Chapter XII

MANAGEMENT OF INTEREST RATE EXPOSURE

PROBLEMS

Problem 1

A Corporate wants to borrow $4 million for 3 months, 9 months from now. The treasurer wants to lock in his borrowing costs. A bank offers a Forward Rate Agreement to cover the borrowing at 10.9%. If the treasurer accepts this offer and 9 months later, the interest rates turn out to be 11.00/11.25, explain how the company would have gained.

Solution

If the Corporate has to borrow from the market after 6 months, it will have to pay an interest rate of 11.25%. As per the forward rate agreement, the bank has to compensate its client to the extent of 11.25-10.9=0.35%. However, since the compensation is paid upfront, it will be discounted at 11.25% to arrive at the present value.

$$\text{So, compensation payable} = \frac{(0.35)\ (3/12)\ (4{,}000{,}000)}{(100)\ (1+0.1125 \times 3/12)}$$

Thus, the company will now borrow ($4,000,000 - $3404) at 11.25%

So, interest payable = (3,996,5960 (0.1125/4)
= $112,404

However, the effective interest outflow will be reduced by $3404

Net interest outflow = 112,404 - 3,404 = 109,000
Effective rate of interest

$$= (109{,}000)\ (4{,}000{,}000) \times \frac{12}{3} \times 100 = 10.9\%$$

Thus, the corporate has been able to lock itself into a borrowing interest rate of 10.90%.

Problem 2

In problem 1, if interest rates after 9 months, turn out to be 10.50/10.75, work out the implications.

Solution

In this case, the company has to compensate the bank to the extent of 1.90 - 10.75 = 0.15%

Upfront compensation payable

$$= \frac{(0.15 / 100) \times (3/12) \times (4{,}000{,}000)}{(1 + 0.1075 / 4)}$$

$$= \$1461$$

So, the company has to borrow 4,000,000+1461 = 4,001,461

Interest payable for three months = (4,001,461) (0.1075/4) = 107,539

If the additional repayment of 1461 is considered, the total outflow is 109,000.

Effective rate of interest locked in

$$= \frac{(109{,}000)}{4{,}000{,}000} \times (12/3) \times 100$$

$$= 10.9\%$$

In this case, also, the corporate has locked itself into an interest rate of 10.9%.

Problem 3

In Problem 1 above, suppose the corporate wants to invest $4 million instead of borrowing. Assume the Forward Rate Agreement is struck at 11% and the interest rates after 6 months turn out to be 10.60 / 10.90. Explain how the company gains.

Solution

The company will receive a compensation of 11-10.60 = 0.40%

So, compensation payable $= \frac{(0.40 / 100) (3/12) (4{,}000{,}000)}{(1 + 0.1060 / 4)}$

$$= \$3,897$$

The company can invest (4,000,000 + 3,897) = 4,003,897 at 10.6%

Interest received = (4,003,897) (0.1060 / 4) = $106,103

Additional sum available = $3,897

So effective interest inflow = 106,103 + 3,897 = $110,000

Hence, effective rate of interest = $\frac{110,000}{4,000,000} \times (12/3) \times 100$

= 11%.

Problem 4

In problem 3, if the rate of interest after 6 months turns out to be 11.25/11.50, work out the implications arising out of the Forward Rate Agreement.

Solution

In this case, the company has to pay compensation of 11.25 - 11 = 0.25% to the bank.

Upfront compensation payable

$$= \frac{(0.25 / 100)\ (3/12)\ (4,000,000)}{(1 + 0.1125 / 4)}$$

= $2432

So, surplus available for investment = 4,000,000 - 2432

= $3,997,568

Interest earned on investment = (3,997,568) (0.1125) /41

= $112,432

From this we have to subtract $2432 being the reduction in principal to arrive at the net interest inflow.

Net interest inflow = 112,432 - 2,432 = $110,000

So, effective rate of

interest = [(110,000) / (4,000,000)] x (12/3) x 100

= 11%

Problem 5

A company based in Zurich expects to receive SF2,000,000 three months from now. It wants to invest this amount for three months and needs protection against a fall in interest rates. A 3/6 Forward Rate Agreement is quoting 1.50/2.00%. Using this FRA, calculate the effective rate of interest earned on the investment if after three months, the interest rates turn out to be :

a) 1.00 / 1.25%
b) 2.25 / 2.50%

Solution

If interest rates turn out to be 1.00 / 1.25%, the company will receive upfront compensation.

Upfront compensation received

$$= \frac{(2{,}000{,}000)\,(0.0150-0.0100) / 4}{(1 + 0.01 / 4)}$$

$$= \text{SF } 2494.$$

Total amount available for investment = SF 2,002,494

Returns after three months = (2,002,494) (1+0.01 / 4)

$$= \text{SF } 2{,}007{,}500$$

$$\text{Effective rate of interest} = \frac{(7500)}{(2{,}000{,}000)}\,(12/3)\,(100)$$

$$= 1.5\%$$

If interest rates after three months are 2.25/2.50%

Compensation is payable by the company.

