Corporation's:

(i) remains at Rs500 after 3 months.

(ii) falls at Rs350 after 3 months.

(iii)rises to Rs600.

Assume the size option is 100 shares of Delta Corporation.

Solution

Given,

Spot Price = 500

Call option:

Premium = 30

Strike price (X) = 550

Put Option:

Premium = 5

Strike price (X) = 450

i) If FSP = 500 after 3m: Premium:

Premium (Call Option) = (100 x 30) = 3000

Premium (Put Option) = (100 x 5) = 500
Total Premium = 3500
Action:
Allow Call Option to Lapse. FSP < X Allow Put Option to Lapse.FSP > X
Profit/Loss:
Overall loss = (3500)

ii) If FSP = 350, after 3m Premium:

Call option Premium = (100 x 30) = 3000
Put option Premium = (100 x 5) = 500
Total Premium - 3500
Action:
Allow **Call option** to **lapse**.FSP < X **Exercise Put Option**. FSP < X **Profit/Loss:**
V_p [100 x (450 – 350)] = 10,000
Less: Premium = (3500)
Overall Profit = 6500

iii) If FSP = 600, after 3m Premium:

Call option Premium = (100 x 300) = 3000
Put option Premium = (100 x 50) = 500
Total Premium = 3500
Action:
Exercise Call Option. FSP > X Allow **Put Option** to **Lapse**. FSP > X
Profit/Loss:
Benefit on exercising call option [100 x (600 - 550) = 5,000
Less: Premium = (3500)
Overall Profit = 1500

Illustration 6

You as an investor had purchased a 4-month call option on the equity shares of X Ltd. of Rs 10, of which the current market price is Rs 132 and the exercise price Rs 150. You expect the price to range between R 120 to Rs 190. The expected share price of X Ltd. and related probability is given below:

Expected Price (Rs)	120	140	160	180	190
Probability	.05	.20	.50	.10	.15

Compute the following:

a) Expected Share price at the end of 4 months.
b) Value of Call Option at the end of 4 months, if the exercise price prevails.
c) In case the option is held to its maturity, what will be the expected value of the call option?

Solution

a) Expected share price at the end of 4m:

Expected share price = [(120 x 0.05) + (140 x 0.20) + (160 x 0.50) + (180 x 0.10) + (190 x 0.15)] = **160.5**

b) Value of call option at end of 4m, if exercise price prevails: = '0' [FSP = X]

c) Expected Value of Call option:

FSP	X	Action	Vc	Probability (P)	P x Vc
120	150	Lapse	0	0.05	0
140	150	Lapse	0	0.20	0
160	150	Exercise	10	0.50	5
180	150	Exercise	30	0.10	3
190	150	Exercise	40	0.15	6
Expected value of call					**14**

Illustration 7

The current market price of an equity shares of Penchant Ltd is Rs 420. Within a period of 3 months, the maximum and minimum price of it is expected to be Rs 500 and Rs 400 respectively. If the risk free rate of interest be 8% p.a., what should be the value of a 3 months Call option under the "Risk Neutral" method at the strike rate of Rs 450? Given e0.02 = 1.0202

Solution

Current Spot price = 420

Upward FSP = 500

Downward FSP = 400

Rf = 8% p.a

Strike price (X) = 450

$(P \times 500) + [(1 - P) \times 400] = 420 \times e^{(3/12)(0.08)}$

$(P \times 500) + [(1 - P) \times 400] = 420 \times 1.0202$

$500P + 400 - 400P = 428.484$

$P = 0.2848$

$1 - P = 0.7152$

Value of Call:

FSP	X	Vc	Probability	Vc x Probability
500	450	50	0.2848	14.24
400	450	0	0.7152	0
Expected Value of call after 3m				14.24

PV of call = (14.24/ 1.0202) = **13.96/-**

V_p = ?

V_c + PV of 'X' = VP + V_s

13.96 + (450/1.0202) = V_p + 420

V_p = 35.05/-

Solution to the Question discussed earlier (Question 24)

Current Spot price = 420

Upward FSP = 500

Downward FSP = 400

Rf = 8% p.a

Strike price (X) = 450

For perfect hedging:

Δ = Change in Vc

a. Write a call option

b. Hold Δ shares

$$\Delta = \frac{50 - 0}{500 - 400}$$

$$= \frac{50}{100}$$

= 0.5

Calculation of Value of a Call:

FSP	X	V_c	FSP x Δ shares	V_s	V_p
500	450	(50)	500x0.5	250	200
400	450	0	400x0.5	200	200

a) Write 1 call option hold 0.5 shares.

b) PV of portfolio = $V_p \times e^{-tR}f$

= 200 x $e^{-(3/12)(0.08)}$

= 200 x $e^{-0.02}$

= 200 x 0.9802

= 196.04

$e^{0.02}$ = 1 + 0.02 + $(0.02)^2/2$ +.....

$e^{-0.02}$ = 1/1.0202

$e^{-0.02}$ = 0.9802

Value of a portfolio = V_c + V_s

196.04 = V_c + (420 x 0.5)

V_c = 13.96

V_p = ?

V_c + PV of 'X' = VP + V_s

13.96 + (450/1.0202) = V_p + 420

V_p = 35.05/-

Illustration 8

Mr. Dayal is interested in purchasing equity shares of ABC Ltd. which are currently selling at Rs 600 each. He expects that price of share may go up to Rs 780 or may go down to Rs 480 inthree months. The chances of occurring such variations are 60% and 40% respectively. A calloption on the shares of ABC Ltd. can be exercised at the end of three months with a strike price of Rs 630.

a) **What combination of share and option should Mr. Dayal select if he wants a perfect hedge?**

b) **What should be the value of option today (the risk-free rate is 10% p.a.)?**

c) **What is the expected rate of return on the option?**

Solution

Spot Price = 600

Strike Price (X) = 630

Upper FSP = 780

Downward FSP = 480

For perfect hedging:

a) Write a call option

b) Hold Δ shares

$$\Delta Shares = \frac{Change\ in\ Vc}{Change\ in\ Vs}$$

Δ shares = (150 – 0)/ (780 – 480) = **0.5 shares Calculation of Value of a Call:**

FSP	X	V_c	FSP x Δ shares	V_s =(FSP x Δ shares)	V_p
780	630	(150)	780x0.5	390	240
480	630	0	180x0.5	240	240

a) Write 1 call option hold 0.5 shares.

b) PV of portfolio = $V_p \times e^{-trf}$

$= 240 \times e^{-(3/12)(0.1)}$

$= 240 \times e^{-0.025}$

$= 240 / 1.0253125$

$= 234.075$

$e^{-0.025} = 1 + 0.025 + (0.025)^2/2 + \ldots\ldots$

$e^{-0.025} = 1.0253125$

Value of a portfolio = $V_C + V_S$

$234.075 = V_C + (600 \times 0.5)$

$V_C = 65.925$

c) Expected value of call option = [(150 x 60%) + (0 x 40%)] = 90/-

Expected rate of return on the option = (90 – 65.925)/ 65.925 = 36.52%

ADDITIONAL QUESTIONS

Illustration 1

Sensex futures are traded at a multiple of 50. Consider the following quotations of Sensex futures in the 10 trading days during February, 2009:

DAY	HIGH	LOW	CLOSING
4-2-09	3306.4	3290.00	3296.50
5-2-09	3298.00	3262.50	3294.40
6-2-09	3256.20	3227.00	3230.40
7-2-09	3233.00	3201.50	3212.30
10-2-09	3281.50	3256.00	3267.50
11-2-09	3283.50	3260.00	3263.80
12-2-09	3315.00	3286.30	3292.00
14-2-09	3315.00	3257.10	3309.30
17-2-09	3278.00	3249.50	3257.80
18-2-09	3118.00	3091.40	3102.60

Abhishek bought one sensex futures contract on February, 04. The average daily absolute change in the value of contract is Rs 10,000 and standard deviation of these changes is Rs 2,000. The maintenance margin is 75% of initial margin.

You are required to determine the daily balances in the margin account and payment on margin calls, if any.

