Derivatives

II Lower Boundary of a Put [LBP]

$$P_0 \geq PV\ of\ K - S_0$$

Eg:

$S_0 = 500$

$K = 600$

$r = 10\%$

$n = 1\ year$

Cal. of LBP

$$P_0 \geq PV\ of\ K - S_0$$

$$\geq \frac{600}{(1.1)^1} - 500$$

$$\geq 545.45 - 500$$

$$P_0 \geq 45.45$$

Case 1 : If Actual $P_0 < 45.45$
Let's say $P_0 = 30$

This gives rise to an Arbitrage Opportunity.

$\because$ P_0 is underpriced, Strategy for Arbitrage:

BUY Put

&

Buy Share

Cal. of Net ₹ Outflow today:

Step 1:	Buy Put	(30)
Step 2:	Buy Share	(500)
	Net ₹ Outflow	(530)

Step 3: Borrow ₹530 today @10% for 1 year.

$$mv = 530\ (1.1)^1$$
$$= 583$$

Cal. of CF on DD:

Particulars	$S_1 > K$	$S_1 < K$
	Put : OTM	Put : ITM
	$S_1 = 900$	$S_1 = 300$
Step 4: Pay mv of Borrowing	(583)	(583)
Step 5: Sell share @ S_1	900	300
Step 6: GP on Put	0	300
	[–]	[$K - S_1$]
Arbitrage Gain	317	17

This Strategy will provide Gain [Min. 17 or Higher], irrespective of S_1 ; ∴, Arbitrage !

Due to this arbitrage opportunity, Demand for 'Buy Put & Buy Share' strategy will increase. Due to this, demand for Put will increase thereby pushing P_0 above ₹ 30. Once it touches ₹ 45.45, Arbitrage opp. ceases to exist. This is why, P_0 cant hang around below 45.45. ∴, ₹ 45.45 is LBP.

<u>Case 2</u> : If Actual $P_0 > 45.45$
Let's say $P_0 = 60$

This gives rise to an 'Arbitrage Opportunity'.

∵ P_0 is over priced, Strategy for Arbitrage :

SELL Put

&

SELL Share

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Cal. of Net ₹ Inflow today :

Step 1 :	Sell Put	60
Step 2 :	Sell Share	500
	Net ₹ Inflow	560

Step 3 : Invest ₹ 560 today @ 10% for 1 year.

$MV = 560\,(1.1)^1$
$= 616$

Cal. of CF on DD :

Particulars	$S_1 > K$ Put : OTM $S_1 = 900$	$S_1 < K$ Put : ITM $S_1 = 300$
Step 4 : Realise MP of Investment	616	616
Step 5 : Buy share @ S_1	(900)	(300)
Step 6 : GP on Put	0	(300)
	[–]	[$S_1 - K$]
~~Arbitrage~~ Gain	(284)	16

∴, this strategy gives Gain only if $S_1 < K$.
∴, Such Strategy can't be called as Arbitrage.

Alternate understanding

Consider foll. 2 Portfolios:

P(C) = 1 Put + 1 share

P(D) = Cash Equivalent to PV of K

Cal. of V(P) on DD:

Particulars	$S_1 > K$ [Put : OTM]	$S_1 < K$ [Put : ITM]
P(C)	$0 + S_1 = S_1$	$[K - S_1] + S_1 = K$
P(D)	K	K

If $S_1 > K$, P(C) > P(D)

If $S_1 < K$, P(C) = P(D)

$\therefore$, Irrespective of S_1,

$$P(C) \geq P(D)$$

$$P_0 + S_0 \geq PV\ of\ K$$

$$\therefore, P_0 \geq PV\ of\ K - S_0$$

Q.41) (i) Cal. of Th. Min. Price of a Put [LBP]

$$P_0 \geq PV \text{ of } K - S_0$$

$$\geq \frac{400}{1.025} - 370$$

$$\geq 390.24 - 370$$

$$P_0 \geq 20.24$$

(ii) If $P_0 = 10$

$\because P_0$ is underpriced, Strategy for Arbitrage:

Buy Put
&
Buy Share

Cal. of Net ₹ Outflow today:

Step1:	Buy Put	(10)
Step2:	Buy Share	(370)
	Net ₹ Outflow	(380)

Step3: Borrow ₹ 380 today @ 5% p.a. for 6m

$MV = 380(1.025)$

$= 389.5$

Cal. of CF on DD:

Particulars	$S_1 > K$	$S_1 < K$
	Put : OTM	Put : ITM
let's say	$S_1 = 500$	$S_1 = 300$
Step4: Repay MV of Borr.	(389.5)	(389.5)
Step5: Sell Share @ S_1	500	300
Step6: GP on Put	0	400−300 i.e. 100
Arbitrage Gain	110.5	10.5

III **PCPT Equation**

	If $S_1 > K$	If $S_1 < K$
P(A)	S_1	K
P(B)	S_1	S_1
P(C)	S_1	K
P(D)	K	K

P(A) = P(C), irrespective of S_1.

$$C_0 + PV \text{ of } K = P_0 + S_0$$

↓

PCPT Equation

Q.35> (iii) **Cal. of P_0 using PCPT Equation**

$S_0 = 380$
PV of K = 395.03
$C_0 = 10.52$

$$C_0 + PV \text{ of } K = P_0 + S_0$$

$$10.52 + 395.03 = P_0 + 380$$

$\therefore P_0 = 25.55$

(IV) Arbitrage under PCPT

This opportunity arises if

$$C_0 + PV\ of\ K \neq P_0 + S_0$$

Q.277 LHS : $C_0 + PV\ of\ K$

$$= 20 + \frac{110}{(1.1)^1}$$

$$= 20 + 100$$

$$= 120$$

RHS : $P_0 + S_0$

$$= 21 + 90$$

$$= 111$$

$$LHS > RHS$$

$$C_0 + PV\ of\ K > P_0 + S_0$$

For strategy, Isolate PV of K

$$PV\ of\ K > \underbrace{P_0 + S_0 - C_0}_{\text{Under Priced ; Buy}}$$

Strategy for Arbitrage :

Buy Put
Buy Share
Sell Call

Step1:	Buy Put	(21)
Step2:	Buy Share	(90)
Step3:	Sell Call	20
	Net ₹ outflow	(91)

Step4: Borrow 91 today @ 10% for 1 year

$MV = 91(1.1)^1$

$= 100.1$

Cal. of CF on DD:

Particulars	If $S_1 > K$ Call : ITM Put : OTM	If $S_1 < K$ Call : OTM Put : ITM
Let's say	$S_1 = 150$	$S_1 = 50$
Step5: Repay MV of Borrowing	(100.1)	(100.1)
Step6: Sell Share @ S_1	150	50
Step7: G/P on Call	(40) [110 − 150]	—
Step8: G/P on Put	—	60 [110 − 50]
AG	9.9	9.9

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Q.287 LHS : $C_0 + PV \text{ of } K$

$= 12 + \frac{110}{(1.1)^1}$

$= 12 + 100$

$= 112$

RHS : $P_0 + S_0$

$= 30 + 90$

$= 120$

$LHS < RHS$

$C_0 + PV \text{ of } K < P_0 + S_0$

For strategy, Isolate PV of K

$PV \text{ of } K < \underbrace{P_0 + S_0 - C_0}_{\text{Over Priced ; Sell}}$

Strategy for Arbitrage :

Sell Put
Sell Share
Buy Call

Step1:	Sell Put	30
Step2:	Sell Share	90
Step3:	Buy Call	(12)
	Net ₹ Inflow	108

Step4: Invest 108 today @ 10% for 1 year

$MV = 108 (1.1)^1$

$= 118.8$

Cal. of CF on DD:

Particulars	If $S_1 > K$ Call : ITM Put : OTM	If $S_1 < K$ Call : OTM Put : ITM
Let's say	$S_1 = 150$	$S_1 = 50$
Step5: Realise MP of Investment	118.8	118.8
Step6: Buy Share @ S_1	(150)	(50)
Step7: G/P on Call	40 [150 − 110]	—
Step8: G/P on Put	—	(60) [50 − 110]
AG	8.8	8.8

M6 : Misc. Qstns

Q.37> [HW]
(i) Calculate C_0 using BSM [with Div. yield].
(ii) Calculate P_0 using PCPT Equation.

Q.19>

Particulars	1	2	3	4	5
S_0	50	50	50	50	50
K	45	48	50	52	55
Intrinsic Value of Call [a]	5	2	0	0	0
Actual Value [b]	9	6	4	3	2
Time Value of Call [b-a]	4	4	4	3	2

Q.20>

Particulars	1	2	3	4	5
S_0	50	50	50	50	50
K	45	48	50	52	55
Intrinsic Value of Put [a]	0	0	0	2	5
Actual Value [b]	1	2	3	5	7
Time Value of Put [b-a]	1	2	3	3	2