Amount of compensation payable

$$= \frac{(2{,}000{,}000)\,(0.0225 - 0.0150) / 4}{(1 + 0.0225 / 4)}$$

$$= \text{SF } 3729.$$

Amount available for investment = 2,000,000 - 3729

$$= \text{SF } 1{,}996{,}271.$$

Interest earned = (1,996,271) (0.0225) / 4 = 11,229

Effective interest earned = 11,229 - 3729 = 7500

$$\text{Effective rate of interest locked in} = \frac{7500}{2{,}000{,}000}\,(12/3)\,(100)$$

=

1.5%

Thus, by entering into a Forward Rate Agreement, the corporate is able to lock into an interest rate of 1.5%.

INTEREST RATE OPTIONS

A Forward Rate Agreement locks an investor into a particular pre agreed rate of interest. On the other hand, an interest rate option gives us much greater flexibility while managing interest rate exposure.

A call option on interest rate gives the option buyer the right to borrow funds on a definite future date for a specified period of time at a specified rate of interest. A put option on the other hand gives the option buyer the right to invest funds.

As the name option suggests, there is a right but no obligation. In return for this facility, the option buyer pays the seller an upfront premium.

Unlike a forward rate agreement, the option buyer does not have to pay any compensation to the option seller even if the interest rate moves in his or her favour.

When a borrower wants to avail of a loan which involves a series of interest payments based on the prevailing market rates on reset dates, a cap can be purchased. A cap is nothing but a series of call options on interest rates to ensure that the maximum interest outflow is predefined with certainty for each period.

In the case of an investor, the corresponding instrument is the collar which is essentially a series of put options on interest rates to ensure that the minimum interest inflow is predefined with certainty for each period.

Whenever the rates move against the option buyer and the buyer finds it profitable to exercise the option, compensation is paid by the seller to the buyer. This compensation is however paid at the end of the tenure of the loan and not upfront as in the case of FRAs.

Combining a cap and floor results in an instrument called collar.

Problem 1

An European call option on 3 month LIBOR is available with the following specifications.

Time to expiry	:	3 months
Strike rate	:	8%
Face value of loan	:	$1 million
Premium	:	$50,000

What are the implications for the option buyer if the 3 month LIBOR after 3 months turns out to be :-

(a) 9% (b) 7%

Assume that the interest rate at the time of purchase of the option is 8%.

Solution

a. If the interest rate turns out to be 9%, compensation is receivable by the option buyer. The cash flows at the time of maturity of the loan are tabulated below. We assume that the interest is paid at the end of the tenure of the loan.

Premium : (50,000) (1 + 0.08 / 4) (1 + 0.09/4) = 52148
Interest : (1,000,000) (0.09/4) = 22500
Compensation : (1,000,000) (0.09 - 0.08) /4 = 52148
The net cash outflow = $ 72,148

If option had not been purchased, the cash outflow at the time of maturity of the loan could have been
(1,000,000) (0.09 / 4) = $ 22,500

b. If the interest rate turns out to be 7%, the option would not be exercised. The relevant cash flows at the time of maturity of the loan are as follows.

Premium	: (50,000)(1 + 0.08/4) (1 = 0.07/4)	= 51,893
Interest	: (1,000,000) (0.07/4)	= 17,500

		=$69,393

The total outflow is $ 69,393

Problem 2

In the earlier problem, for part (a) work out the premium such that the borrower is indifferent between not buying an option and buying an option and exercising it.

Solution

Let the premium be p.
Actual interest rate = 9%
Premium paid = (p) (1 + 0.08/4) (1 + 0.09/4) = 1.043 p
Interest paid = (1,000,000) (0.09/4) = 22,500
Compensation received = (1,000,000) (0.09-0.08)/4 = 2500

The necessary strike rate can be calculated by equating the total outflows in the two cases.

i.e., $1.043p + 22500 - 2500 = (1{,}000{,}000)\,(0.09) / 4$
or $p = \$\ 2397.$

Problem 3

An European put option on 3 month LIBOR has the following specifications.

Time to expiry	:	3 months
Strike rate	:	8%
Face Value	:	$1 million
Premium	:	$20,000

Currently, the 3 month LIBOR rate is 8%. What are the implications if the interest rates after 3 months turn out to be : (a) 7% (b) 9%

Solution

(a) If interest rate turns out to be 7%, the option will be exercised. The relevant cash flows at the time of maturity of the loan are tabulated below :

Option premium	: $(20{,}000)\,(1 + 0.08/4)\,(1 + 0.07/4)$	$= 20{,}757$
Interest inflow	: $(1{,}000{,}000)\,(0.07 / 4)$	$= 17{,}500$
Compensation	: $(1{,}000{,}000)\,(0.08 - 0.07) / 4$	$= 2{,}500$

Net cash inflow $= 17{,}500 + 2{,}500 - 20{,}757 = -757$

(b) If interest rate turns out to be 9%, the option expires without being exercised. The relevant cash flows at the time of maturity of the loan are as follows.