Solution

Initial Margin = $\mu + 3\sigma$

Initial Margin = 10,000 + 3(2000) = **16,000** **Maintenance Margin of initial margin** = **75%**

= 16000 x 75% = **12000**

Margin Account of Abhishek:

Date	Calculation of Profit/Loss	Profit/(Loss)	Margin Call	Balance
4/02/09	-	-	-	16,000
5/02/09	50(3294.4 – 3296.5)	(105)	-	15,895
6/02/09	50(3230.4 – 3294.4)	(3200)	-	12,695
7/02/09	50(3212.3 – 3230.4)	(905)	4210 (WN-1)	16,000
10/02/09	50(3267.5 – 3212.3)	2760	-	18,760
11/02/09	50(3263.80 – 3267.5)	(185)	-	18,575
12/02/09	50(3292 – 3263.80)	1,410	-	19,985
14/02/09	50(3309.30 – 3292)	865	-	20,850

17/02/09	50(3257.80 – 3309.30)	(2575)	-	18,275
18/02/09	50(3102.60 – 3257.80)	(7760)	5485 (WN-2)	16,000

WN 1: (1600 – 12695 – 905) = 4210

WN 2: (1600 – (18275 – 7760)) = 5485

Illustration 2

A Mutual Fund is holding the following assets in ₹ Crores:

Investments in diversified equity shares	**90.00**
Cash and Bank Balances	**10.00**
	100.00

The Beta of the equity shares portfolio is 1.1. The index future is selling at 4300 level. The Fund Manager apprehends that the index will fall at the most by 10%. How many index futures he should short for perfect hedging? One index future consists of 50 units. Substantiate your answer assuming the Fund Manager's apprehension will materialize.

Solution

Number of index future to be sold by the Fund Manager is: $\frac{11\times 90,00,000}{4,300\times 50}$=4,605

Justification of the answer:

Loss in the value of the portfolio if the index falls by 10% is (1.1) $\frac{10}{100}\times 90$ Crore = 9.90 Crore

Gain by short covering of index future is: $\frac{0.1\times 4,300\times 50\times 4,605}{1,00,00,000}$ =9.90 Crore

This justifies the answer. Further, cash is not a part of the portfolio.

Illustration 3

A trader is having in its portfolio shares worth Rs 85 lakhs at current price and cash Rs 15 lakhs.

The beta of share portfolio is 1.6.

Determine:

a) Current portfolio beta

b) After 3 months the price of shares dropped by 3.2%. Portfolio beta after 3 months if the trader on current date goes for longposition on Rs 100 lakhs Nifty futures.

Solution

a) Current portfolio:

Shares = 85 lakhs, β = 1.6

Cash = 15 lakhs, β =0

After 3m, MP of shares declines by 3.2%.

Portfolio $\beta_p = W_A\ \beta_A$ + $W_B\ \beta_B$

β_p = (0.85 x 1.6) + (0.15 x 0) = **1.36**

b) % change in Index = Δ value of shares/ β of share

= 3.2%/ 1.6% = **2%**

Long position of Index 100 lakhs

Short position of Index 98 lakhs

Loss (2) lakhs

Cash balance after 3m:

Opening balance 15,00,000 Less: Loss (Index at short) (2,00,000) Cash balance after 3m 13,00,000

Value of share after 3m:

Value = 85 lakhs – (85 lakhs x 3.2%)

Value = 82,28,000

Total value of portfolio = **(13,00,000 + 82,28,000)**

= 95,28,000

% change in value of portfolio = **(1,00,00,000 - 95,28,000)/ 1,00,00,000**

= 4.72%

$$\beta_p = \frac{\Delta \text{ Value of Share}}{\Delta \text{ Value of Market}} = \frac{4.72}{2} = 2.36$$

Illustration 4

On January 1, 2013 an investor has a portfolio of 5 shares as given below:

Security	Price	No. of Shares	Beta
A	349.30	5,000	1.15
B	480.50	7,000	0.40
C	593.52	8,000	0.90
D	734.70	10,000	0.95
E	824.85	2,000	0.85

The cost of capital to the investor is 10.5% per annum. You are required to calculate:

a) The beta of his portfolio.

b) The theoretical value of the NIFTY futures for February 2013.

c) The number of contracts of NIFTY the investor needs to sell to get a full hedge until February for his portfolio if the current value of NIFTY is 5900 and NIFTY futures have a minimum trade lot requirement of 200 units. Assume that the futures are trading at their fair value.

d) The number of future contracts the investor should trade if he desires to reduce the beta of his portfolios to 0.6.

No. of days in a year be treated as 365.

Given: In (1.105) = 0.0998 and e(0.015858) = 1.01598

Solution

a) Calculation of Portfolio β:

Security	Market Price	β	Proportion	Proportion x β
A	17,46,500	1.15	0.093	0.107
B	33,63,500	0.40	0.178	0.071
C	47,48,160	0.90	0.252	0.227
D	73,47,000	0.95	0.390	0.371
E	16,49,700	0.85	0.087	0.0743
	1,88,54,860		**Pβ**	**0.849**

b) Calculation of theoretical Value of futures contract:

FFP = spot price x e^{tr}

= 5900 x $e^{(10.5\%)(2/12)}$ = 5900 x 1.017653 = 6004.15/-

c) No. of contracts of NIFTY:

No of contracts = $\frac{\text{Portfolio value x } \beta_P}{\text{Value of futures contract}}$

No. of contracts = (1,88,54,860 x 0.849)/ (200 x 6004.15) = 13.33 ~ 14 contracts

d) Desired β = 0.6

To reduce β to 0.6, no of future contracts to be traded = $\frac{1,88,54,860 \text{ x } (0.849 - 0.6)}{200 \times 6004.15} = 3.91 \sim 4$

Illustration 5

The following quotes are available for 3-months options in respect of a share of P Ltd. which is currently traded at ₹ 310.

Strike Price	**₹ 300**
Call option	**₹ 30**
Put option	**₹ 20**

An investor devises a strategy of buying a call and selling the share and a put option. Risk free interest rate is 10% per annum.

Using Put-call parity theory

(i) Find out profit/loss of the investor.

(ii) What would be the position if the strategy adopted is selling a call and buying the put and the share? ($e^{0.025}$ = 1. 0253; $e^{0.25}$ = 1. 2840)

Solution

(i) According to Put-Call Parity

$p = c + X e^{-rt} - S$

$S + p = c + X e^{-rt}$

Here,

P = Put option price

c = Call option price

S = Spot Price

X = Ex. Price

Left Hand Side (LHS)= ₹ 310 + ₹ 20= ₹ 330

Right Hand Side (RHS)= ₹ 30 + ₹ 300/[(0.10 × 3/12)]= ₹ 322.60

Since LHS is not equal to RHS and the difference is ₹ 330 – ₹ 322.68 = ₹ 7.40

There is an arbitrage opportunity and the investor is devising a strategy of buying acall and selling the share and a put option.

From the put-call parity equation we can see that it is equivalent to;

$c-S-p = -X e^{-rt}$ or $(c-S-p)+X e^{-rt} = 0$

Arbitrage Profits per Share			
Position	**Immediate Cash Flow**	**Payoff in 3 Months**	
		St ≤ 300	**St > 300**
Sell Stock	310	- St	- St
Deposit PV (300)	-292.60	300	300
Buy Call	-30	0	St -300
Sell Put	+20	-(300 - St)	0
Total	₹ 7.40	0	0

St = Stock Price at expiration

This strategy would be adopted, since the initial payoff is positive.

(ii) If the investor would adopt by selling a call and buying the share and put option,then the Put-Call Parity Equation would be equivalent to $-c+S+p = X e^{-rt}$. The resultof net cash outflow (initial payoff):

Arbitrage Profits per Share			
Position	**Immediate Cash Flow**	**Payoff in 3 Months**	
		St ≤ 300	**St > 300**
Buy Stock	- 310	St	St
Borrow PV (300)	+292.60	- 300	- 300
Sell Call	+30	0	- (St - 300)
Buy Put	- 20	(300 - St)	0
Total	- ₹ 7.40	0	0

This strategy would not adopted, since the initial payoff is negative.

Illustration 6

Consider a two-year American call option with a strike price of Rs 50 on a stock the current price of which is also Rs 50. Assume that there are two time periods of one year and in each year the stock price can move up or down by equal percentage of 20%. The risk-free interest rate is 6%. Using binominal option model, calculate the probability of price moving up and down. Also draw a twostep binomial tree showing prices and payoffs at each node.

