Financial Derivatives and Risk Management
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Lecture 58
Currency Swaps; Value at Risk

Designing an interest rate swap

The procedure of designing a swap is best illustrated by an example. Consider the following data:

Companies A and B have been offered the following rates per annum on a USD 20 million 5-year loan:

	Fixed rate	Floating rate
Company A:	5.0%	LIBOR + 0.1%
Company B:	6.4%	LIBOR + 0.6%

Company A requires a floating-rate loan; Company B requires a fixed-rate loan. Design a swap that will net a bank, acting as intermediary, 0.1% per annum and that will appear equally attractive to both companies.

Solution

From the above data, we infer the following:

Requirement:	A: Floating Rate;	B: Fixed Rate	
Cost if sourced according to requirement:	A: L+0.1%	B: 6.4%	Total: L+6.5%
Cost if sourcing is swapped:	A: 5%	B:L+0.6%	Total: L+5.6%
Savings if the sourcing is swapped:			0.9%
Commission to intermediary:			0.1%
Net saving:			0.8%
Saving	A: 0.4%	B: 0.4%	
Net cost: Original Cost -Savings:	L+0.1-0.4=L-0.3%	B=6.4-0.4=6%	

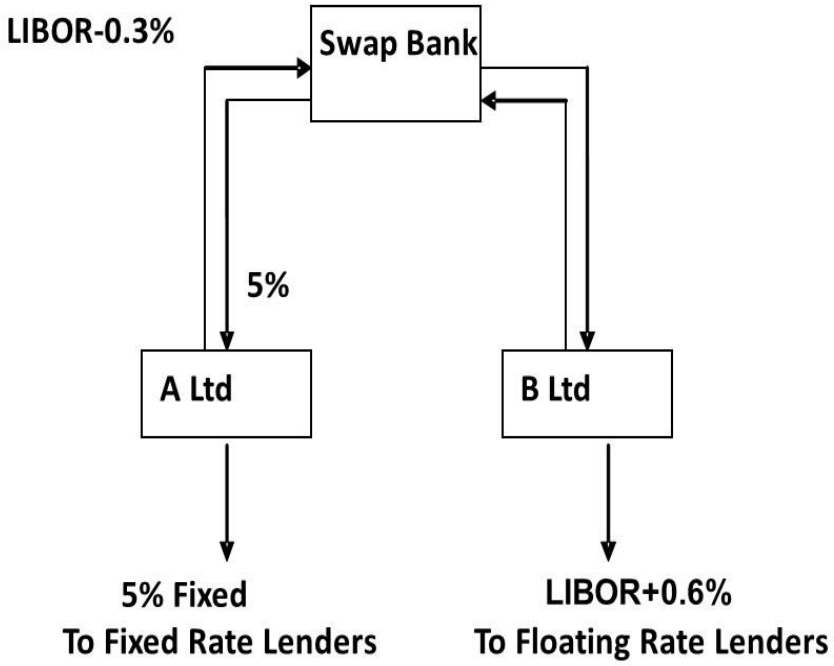
These are the basic parameters of the swap. Within this we can have different combinations. The example that I have taken is

A:	Requirement:			Floating Rate
		Fixed	Floating	
	Borrows & pays to lenders:	(5.00%)		
	Receives from swap bank:	5.00%		
	Pays to swap bank:		(L-0.30%)	
	Net flow:		(L-0.30%)	

B:	Requirement:			Fixed Rate
		Fixed	Floating	
	Borrows & pays to lenders:		(L+0.6%)	
	Receives from swap bank:		L-0.30%	
	Pays to swap bank:	(5.10%)		
Net flow:		(5.10%)	(0.90%)	(6.00%)

Swap bank

	Fixed	Floating
Receives from A:		L-0.30%
Receives from B:	5.10%	
Pays to A:	(5.00%)	
Pays to B:		(L-0.30%)
Net flow:	0.10%	



A borrows 5% fixed. Against this he receives 5.00% from the swap bank. So this stream is neutralized. But his cost of funds is L-0.3%, so he pays L-0.3% to the swap bank (intermediary).

The swap bank transfers this stream of L-0.3% to B without any cut.