Option premium	: $(20{,}000)\ (1+ 0.08/4)\ (1 + 0.09/4)$	$= 20{,}859$
Interest inflow	: $(1{,}000{,}000)\ (0.09/4)$	$= 22{,}500$
Net inflow	: $22{,}500 - 20{,}757$	$= 1{,}641$

Problem 4

In problem 3(a) work out the strike rate which will make the lender indifferent between not buying the option and buying the option and exercising it.

Solution

If the option is not purchased, interest inflow at the time of maturity of the loan $= (1{,}000{,}000)\,(0.07/4) = 17{,}500$

If the option is purchased and exercised, the following are the cash flows assuming that the strike rate is R.

Option premium : (20,000) (1 + 0.08/4) (1 + 0.07/4) = 20,757
Interest inflow : (1,000,000) (0.07/4) =17,500
Compensation : (1,000,000) (R - 0.07) / 4 = (250,000) (R - 0.07)

To calculate R, we equate the net cash inflows in the two cases.

i.e., 17,500 + (250,000) (R - 0.07) - 20,757 = 17,500
or R = 15.3%

Problem 5

The following interest rate options are presently being traded.

a. European call
   Time to expiry : 3 months
   Strike rate : 8%
   Face Value : $1 million
   Premium : $10,000

b. European put Identical specifications as in the case of the call option given above.

Suppose the current 3 months LIBOR is 8% and you buy both the options. What would be the implication if the interest rate after 3 months turns out to be (i) 7% , (ii) 9%.

Solution

If interest rate turns out to be 7%, only put option will be exercised. At the time of maturity of the options, following are the relevant cash flows involved.

Premium = (20,000) (1 + 0.08/4) (1 + 0.07/4) = 20,757
Compensation = (1,000,000) (0.08 - 0.07) / 4 = 2,500
Net Cash flow = - 20,757 + 2,500 = -18,257

If interest rate turns out to be 9%, only call option will be exercised. At the time of maturity of the options, following are the relevant cash flows.

Premium = (20,000) (1 + 0.08/4) (1 + 0.09/4) = 20,859
Compensation = [(1,000,000) (0.09 - 0.08)]/4 = 2,500
Net cash flow = - 20,859 + 2,500 = -18,359

Problem 6

A Corporation has to pay interest at the rate of LIBOR + 1% on a $100 million loan. Interest is payable every six months, starting six months from now. To protect itself from fluctuation in LIBOR, it decides to buy a cap with LIBOR as reference rate and strike rate of 9%. The cap provider charges a fee of $2 million. If interest rates move as follows, calculate the effective cost of funding. Assume that the entire principal is to be repaid on maturity.

Repayment date	LIBOR (%)
01.07.96	9.5
01.01.97	9.0
01.07.97	9.0
01.01.98	8.5
01.07.98	8.0
01.01.99	8.0

Solution

On each repayment date we check whether prevailing LIBOR exceeds 9%. If so the interest rate applicable will be 9 + 1 = 10% as the corporation will receive compensation from the cap provider. If on the other hand LIBOR<9%, the effective rate of interest will be LIBOR + 1%. The applicable rate of interest is divided by two since interest payments are made on half yearly basis.

At time, t=0, the net inflow will be the value of the loan less the fee payable. This works out to $100,000,000 - $2,000,000 = 98,000,000.

Interest outflows on each repayment date are tabulated below.

Repayment date	Effective semi-annual Interest rate	Interest outflow ($)
01.07.97	(0.09+0.01) / 2=0.05	5,000,000
01.01.97	(0.09+0.01) / 2=0.05	5,000,000
01.07.97	(0.09+0.01) / 2=0.05	5,000,000
01.01.98	(0.085+0.01) / 2=0.0475	4,750,000
01.07.98	(0.08+0.01) / 2=0.045	4,500,000
01.01.99	(0.08+0.01) / 2=0.045	4,500,000

Equating the value of inflows with the present value of outflows using a discount rate, r we get :-

$$98{,}000{,}000 = \frac{5{,}000{,}000}{(1+r/2)} + \frac{5{,}000{,}000}{(1+r/2)^2} + \frac{5{,}000{,}000}{(1+r/2)^3} + \frac{4{,}750{,}000}{(1+r/2)^4}$$

$$+ \frac{4{,}500{,}000}{(1+r/2)^5} + \frac{4{,}500{,}000}{(1+r/2)^6} + \frac{100{,}000{,}000}{(1+r/2)^6}$$

By trial and error, we get r = 0.104 = 10.4%

Hence, the effective cost of funds is 10.4%

In this case, since the LIBOR moved favourably, the Cap did not prove to be very beneficial. Had the LIBOR moved further upwards, the corporation would have gained more from the Cap.