Solution

P = Upper FSP

1 – P = lower FSP

$(P \times 60) + [(1 - P) \times 40] = 50 \times e^{0.06}$

$60P + 40 - 40P = 53.09$

$P = 0.6545$

$1 - P = 0.3545$

$e^{0.06} = 1 + (0.06/1) + (0.06)^2/2 + ...$

$e^{0.06} = 1.0618$

Calculation of Value of a call after 1 yr if FSP is 60:

Strike Price	FSP	V_c	Probability	V_c x Probability
50	72	22	0.6545	14.399
50	48	0	0.3455	0
Expected value of call at the end of 2nd year				14.4

Expected Value of call at the end of 1st year (14.4/ 1.0618) 13.56

Calculation of Value of a call after 1 yr if FSP is 40:

Strike Price	FSP	V_c	Probability	V_c x Probability
50	72	22	0.6545	14.399
50	48	0	0.3455	0
Expected value of call at the end of 2nd year				14.4

Expected Value of call at the end of 1st year (0/ 1.0618) 0

Expected value of a call after 1yr, irrespective of FSP = (0.6545 x 13.56) + (0.3455 x 0) = 8.87

Present value of a call (8.87/ 1.0618) = 8.35

Alternatively:

Calculation of Present Value of a call:

Strike Price	FSP	V_c	Joint Probability (JP)	V_c x JP
50	72	22	0.4284	9.4248
50	48	0	0.452	0
50	32	0	0.119	0
Expected Value of call at the end of the 2nd year				9.4248

Present value of call [9.4248/ $(1.0618)^2$] 8.35

Two Period Binomial Tree

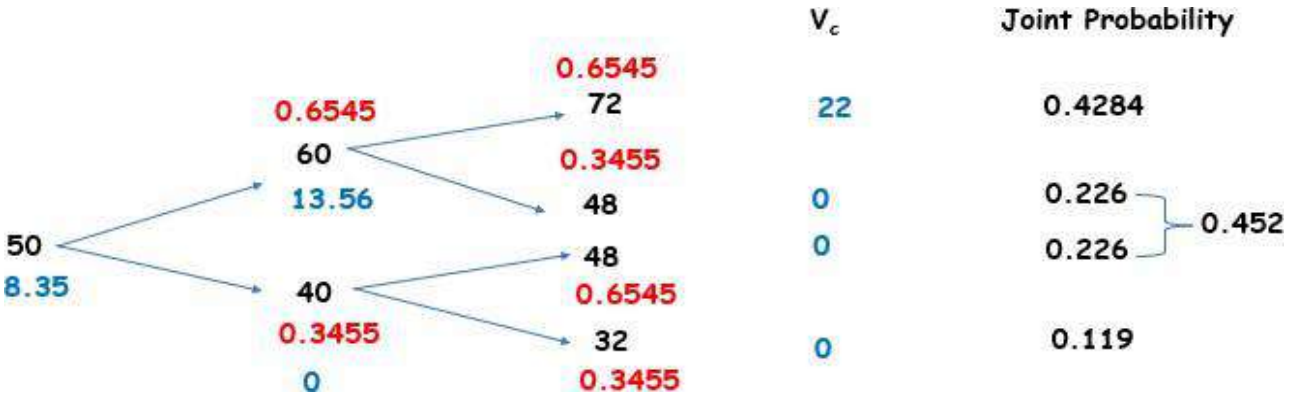


Illustration 7

The shares of EXECPRO LTD. are currently priced at 408 and call option exercisable in three months time has an exercise rate of 400. Risk free interest rate is 5% p.a. and standard deviation (volatility) of /shares price is 22%. The Company is going to declare a dividend of ₹ 10 and it is expected to be paid in two months time.

Required:

(i) **Determine the value of a three-month CALL OPTION on the share of Execpro Ltd. based on Black Scholes Model.**

(ii) **What would be the worth of PUT OPTION if the current price is considered to be 390?**

Note: Extracted from the tables:

1. **in (0.99521) = 0.00480, In (1.00481) = 0.004798**
2. **Value of e^{-x}: $e^{-0.01}$= 0.99005 $e^{-0.125}$ = 0.987578, $e^{-0.00833}$ =0.9917**
3. **Cumulative standardized normal probability distribution: NCX.**

When x ≥ 0: N (0.125) = 0.5498, N (0.015) = 0.5060

When X ≤ 0: N (-0.125) = 0.4502 , N (-0.015) = 0.4940 (6+2 = 8 marks)

Solution

(i) Since dividend is expected to be paid in two months time we have to adjust the share price and then use BLACK SCHOLES MODEL to value the option:

Present Value of Dividend (using continuous discounting)

= Dividend X e^{-rt} = 10 X $e^{-0.05x0.1666}$

= ₹ 10 X $e^{-0008333}$

= ₹ 9.917

Adjusted price of shares is ₹408 - ₹9.917 = ₹398.083

This can be used in Block Scholes model

$$d_1 = I_n \frac{\left(\frac{398.083}{400}\right)+[0.05+\frac{1}{2}(0.22)^2]0.25}{0.22\sqrt{0.25}}$$

$= \frac{-0.00480+0.01855}{0.11}$

$= 0.125$

$d_1 = I_n \frac{\left(\frac{398.083}{400}\right)+[0.5+\frac{1}{2}(0.22)^2]0.25}{0.22\sqrt{0.25}}$

$= \frac{-0.00480+0.00645}{0.11}$

$= 0.015$

N (d1) = N (.125) = 0.5498

N (d2) = N (.015) = 0.5060

Value of Call Option: $V_S \times N(d_1) - E.e^{-rt} N(d_2)$.

VC= Value of Option = $398.083 (0.5498) - 400 \times e^{-0.05 \times 0.25} \times 0.5060$

= 218.866 – 400 x 0.987578 x 0.5060

=218.866 - 199.8858 = ₹ 18.9802 ~ 18.98

= ₹ 18.98

(ii) Value of PUT OPTION: Vp = - Vs + Vc + Pv (E)

Vp = -390 + 18.98 + 0.987578 x 400

=-390 + 18.98 + 395.03 = ₹ 24.01

= ₹ 24.01.

Illustration 8

The question share of VCC Ltd. is quoted at Rs 210. A 3-month call option is available at a premium of Rs 6 per share and a 3-month put option is available at a premium of Rs 5 per share. Ascertainthe net payoffs to the option holder of a call option and a put option.

a) The strike price in both cases in Rs 220; and

b) The share price on the exercise day is Rs 200, 210, 220, 230, 240.

Also indicate the price range at which the call and the put options may be gainfully exercised.

Solution

Calculation of Net Payoffs to Call option Holder:

FSP	X	Premium	Action	Vc	Net Payoff
200	220	6	Lapse	0	(6)
210	220	6	Lapse	0	(6)
220	220	6	Lapse	0	(6)
230	220	6	Exercise	10	4
240	220	6	Exercise	20	14

Calculation of Net Payoffs to Put option Holder:

FSP	X	Premium	Action	Vc	Net Profit
200	220	5	Exercise	20	15

210	220	5	Exercise	10	5
220	220	5	Lapse	0	(5)
230	220	5	Lapse	0	(5)
240	220	5	Lapse	0	(5)

Call option can be gainfully exercised if price is above 220/-

Put option can be gainfully exercised if price is below 220/-

Illustration 9

An investor has the following four stocks in his portfolio:

Security	No. of shares	Market Price per share (₹)	Beta (β)
A	6000	40	0.9
B	3000	20	1.0
C	5000	25	1.5
D	1000	225	1.1

(i) Compute the portfolio beta (β).

(ii) If the investor seeks to reduce the β to 0.8, how much risk-free investment should he bring in?

(iii) Independent of (ii), if the investor would like to have an overall weighted β of 1.02 without bringing in more money, by selling shares of C and buying A instead, How many shares of C should be sold?

(iv) Independent of (ii), if the investor would like to have an overall weighted β of 1.02 without bringing in more money, by selling shares of C and buying A instead, what would be the revised weighted β of A, B, C and D?