Now, let us look at B's position:

B borrows at L+0.6%. He receives L-0.3% from swap bank. So he has to add 0.9% to this stream and pass it on to the lenders. It also pays 5.1%* to the swap bank. His net cost is 5.1%+0.9%=6%

Now, the swap bank.

Receives L-0.3% from A, it pays off this L-0.3% to B. It pays 5% to A and also needs a cut of 0.1%. He recovers 5.1%* from B.

Reconciliation

Differential in fixed rates:	1.4%
Differential in floating rates:	0.5%
Savings by swap:	0.9%
FI Commission:	0.1%
Hence, saving for each party	0.4%

Swap: A borrows fixed at 5%, A receives 5% from FI and pays LIBOR-0.3% to FI.
B borrows at LIBOR +0.6%, B receives LIBOR -0.3% from FI and pays 5.1% to FI, FI pays 5% to A.

It is strongly emphasized that swap that meets the given requirements is not unique. Many, in fact countless swaps can designed meeting the prescribed mandates in the problem.

Currency swaps

Now we move on to we move on to currency swaps. There can be situations in which the entities may prefer exchanging streams of currencies in order to suit their exposures. The typical example that we had discussed earlier was that of an entity having borrowings in Japanese Yen to finance some capital expenditure with its revenue earnings arising in USD. Such an entity might desire to reduce its exchange risk arising from the incompatibility of its debt servicing currency and its earnings currency. It could do so through a currency swap.

Now, a currency swap could will take the form of a fixed to fixed currency swap where the interest rates are fixed over the tenure of the swap and only the currencies for the payment of interest (albeit at fixed rates) and/or principal are exchanged or a combination of interest rate swap and currency swaps in which interest streams involve a fixed rate to floating rate swapping in addition to the currency swapping. There could also be situations where the principal is exchanged at the end of this swap or the principal is purely notional and no exchange of the principal is envisaged. So these are few variants of currency swaps. However, whatever be the case, it would be embedded/ incorporated in the substratum of the swap contract.

Example of currency swap

Consider the following data:

		A Ltd	B Ltd
Requirement:		USD 15m Loan	AUD 20m Loan
Amount		15 m	20 m
Cost:	USD	7%	5%
	AUD	8%	7.6%
Exchange rate:		0.75 USD = 1.00 AUD	
Commission of swap bank		0.1%	0.1%

Requirement:	A: USD (15m)	B: AUD (20m)
Cost if sourced according to requirement:	A: 7.00%	B: 7.6%
Cost if sourcing is swapped:	B: 5.00%	A: 8.00%
Savings if the sourcing is swapped:	2.00%	-0.40%
Commission to intermediary:	0.1%	0.1%
Net saving:	1.90%	-0.50%

These are the basic parameters of the swap.

We have got two entities A and B. The requirement of A is USD, that of B is AUD. The amount required by A is USD 15 million, that by B is AUD 20 million which are equivalent at the current exchange rate of USD 0.75=AUD 1.00.

The USD interest rates for A are 7.00% B are 5.00% respectively while the AUD rates are 8.00% and 7.60%. Thus, the differential in the USD market is 2.00% and in the AUD market it is -0.40%.

The following observations are in order:

(i) AUD rates are higher than USD interest rates;
(II) B Ltd has an absolute advantage over A Ltd in both markets, probably due to his higher creditworthiness. B Ltd obtains more favorable rates for both currencies viz USD & AUD.
(iii) The spreads in the USD markets (2.00%) are much higher than those in the AUD markets (0.40%). Thus, B Ltd has a comparative advantage in the USD market, whereas A Ltd has a comparative advantage in the AUD market.

In view of (iii), it is apparent that both A & B can undertake a cost reduction by a currency swap i.e. by A borrowing in the AUD market at 8.00% and B borrowing in the USD markets at 5.00%.