Solution:

(i) Portfolio Beta = 1.094 or 1.0938

(ii) ₹2,38,828

(iii) 3296.69 shares of C should be sold.

(iv) Revised weighted Beta = 1.01775 or 1.02

Illustration 10

An investor has the following constituent holdings in his portfolio:

Security	No. of shares	Price per share (₹)	Share Beta
A	400	500	1.4
B	500	750	1.2
C	200	250	1.6

i. Find the market value weighted average beta of his portfolio.

ii. If the investor wants a target beta for his portfolio at 0.9, how would he dispose of his securities and replace them with Government securities if he want to sell in the order of risk? Present the revised tabulation of his holding and prove that the target beta has been achieved by your advice.

iii.

iv. If he is willing to invest further, how much investment should he make in G Sec to make his beta 0.9, without selling any share at all?

Solution

i.

Security	Nos	Price(₹)	Value(₹)	Beta	Weight	Weight x Beta
A	400	500	2,00,000	1.4	0.32	0.448
B	500	750	3,75,000	1.2	0.6	0.72
C	200	250	50,000	1.6	0.08	0.128
Total	1100		625000			1.296

Portfolio's beta based on market value weights is = 1.296

ii. Target beta = 0.9.

We should first replace the riskiest of the securities with Govt. zero beta securities. Then we go for the next riskier one. Hence, C, being of lower market value should be fully replaced by Govt. securities.

If we assume full of A to be sold, then, b x 1.2 = .9 × 625000 = ₹ 562500. Then, solving, we get b = 468750 which is more than ₹ 3,75,000 . This means that any of B should not be sold and that A too should not be sold in full.

Hence, 375000 × 1.2 + a × 1.4 = 625000 × 0.9

450000 + 1.4 a = 562500 Or, a = 112500/1.4 = ₹ 80357.

₹ 80357 value of A should be retained in the portfolio. This amounts to 80357/500

= ₹160.714 shares, which is 161 shares.

Hence the new portfolio will consist of 161 shares of A, 500 shares of B and no share of C and Govt., securities worth ₹ 169500 (50,000 from C and 200000 – 80500 = ₹ 119500 from A)

Proof:

Security	Nos	Price (₹)	Value (₹)	Beta	Weight	Weight x Beta
A	161	500	80,500	1,4	0.1288 = 80500/625000	0.18032
B	500	750	3,75,000	1.2	0.6 = 375000/625000	0.72
C	0	250	0	1.6		0
Govt. Securities			169500	0		0
Total			625000			0.90032

Thus the new portfolio beta will be the targeted 0.9

iii. Without selling any share, if investment has to be made, say for value 'g' in govt,security, weighted beta

$= \frac{(6,25,000 \times 1.296)+(g \times 0)}{(6,25,000+g)} = 0.9$

= 6,25,000 (1.296 – 0.90) = 0.90 g

$g = \frac{625000 \times 0.396}{0.90}$ = ₹ 2,75,000 market value worth G Sec should be purchased.

Illustration 11

Sagar owns a portfolio in three stocks as detailed below:

Stock	No. of shares	Price (Rs./share)	Beta
X	400000	400	1.3
Y	800000	300	1.2
Z	1200000	100	1.1

The index futures is traded at Rs. 10,250. Assume that the index factor is 100.

(i) Compute the existing portfolio beta upto two decimals.

(ii) Find out the number of contracts (rounded off to the nearest integer) of stock index futures to be bought or sold in order to :

(A) Decrease the portfolio β to 0.8

(B) Increase the portfolio β to 1.5. What will be the proportion of market value of investments in X to the value of total investments plus 10% margin on futures?

Solution

Stock	No. of Shares	Price Rs/Share	Beta	Market Value	Weighted Value of beta
X	400000	400	1.3	16,00,00,000	20,80,00,000
Y	800000	300	1.2	24,00,00,000	28,80,00,000
Z	1200000	100	1.1	12,00,00,000	13,20,00,000
Total				52,00,00,000	62,80,00,000

Weighted Beta = 62,80/52,00 = 1.21

Futures Contract value = 10,250 x 100 = 10,25,000

No. of contracts = (1.21-0.8) x 52,00,00,000 / 10,25,000 = 0.41 x 507.32 = 208 contracts have to be sold in the futures market.

Margin money = 10% x 208 x 10,25,000 = 2,13,20,000

Total investments = 52,00,00,000 +2,13,20,000 = 54,13,20,000

Proportion of X= 16,00,00,000 / 54,13,20,000 = 29.55%, say 30%

To increase the beta on 1.5, no of futures to be purchased = (1.5 – 1.21) x 52,00,00,000

/10,25,000 = 0.29 x 507.32 = 147.1229 = 147 contracts.

Value of the futures contracts = 147 x 10,25,000 = 15,06,75,000

Initial Margin 10% = 1,50,67,500

Total value of investments in shares = 52,00,00,000

Margin = $\frac{+\ 1,50,67,500}{53,50,67,500}$

Proportion of X = $\frac{\mathbf{16,00,00,000}}{\mathbf{53,50,67,500}} = \mathbf{29}.90$ or 30%

Illustration 1

Spot rate 1 US $ = ₹ 48.0123

180 days Forward rate for 1 US $ = ₹ 48.8190

Annualised interest rate for 6 months – Rupee = 12% P.a

Annualised interest rate for 6 months – US $ = 8% P.a

Is there any arbitrage possibility? If yes how an arbitrageur can take advantage of the situation, if he is willing to borrow ₹ 40,00,000 or US $83,312.

Solution

Spot rate 1 US $ = ₹ 48.0123

180 days Forward rate for 1 US $ = ₹ 48.8190

As per **interest rate parity theory**,

$$\text{Forward Rate (F)} = \frac{\text{Spot rate}(1+\text{interest rate of home currency})^n}{(1+\text{interest rate of foreign currency})^n}$$

$$1\ \$ = \frac{48.0123\left[1+\left(0.12\times\frac{6}{12}\right)\right]}{1+\left(0.08\times\frac{6}{12}\right)}$$

$$= ₹\ 48.9356$$

Actual Forward Rate < Theoretical Forward Rate, hence $ is under-valued Course of Action – Sell $ Spot, Buy $ Forward

Arbitrage Process:

Step 1: Enter into forward contract for purchase of $ after 180 Days. @ 48.8190

Step 2: Borrow US$ 83,312 for 6 months @ 8% p.a.

Step 3: Convert US$ 83,312 ($ 83,312 x 48.0123) = ₹ 40,00,000

Step 4: Invest ₹ 40,00,000 for 6 months @ 12%

Step 5: Realise investment and receive ₹ 42,40,000 [₹ 40,00,000 x (1+(0.12x6/12)]

Step 6: Convert ₹ 42,40,000, $[\frac{42,40,000}{48.8190}]$ = $ 86,851

Step 7: Amount to be repaid after 6 months = US $ 83,312 (1+0.08 x 6/12) = US$ 86,644.48

Arbitrage Profit = ₹ 206.52

Illustration 2

Sun Ltd. Is planning to import equipment from Japan at a cost of 3,400 lakh Yen.

The company may avail loans at 18% p.a with Quarterly resets with which it can import the equipment.

The company also has an offer from Osaka branch of an India Based bank extending credit of 180 days @ 2% p.a against opening of an irrevocable letter of credit

Additional Information:

Present Exchange rate Rs. 100 = 340 yen

180 days forward rate Rs. 100 = 345 yen

Commission charges for letter of credit @2% per 12 months

Advice the company whether the offer from foreign branch should be accepted.

Solution

Calculation of Outflow under Option of availing loan @ 18% interest

Cost of equipment (3,400/340)	= 1,000 lakhs	[3,400/340 * 100]
Add: Interest @4.5% (18/4) for Quarter 1	= 45 lakhs	[1000*4.5%]
	= 1,045 lakhs	
Add: Interest @4.5% (18/4) for Quarter 2	= 47.03 lakhs	[1045*4.5%]
	= 1,092.03 lakhs	
Total Cash Outflow	= 1,092.03 lakhs	

Total Cash Outflow in case of Option of availing letter of credit from Osaka Branch

Cost of Letter of Credit	
Commission	= 10 lakhs [((3400/340) x 100) x 1%]
Add: Interest	= 0.90 lakhs [10 x 18% x 6/12]
Cost of letter of credit	= 10.90 lakhs
Outflow on payment	
Cost of machine	= 3,400 yen
Add: Interest for lagging	= 34 lakhs [3400 x 2% x 6/12]
Total in Yen	= 3434 lakhs
Payment in INR	= 995.36 lakhs [3434 x 100/345] (forward rate)
Total Outflow	= 10.90 + 995.36 lakhs
	= 1006.26 lakhs

The company shall consider the option involving letter of credit from Osaka Branch since the outflow is less compared to the other.

Illustration 3

A company operating in Japan has today affected sales to an Indian company, the payment being due 3 months from the date of invoice. The invoice amount is 108 lakhs yen. At today's spot rate, it is equivalent to Rs. 30 lakhs. It is anticipated that the exchange rate will decline by 10% over the 3 months period and in order to protect the yen payments, the importer proposes to take appropriate action in the foreign exchange market. The 3 months forward rate is presently quoted as 3.3 yen per rupee. You are required to calculate the expected loss and to show how it can be hedged by a forward contract.

Solution

Exposure - Payable 108 lakh Yen

Present exchange rate	= 108 lakhs /30 lakhs = 3.6
	= 3.6 Yen
Expected exchange rate after 3 months, ₹ 1	= 3.24 Yen [3.6-10%]

Expected loss if no hedging is done:

Present worth of goods	= ₹ 30 lakhs
Expected outflow after 3 months	= ₹ 33.33 lakhs (108 lakhs /3.24)
Expected loss	**= ₹ 3.33 lakhs**

Expected loss under forward contract:

Present worth of goods	= ₹ 30 lakhs
Outflow under forward contract	= ₹ 32.73 lakhs (108 lakhs / 3.3)
Expected loss	**= ₹ 2.73 lakhs**

By entering into a forward contract, loss can be reduced by ₹ 0.6 lakhs.

Illustration 4

Columbus Surgical Inc. is based in US, has recently imported surgical raw materials from the UK and has been invoiced for £ 4,80,000, payable in 3 months. It has also exported surgical goods to India and France.

The Indian customer has been invoiced for £ 1,38,000, payable in 3 months, and the French customer has been invoiced for € 5,90,000, payable in 4 months.

Current spot and forward rates are as follows:

£ / US$

Spot:	**0.9830 – 0.9850**
Three months forward:	**0.9520 – 0.9545**

US$ / €

Spot:	**1.8890 – 1.8920**
Four months forward:	**1.9510 – 1.9540**

Current money market rates are as follows:

UK: 10.0% – 12.0% p.a.

France: 14.0% – 16.0% p.a.

USA: 11.5% – 13.0% p.a.

You as Treasury Manager are required to show how the company can hedge its foreign exchange exposure using Forward markets and Money markets hedge and suggest which the best hedging technique is.

Solution

Exposure – Payable 4,80,000 £ in 3 months

Receivables 1,38,000 £ in 3 months

i.e., Net Payables – 3,42,000 £ in 3 months

A. Payable 3,42,000 in 3 months

a. Money Market Hedging:

Step 1: Deposit P.V. of exposure = $\frac{3,42,000}{\left[1+\left(0.1\times\frac{3}{12}\right)\right]}$ = £ 3,33,658

Step 2: For purchase of 3,33,658 £, $'s spent = 3,33,658 x $\frac{1}{0.983}$ = $ 3,39,428

Step 3: Borrow $ 3,39,428 for 3 months @ 13% p.a.

Step 4: Repay the loan, then outflow = 3,39,428 (1+0.13 x 3/12) = $ 3,50,459

Step 5: Realise the deposit & pay £ 3,42,000

b. **Outflow under forward contract** = £ $\frac{3,42,000}{0.9520}$ = $3,59,244

Decision: Money Market Hedging is better.

B. Receivable - 5,90,000 € in 4 months :

a. Money Market Hedging : Receivable - € 5,90,000 in 4 months .

Step 1: Borrow P.V. of exposure = $\frac{5,90,000}{\left[1+\left(0.16\times\frac{4}{12}\right)\right]}$ = € 5,60,127

Step 2: Sell € and receive [5,60,127 × 1.8890] = $ 10,58,080

Step 3: Deposit 10,58,112 $ for 4 months @ 11.5 % p.a.

Step 4: Realise deposit and receive 10,58,080 × [1+(0.115×4/12)] =$10,98,640

Step 5: Receive € 5,90,000 and pay loan in France .

b. **Inflow under Forward contract** = 5,90,000 × 1.9510

= 11,51,090 $

Decision: Forward contract is preferable.

Illustration 5

EFD Ltd. is an export business house. The company prepares invoice in customers' currency. Its debtors of US$.1,00,00,000 is due on April 1, 2015.

Market information as at January 1, 2015 is:

Exchange rates	US$/INR	Currency Futures	US$/INR
Spot	0.016667	Contract size: Rs. 24,816,975	
1-month forward	0.016529	1- month	0.016519
3-months forward	0.016129	3- month	0.016118

	Initial Margin	Interest Rates in India
1-Month	Rs 17,500	6.5%
3-Month	Rs 22,500	7%

On April 1,2015 the spot US$/INR is 0.016136 and currency future rate is 0.016134. Which of the following methods would be most advantageous to EFD Ltd?

i) Using forward contract

ii) Using currency futures

iii) Not hedging the currency risk

Solution

Exposure = US$ 1,00,00,000 (Receivables)

Total Inflow in case of Forward Contract

Total Inflow [10,000,000/0.06129] = ₹62,00,01,240

Total Inflow in case of Futures contract

Exposure – Receivables		
Position - Long		
No of contracts required	= 25	[(1,00,00,000/0.06118)/2,48,16,975]
Initial Margin Payable	= 5,62,500	[25 x 22,500]
Interest on margin	= 9,844	[5,62,500 x 7% x 3/12]
Profit on Futures		
Long @	= (0.016118)	
Short @	= 0.016134	
	= 0.000016	
Total Profit on Futures Contract	= 0.000016 x 2,48,16,975 x 25 ÷ 0.016136	
	= 6,15,195	
Inflow at the end of contract	= 61,97,32,276	[1,00,00,000/0.016136]
Add: Profit on Futures	= 6,15,195	
Less: Interest on Margin	= (9844)	
	= 6,20,337,627	

Total Inflow in case of Forwards = 62,00,01,240

Total Inflow in case of Futures = 62,03,37,627

Inflow in case of No Hedge = 61,97,32,276 [1,00,00,000/0.016136]

Futures option would be the most advantageous as the inflow is the highest.

Illustration 6

XYZ Ltd. a US firm will need £ 3,00,000 in 180 days. In this connection, the following information is available:

Spot rate 1 £ = $ 2.00

180 days forward rate of £ as of today = $1.96

Interest rates are as follows:

	U.K.	US
180 days deposit rate	4.5%	5%
180 days borrowing rate	5%	5.5%

A call option on £ that expires in 180 days has an exercise price of $ 1.97 and a premium of $ 0.04. XYZ Ltd. has forecasted the spot rates 180 days hence as below:

Future rate	Probability
$ 1.91	25%
$ 1.95	60%
$ 2.05	15%

Which of the following strategies would be most preferable to XYZ Ltd.?

a) A forward contract,

b) A money market hedge,

c) An option contract,

d) No hedging.

Show calculations in each case.