A:	Requirement:			USD (15m)
		USD	AUD	
	Borrows & pays to lenders:		(8.00%)	
	Receives from swap bank:		8.00%	
	Pays to swap bank:	(6.30%)		
	Net flow:	(6.30%)		

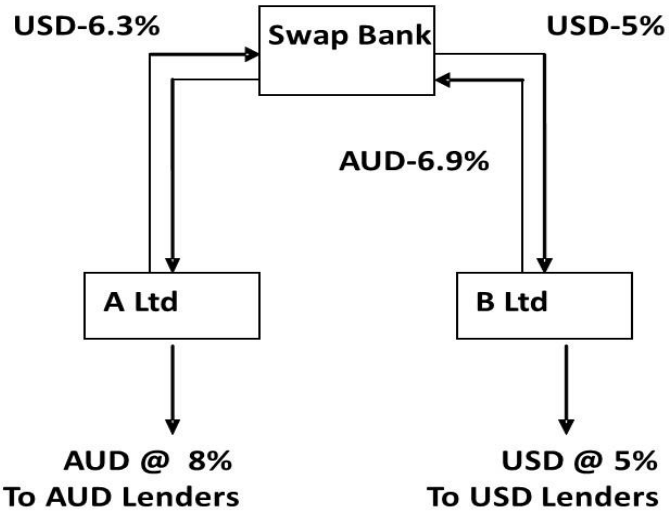
B:	Requirement:			AUD (20m)
		USD	AUD	
	Borrows & pays to lenders:	(5.00%)		
	Receives from swap bank:	5.00%		
	Pays to swap bank:		(6.90%)	
Net flow:			(6.90%)	

Swap bank

	USD	AUD
Receives from A:	6.30%	
Receives from B:		6.90%

Pays to A:		(8.00%)
Pays to B:	(5.00%)	
Net flow:	1.30%	(1.10%)

We can design the swap innumerous ways. However, the one presented above has the distinct advantage that it makes both A & B free from exchange risk. The entire exchange risk is shifted to the intermediary swap bank that has unbalanced outflow in AUD and inflow in USD.



In this swap, B borrows USD @ 5.00% and A borrows AUD @ 8.00%. After undertaking the swap on the lines above, A ends up with a net cost of 6.30% on USD loan which is 0.70% less than what it would have paid without swapping (7.00% USD) while B ends up with 6.90% on the AUD loan which is again 0.70% better than the unswapped situation (7.60% AUD). The intermediary gets an inflow of 1.30% in USD against an outflow of 1.10% AUD. Thus, the swap bank gets an inflow of 1.30% p.a. on its USD cash flows and outflow of 1.10% p.a. on its AUD flows under the swap. Of course, the bank can cover its exposure through forward markets by buying AUDs forward against USD or vice versa. Its exposure each year would be an inflow of USD 195,000 (1.30% of 15 million) and an outflow of AUD 220,000 (1.10% of 20 million). Thus, it could cover this imbalance by buying AUD 220,000 each year forward over the tenure of the swap or selling USD 195,000.

Valuation of currency swaps

As in the case of IRS, we can do this valuation exercise in two ways viz (i) assume that the swap is equivalent to an exchange of bonds in the two currencies; or (ii) assume that the forward exchange rates implied by the interest rates of the two currencies are actually realized. We illustrate both the approaches by the following example:

Example

Suppose that the term structure of LIBOR/swap interest rates is flat in both Japan and the United States. The Japanese interest rate is 4% per annum and the US rate is 9% per annum (both with

continuous compounding). Some time ago a financial institution has entered into a currency swap in which it receives 5% per annum in JPY and pays 8% per annum in USD once a year (annual compounding). The principals in the two currencies are USD 10 million and JPY 1,200 million, which will also be exchanged at the end of the swap. The swap will last for another 3 years, and the current exchange rate is 110 JPY = 1 USD.

Solution

Method 1: Assuming an exchange of bonds in the two currencies

Since the FI receives the JPY stream (5%) and pays the USD stream (8%), the value of the swap from its perspective is $V_{swap}=V_{JPY}-V_{USD}$

Now, for valuing the JPY bond, we have:

Principal Amount:	JPY 1,200 million
Coupon Rate:	5% annual compd
Tenure:	3 years
Current rate:	4% cc

Thus, $V_{JPY} = 1200\times 0.05e^{-0.04\times 1} + 1200\times 0.05e^{-0.04\times 2} + 1200\times 1.05e^{-0.04\times 3}$

$= 57.6474 + 55.3870 + 1117.5198 = 1230.5542$ million JPY = USD 11.1869 million.