Solution

Exposure – Payable 3,00,000 £ after 180 days

a) Forward contract:

180 days forward rate, £ 1 = 1.96 $

Outflow = 3,00,000 × 1.96 = 5,88,000 $

b) Money market hedging:

Since Payable to be made in £, the deposit is made in UK

£ Deposit to be made in UK =3,00,000/1.045 = 2,87,081 £

$s to be spent on 2,87,081 £ = (2,87,081 × 2) = 5,74,162 $

After 180 days:

Outflow on repayment of borrowings = 5,74,162 × (1.055) = 6,05,741 $

Deposit withdrawal 3,00,000 £

Hedging Process

Step 1: Borrow 5,74,162$ in US market

Step 2: Convert $5,74,162 to £ at spot rate of 2$/£ and receive £2,87,081

Step 3: Deposit £2,87,081 in UK market

Step 4: After 180 days, repay borrowing @ $6,05,741

Step 5: Withdraw deposit of £3,00,000 (including Interest) and pay it to supplier

c) Currency Options :

Expected spot rate in 180 days	Prem./unit	Exercise option	Total price per unit	Total price for £ 3,00,000xi	Prob.pi	pixi
1.91	0.04	No	1.95	5,85,000	0.25	1,46,250
1.95	0.04	No	1.99	5,97,000	0.60	3,58,200
2.05	0.04	Yes	2.018	6,03,000	0.15	90,450
						5,94,900
Add: Interest on premium @ 5.5% (12,000 x 5.5%)						660
						5,95,560

*($1.97 + $0.04)

d) No hedge option:

Expected future spot rate	Dollar needed Xi	Prob. Pi	Pi Xi
1.91	5,73,000	0.25	1,43,250
1.95	5,85,000	0.60	3,51,000
2.05	6,15,000	0.15	92,250
			5,86,500

The probability distribution of outcomes for no hedge strategy appears to be most preferable because least number of $ are needed under this option to arrange £ 3,00,000.

Illustration 7

An importer booked a forward contract with his bank on 10th April for USD 2,00,000 due on 10th June @ ₹ 64.4000. The bank covered its position in the market at ₹ 64.2800. The exchange rates for dollar in the interbank market on 10th June and 13th June were:

	10th June	13th June
Spot USD 1=	₹ 63.8000/8200	₹ 63.6800/7200
Spot/June	₹ 63.9200/9500	₹ 63.8000/8500
July	₹ 64.0500/0900	₹ 63.9300/9900
August	₹ 64.3000/3500	₹ 64.1800/2500
September	₹ 64.6000/6600	₹ 64.4800/5600

Exchange Margin 0.10% and interest on outlay of funds @ 12%. The importer requested on 13th June for extension of contract with due date on 10th August.

Rates to be rounded off to 4 decimals in multiples of 0.0025.

On 10th June, Bank Swaps by selling spot and buying one month forward.

Calculate:

(i) Cancellation rate

(ii) Amount payable on $ 2,00,000

(iii) Swap loss

(iv) Interest on outlay of funds, if any

(v) New contract rate

(vi) Total Cost

Solution

(i) Cancellation Rate:

The forward sale contract shall be cancelled at Spot TT Purchase for $ prevailing on the date of cancellation as follows:

$/ ₹ Market Buying Rate	₹ 63.6800
Less: Exchange Margin @ 0.10%	₹ 0.0636
	₹ 63.6163
Rounded off to	₹ 63.6175

(ii) Amount payable on $ 2,00,000

Bank sells $2,00,000 @ ₹ 64.4000	₹ 1,28,80,000
Bank buys $2,00,000 @ ₹ 63.6175	₹ 1,27,23,500
Amount payable by customer	₹ 1,56,500

(iii) Swap Loss

On 10th June the bank does a swap sale of $ at market buying rate of ₹ 63.8000 and forward purchase for June at market selling rate of ₹ 63.9500.

Bank buys at ₹ 63.9500

Bank sells at ₹ 63.8000

Amount payable by customer ₹ 0.1500

Swap Loss for $ 2,00,000 is ₹ = ₹ 30,000

(iv) **Interest on Outlay of Funds**

On 10th June, the bank receives delivery under cover contract at ₹ 64.2800 and sell spot at ₹ 63.8000.

Bank buys at ₹ 64.2800

Bank sells at ₹ 63.8000

Amount payable by customer ₹ 0.4800

Outlay for $ 2,00,000 is ₹ 96,000

Interest on ₹ 96,000 @ 12% for 3 days ₹ 96

(v) **New Contract Rate**

The contract will be extended at current rate

$/ ₹ Market forward selling Rate for August	₹ 64.2500
Add: Exchange Margin @ 0.10%	₹ 0.0643
	₹ 64.3143

Rounded off to ₹ 64.3150

(vi) **Total Cost**

Cancellation Charges	₹ 1,56,500.00
Swap Loss	₹ 30,000.00
Interest	₹ 96.00
	₹ 1,86,596.00

Illustration 8

A Ltd. of U.K. has imported some chemical worth of USD 3,64,897 from one of the U.S. suppliers. The amount is payable in six months time. The relevant spot and forward rates are:

Spot rate USD 1.5617-1.5673

6 months' forward rate USD 1.5455 –1.5609

The borrowing rates in U.K. and U.S. are 7% and 6% respectively and the deposit rates are 5.5% and 4.5% respectively.

Currency options are available under which one option contract is for GBP 12,500. The option premium for GBP at a strike price of USD 1.70/GBP is USD 0.037 (call option) and USD 0.096 (put option) for 6 months period.

The company has 3 choices:

(i) Forward cover

(ii) Money market cover, and

(iii) Currency option

Which of the alternatives is preferable by the company?

Solution

Exposure – Payable 3,64,897 $ after 6 months

a) Forward Cover:

6 month forward rate $ = 1.5455 – 1.5609

Customer – buy $

Bank - Sell $

Relevant rate – Ask rate of $

$- \frac{1}{Bidrate\ bidrate\ of\ £}$

Outflow $= \frac{3,64,897}{1.5455}$ = £ 2,36,103

b) Money Market Hedging:

Step 1: Deposit PV of exposure = $3,64,897/[1 + \left(\frac{0.045}{2}\right)]$ = $ 3,56,867

Step 2: £ to be borrowed $= \frac{3,56,867}{1.5617}$ = £ 2,28,512

Step 3: After 6 months, withdraw deposit and pay supplier $ 3,64,897

Step 4: Repay borrowing = 2,28,512 (1+0.035) = £ 2,36,510

c) **Currency Options:**

Strike price, £ 1 = $ 1.7

Buy - $

Sell - £

Relevant option – Put option

Contract size = £ 12,500

Payable - $ 3,64,897

No. of Contracts $= \frac{\$\frac{3,64,897}{1.7}}{12,500}$ = 17 Contracts

Exposure covered = 17 x 12,500 x 1.7 = $ 3,61,250

Exposure uncovered = 3,64,897 – 3,61,250 = $ 3,647

Outflow under Option contract = 17 × 12,500 = £ 2,12,500

Outflow on uncovered exposure $= \frac{3,647}{1.5455}$ = £ 2,359

Premium [Put Option] $= \frac{17 \times 12,500 \times 0.096}{1.5617}$ = £ 13,063

Interest on Premium $= 13,063 \times 7\% \times \frac{6}{12}$ = £ 457

Total Outflow = 2,28,379 £

Decision: Currency options is the best alternative.

Additional questions

Illustration 1

You, a foreign exchange dealer of your bank, are informed that your bank has sold a T.T. on Copenhagen for Danish Kroner 10,00,000 at the rate of Danish Kroner 1 = Rs. 6.5150. You are required to cover the transaction either in London or New York market. The rates on that date are as under:

Mumbai-London	Rs. 74.3000	Rs. 74.3200
Mumbai-New York	Rs. 49.2500	Rs. 49.2625
London-Copenhagen	DKK 11.4200	DKK 11.4350
New York-Copenhagen	DKK 07.5670	DKK 07.5840

In which market will you cover the transaction, London or New York, and what will be the exchange profit or loss on the transaction? Ignore brokerages.

Solution

Given quotes;

a) New York:

₹/$ = 49.25 – 49.2625

DKK/$ = 7.5670 – 7.5840

Dealer sold DKK @ ₹ 6.515

To Cover - buy DKK

Other dealer – sell DKK

Relevant rate – Ask rate of DKK against ₹

₹/DKK = ₹/$ × $/DKK

= 49.2625 × 1/7.5670

= 6.51017

Profit = 10,00,000 × (6.515 – 6.51017)

Profit = ₹ 4830

Given quotes;

b) London:

₹/£ = 74.30 – 74.32

DKK/£ = 11.42 – 11.435

Dealer sold DKK @ ₹ 6.515

Cover - buy DKK

Other dealer – sell DKK

Relevant rate – Ask rate of DKK against ₹

₹/DKK = ₹/£ × £/DKK

$=74.32 \times \frac{1}{11.42}$

= 6.5078

Profit = 10,00,000 × (6.515 – 6.5079)

= ₹ 7100

Transaction should be covered in London market.

Illustration 2

The US dollar is selling in India at Rs.55.50. If the interest rate for 6 months borrowing in India is 10% per annum and the corresponding rate in USA is 4%.

a) Do you expect that US dollar will be at a premium or at discount in the Indian Forex Market?

b) What will be the expected 6-months forward rate for US dollar in India? And

c) What will be the rate of forward premium or discount?

Solution

a) Since the interest in US is less, US dollar will be at premium.

b) As per interest rate parity theory,

$$\text{Forward Rate (F)} = \frac{\text{Spot rate}(1+\text{interest rate of home currency})^n}{(1+\text{interest rate of foreign currency})^n}$$

$$1\ \$ = \frac{55.5\left[1+\left(0.10\times\frac{6}{12}\right)\right]}{1+\left(0.04\times\frac{6}{12}\right)}$$

$$= ₹\ 57.13$$

c) Rate of Premium $= \frac{FR-SR}{SR} \times 100 \times \frac{12}{n}$

$$= \frac{57.13-55.5}{55.5} \times 100 \times \frac{12}{6}$$

$$= 5.87\%$$

Illustration 3

Given the following information:

Exchange rate

Canadian dollar 0.665 per DM (spot)

Canadian dollar 0.670 per DM (3 months)

Interest rates – DM 7% p.a. Canadian Dollar – 9% p.a.

What operations would be carried out to take the possible arbitrage gains?

Solution

Spot exchange rate, 1 DM = 0.665 Can $

3 months forward rate 1 DM = 0.670 Can $

Interest rate in DM – 7% p.a.

Interest rate in Can $ - 9% p.a.

As per **interest rate parity theory**,

$$\text{Forward Rate (F)} = \frac{Spot\ rate(1+interest\ rate\ of\ home\ currency)^n}{(1+interest\ rate\ of\ foreign\ currency)^n}$$

$$1\ DM = \frac{0.665\left[1+\left(0.09\times\frac{3}{12}\right)\right]}{1+\left(0.07\times\frac{3}{12}\right)}$$

$$= 0.668\ Can\ \$$$

Actual forward rate is greater than theoretical forward rate i.e., DM overpriced.

Arbitrage process:

Step 1: Enter into forward contract for sale of DM after 3 months.

Step 2: Borrow Can $ for 3 months @ 9% p.a.

Step 3: Sell Can $ 1000 and receive 1503.7 DM [1000/0.665]

Step 4: Invest 1503.7 DM for 3 months @ 7% p.a.

Step 5: Realize the deposit after 3 months and receive 1530.01 DM [1503.7(1+0.07×3/12)]

Step 6: Sell DM and buy Can $ 1025.10 [1512.47 × 0.67]

Step 7: Repay loan 1022.5 [1000 × (1+0.09×3/12)]

Arbitrage profit = 1025.10 Can $ – 1022.5 Can $

= 2.6 Can $

Illustration 4

Following information relates to AKC Ltd. which manufactures some parts of an electronics device which are exported to USA, Japan and Europe on 90 days credit terms. Cost and Sales information:

	Japan	USA	Europe
Variable Cost Per Unit	Rs. 225	Rs. 395	Rs. 510
Export sale price per unit	Yen 650	US$10.23	Euro 11.99
Receipts from Sale due in 90	Yen 78,00,000	US$ 1,02,300	Euro 95,920

Foreign exchange rate information:

	Yen/Rs	US$/Rs	Euro/Rs
Spot Market	2.417-2.437	0.0214-0.0217	0.0177- 0.0180
3 months forward	2.397-2.427	0.0213-0.0216	0.0176- 0.0178
3 months spot	2.423-2.459	0.02144-0.02156	0.0177- 0.0179

Advice AKC Ltd. by calculating average contribution to sales ratio whether it should hedge it's foreign currency risk or not.

Solution

Working Note 1: No. of units-

Particulars	Japan	USA	Europe
Sales	Yen 78,00,000	US$ 1,02,300	Euro 95,920
Selling price per unit	Yen 650	US$ 10.23	Euro 11.99
No. of units	12,000	10,000	8,000

Working Note 2: Relevant Rate-

Customer - Sell foreign currency

Bank - Buy foreign currency

Relevant Rate- Bid rate of foreign currency

$= \frac{1}{Ask\ rate\ of\ ₹}$

Calculation of contribution to sales ratio:

1) If hedging is not done

Particulars	Japan	USA	Europe	Total
Sales (FC)	Yen 78,00,000	US$ 1,02,300	Euro 95,920	
Sales (Rs)	32,13,844 [78,00,000/2.427]	47,36,111 [1,02,300/0.0216]	53,88,764 [95,920/0.0178]	1,33,38,719
(-) variable costs	27,00,000 [12,000 x 225]	39,50,000 [10,000 x 395]	40,80,000 [8,000 x 510]	(1,07,30,000)
Contribution				26,08,719

$\frac{Contribution}{Sales} = \frac{26,08,719}{1,33,38,719} = 19.56\%$

2) If hedging is done

Particulars	Japan	USA	Europe	Total
Sales (FC)	Yen 78,00,000	US$ 1,02,300	Euro 95,920	
Sales (Rs)	31,72,021 [78,00,000/2.459]	47,44,848 [1,02,300/0.02156]	53,58,659 [95,920/0.0179]	1,32,75,578
(-) variable costs	27,00,000 [12,000 x 225]	39,50,000 [10,000 x 395]	40,80,000 [8,000 x 510]	(1,07,30,000)
Contribution				25,45,578

$\frac{Contribution}{Sales} = \frac{25,45,578}{1,32,75,578} = 19.17\%$

Illustration 5

Drilldip Inc. a US based company has a won a contract in India for drilling oil field. The project will require an initial investment of ₹ 500 crore. The oil field along with equipments will be sold to Indian Government for ₹ 740 crore in one year time. Since the Indian Government will pay for the amount in Indian Rupee (₹) the company is worried about exposure due exchange rate volatility.

You are required to:

a) Construct a swap that will help the Drilldip to reduce the exchange rate risk.

b) Assuming that Indian Government offers a swap at spot rate which is 1US$ = ₹ 50 in one year, then should the company should opt for this option or should it just do nothing. The spot rate after one year is expected to be 1US$ = ₹ 54. Further you may also assume that the Drilldip can also take a US$ loan at 8% p.a.

Solution

a) The following swap arrangement can be entered by Drilldip:

i. Swap a US$ loan today at an agreed rate with any party to obtain Indian Rupees (₹) to make initial investment.

ii. After one year swap back the Indian Rupees with US$ at the agreed rate. In such case the company is exposed only on the profit earned from the project.

b) With the swap

	Year 0 (Million US$)	Year 1 (Million US$)
Buy ₹ 500 crore at spot rate of 1US$ = ₹ 50	(100.00)	----
Swap ₹ 500 crore back at agreed rate of ₹ 50	----	100.00
Sell ₹ 240 crore at 1US$ = ₹ 54	----	44.44
Interest on US$ loan @8% for one year	----	(8.00)
	(100.00)	136.44

Net result is a net receipt of US$ 36.44 million.

Without the swap

	Year 0 (Million US$)	Year 1 (Million US$)
Buy ₹ 500 crore at spot rate of 1US$ = ₹ 50	(100.00)	----
Sell ₹ 740 crore at 1US$ = ₹ 54	----	137.04
Interest on US$ loan @8% for one year	----	(8.00)
	(100.00)	129.04

Net result is a net receipt of US$ 29.04 million.

Decision: Since the net receipt is higher in swap option the company should opt for the same.

Illustration 6

Rongal Ltd. An Indian Company exports cotton garments to U.S. during the year 2022-23. It has exported 120000 pieces of garments at an average price of $ 20 per piece. Average cost of producing each piece is Rs. 550 for the company. The elasticity of demand for the company's product in the U.S market is 1.5

Prevailing Rupee-Dollar exchange rate during the last year was Rs.80. In the current year Rupee-Dollar exchange rate is expected to depreciate to Rs.81.