Similarly, for the USD bond, we have

Principal Amount:	USD 10 million
Coupon Rate:	8% annual compd
Tenure:	3 years
Current rate:	9% cc

Thus, $V_{USD} = 10\times 0.08e^{-0.09\times 1} + 10\times 0.08e^{-0.09\times 2} + 10\times 1.08e^{-0.09\times 3}$

$= 0.7311 + 0.6682 + 8.2445 = 9.6438$ million USD.

$V_{swap}=V_{JPY}-V_{USD}$ = USD 11.1869-9.6438 = USD 1.5431 million.

Method 2: Using implicit forward exchange rates

Step 1: We work out the cash flows in the respective currencies at the relevant payment dates. The swap is a fixed to fixed currency swap involving receipt of 5% p.a. on JPY 1,200 against payment of 8% p.a. on USD 10 million annually for three years.

Hence, the cash flows each year (for three years) will be (from the FI's perspective) inflow of JPY 60 million vs an outflow of USD 0.80 million. Additionally, at the end of the swap's tenure i.e. at t=3 years, cash flows of JPY 1,200 million (inflow) and USD 10 million (outflow) will occur on account of principal payments.

Step 2: The next step is to calculate the forward exchange rates on the various payment dates. For this purpose, we use the interest parity theorem. We have,

$$F = S\,\mathbf{exp}\left[\left(r_h - r_f\right)T\right] \quad e.g.\ \textit{for one year forward we have}$$

$$F_1(\$/Y) = S(\$/Y)\,\mathbf{exp}\left[\left(r_\$ - r_Y\right)T\right] = \frac{1}{110}\,\mathbf{exp}\left[\left(0.09 - 0.04\right)1\right] = 0.00955701$$

$$F_2(\$/Y) = S(\$/Y)\,\mathbf{exp}\left[\left(r_\$ - r_Y\right)T\right] = \frac{1}{110}\,\mathbf{exp}\left[\left(0.09 - 0.04\right)2\right] = 0.010047008$$

$$F_3(\$/Y) = S(\$/Y)\,\mathbf{exp}\left[\left(r_\$ - r_Y\right)T\right] = \frac{1}{110}\,\mathbf{exp}\left[\left(0.09 - 0.04\right)3\right] = 0.010562129$$

Step 3: If we want to calculate the value of the swap in USD, we convert the JPY cash flows to USD cashflows at the aforesaid forward exchange rates. We then work out the net cash flows in USD. We have:

Year	USD Cash Outflow	JPY Cash Inflow	Eq USD Cash Inflow	Net USD Cashflow
1	0.80	60	0.5734	-0.2266
2	0.80	60	0.6028	-0.1972
3	10.80	1260	13.3083	2.5083

Step 4: We discount each of these differential cash flows at the relevant USD spot rates and work out the aggregate present value of these differences. This represents the value of the swap.

Year	Differential Cashflow (USD)	Discount Rate	Discount Factor	DCF
1	-0.2266	9.00% cc	0.9139	-0.2071
2	-0.1972	9.00% cc	0.8353	-0.1647
3	2.5083	9.00% cc	0.7634	1.9148
Value of the swap				1.5430

USING IMPLICIT FORWARD RATES				
CALCULATION OF IMPLICIT FORWARD RATES				
AT				
TIME	**FWD RATE**	**USD OUTFLOW**	**YEN INFLOW**	**USD EQ OF**
0	**0.009090909**			**YEN INFLOW**
1	**0.00955701**	**0.8**	**60**	**0.573420598**
2	**0.010047008**	**0.8**	**60**	**0.602820501**
3	**0.010562129**	**10.8**	**1260**	**13.30828314**
	NET USD INFLOW		**DISC FACTOR**	
0				
1	**-0.226579402**		**0.913931185**	**-0.207077981**
2	**-0.197179499**		**0.835270211**	**-0.164698162**
3	**2.508283144**		**0.763379494**	**1.914771918**
VALUE OF SWAP				**1.542995775**