Required:

i. **Assess the change in profit due to the transaction exposure.**
ii. **Assess the change in profit due to economic exposure, if the company passes the**
iii. **benefit of depreciation on to buyer.**

Solution

Illustration 1

X Ltd. is interested in expanding its operation and planning to install manufacturing plant at US. For the proposed project it requires a fund of $ 10 million (net of issue expenses/ floatation cost). The estimated floatation cost is 2%. To finance this project, it proposes to issue GDRs. You as financial consultant is required to compute the number of GDRs to be issued and cost of the GD R with the help of following additional information.

a) Expected market price of share at the time of issue of GDR is Rs. 250 (Face Value Rs. 100)

b) 2 Shares shall underly each GDR and shall be priced at 10% discount to market price.

c) Expected exchange rate Rs. 60/$.

d) Dividend expected to be paid is 20% with growth rate 12%.

Solution

Market price of share = 250/-

Fund required = $100 lakhs

Issue size = (100 lakhs/ 98%) = $102.04 lakhs

Issue price of GDR in ₹ = (2 x 250 x 90%) = ₹ 450

Present exchange rate 1$ = ₹60

Issue price of GDR in $ = (450/60) = $7.5

a) **No. of GDR's to be issued** (102.04 lakhs/ 7.5) = **13.6 lakh GDR's**

b)

$$\textbf{Cost of GDR} = \frac{D_1 + g}{NP}$$

D_1 = (100 x 20% x **2**) = 40

NP = (450 x **98%**) = 441

g = 12%

Cost of GDR = 40/441 + 12%

= **21.07%**

Illustration 1

Companies X and Y want to raise US$ 50 million each. They have been offered the following rates per annum:

Company	Fixed	Floating
X	7.5	LIBOR + 25 bps
Y	8.45	LIBOR + 37 bps

Bank B, on a commission of 0.2% (fully borne by Y) is arranging an interest rate swap between X and Y. X wants a floating rate and Y wants a fixed rate. Work out the payables and receivables on the swap (in %), given that the benefits (after commission) are shared between X and Y in the ratio 60 : 40. What will be the effective rate of interest payable by X and Y their respective gains (in %) due to the swap? How many dollars does each save per annum due to the swap?

Solution

Company	Fixed	Floating
X	7.5	LIBOR + 25 bps
Y	8.45	LIBOR + 37 bps.
Differential	0.95	0.12
Net difference	0.95-0.12 = 0.83	
Bank's Commission	0.20	
Balance Gain 0.83 – 0.20 = 0.63	60% x 0.63 = 0.378	40% × 0.63 = 0.252

	X	Y
Borrow	At fixed rate 7.5%	At floating rate LIBOR + 0.37%
Pay bank	(7.5%)	(LIBOR+ 0.37%)
Collect differential from Y 7.5% - (LIBOR+ 0.25%)	+ 7.25 % - LIBOR	(7.25-LIBOR)
Pay Bank's Commission		(0.2)
Receive gain from Y	+0.378	(0.378)
Net interest = Effective rate of interest	- 0.25-LIBOR + 0.378 = (LIBOR -0.128)	(7.25+0.37+0.2+0.378) = 8.198
Original Interest	LIBOR+ 0.25	8.45
Gain p.a. due to the swap	0.378	0.252
Gain in dollars p.a.	0.378% x 50 m = $ 1,89,000	0.252 x 50 m = $1,26,000

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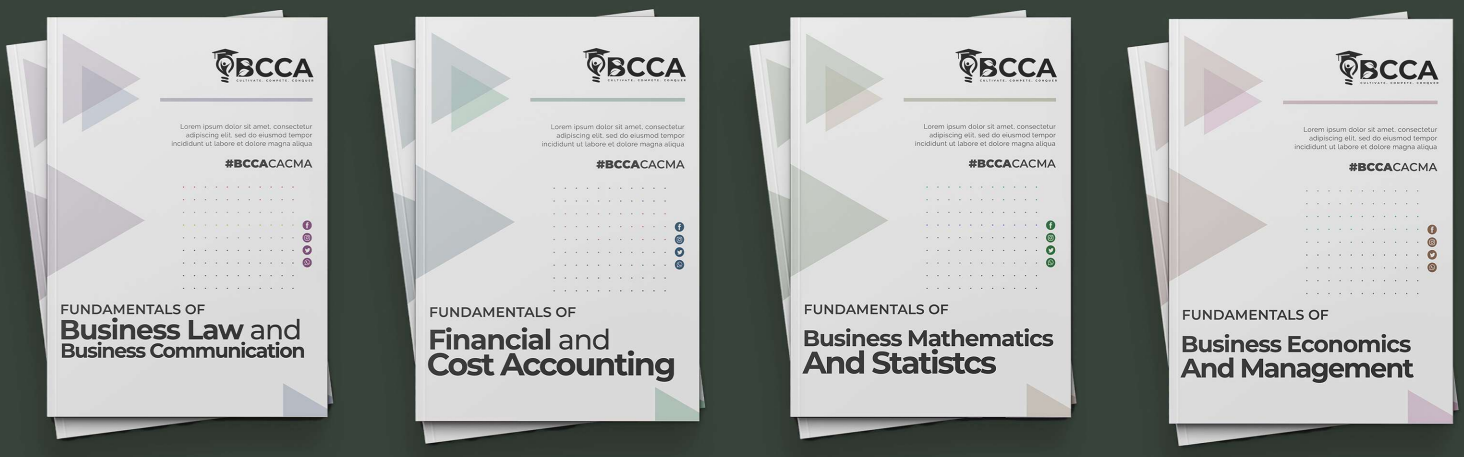

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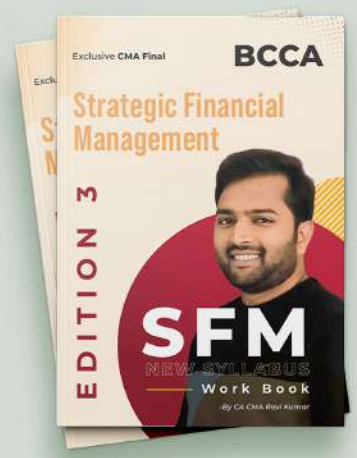

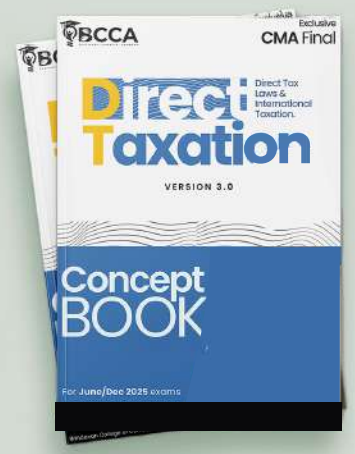

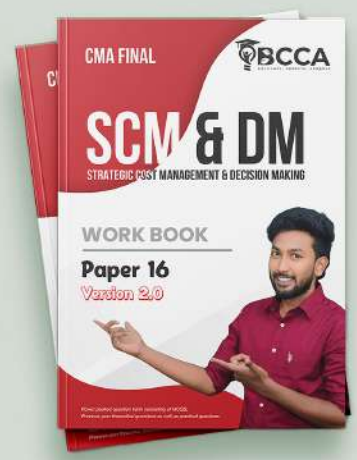

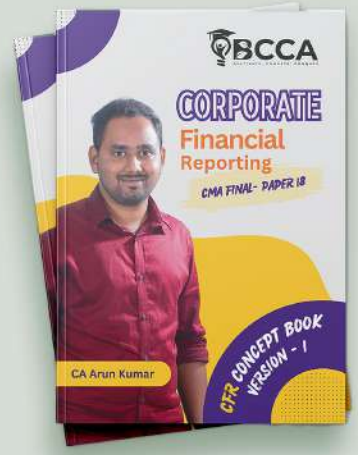

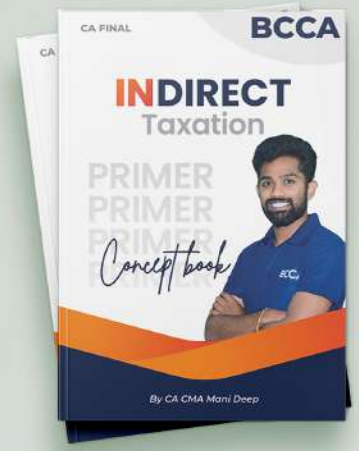

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