CHAPTER 5

Swaps

In this chapter, we will discuss what a swap is, its related concepts, and the mechanism of interest rate swaps, cross currency swaps and other types of swaps.

What is a Swap?

When we talk about swaps, we usually talk about interest rate swaps and cross currency swaps. These are so called generic or basic swaps. In general, a generic swap is a contract in which two parties agree to exchange periodic payments within an agreed time period. Other generic swaps include contracts which involve exchanging baskets of securities or commodities. There are also non-generic swaps. They usually contain variations of generic swaps and other derivative instruments.

Why Financial Institutions Swap?

The concept of a swap is quite simple. It is no more complicated than swapping things between two parties. If I have commodity A that I do not need, you have commodity B that you do not need, and we both need the other's commodity, the best solution is to exchange (swap) these two commodities at a reasonable pre-determined price. Please see example below:

ABC Bank's asset/liability structure is liability sensitive (this is a bankers’ jargon which means that the liabilities are re-priced faster than the assets) because the duration (it means the term-to-maturity here) of its deposits is shorter than the duration of its loans. This creates a mismatch between its assets and liabilities. In order to balance this mismatch, ABC Bank can do two things: (1) extend its liability duration by offering only longer-term deposits or shorten its asset duration by making only shorter-term loans or floating rate loans; and/or (2) utilize risk management tools (derivatives) to modify its asset/liability structure.

It is not practical to actually change a bank's asset or liability duration by intentionally lending short or borrowing long. This may prove to be more costly. The practical way to extend its liability duration or shorten its asset duration is to utilize risk management tools, such as swaps to accomplish this task. We will discuss this arrangement in detail later.

XYZ Life Insurance Company's asset/liability structure is asset sensitive. It collects insurance premiums from policy holders each month for many years and pays them out when the policy expires (usually in tens of years) or when the insured is dead. This also creates a mismatch between assets and
liabilities. Its situation is just the opposite of ABC Bank. Therefore, XYZ Life Insurance Company and ABC Bank can come to an agreement to swap something in order to balance their asset/liability structures.

The History of Swaps

The idea of financial swap was created in the UK as a means of circumventing foreign-exchange controls in the 1970s, which were intended to prevent an outflow of British capital. At that time, the British Government imposed taxes on foreign-exchange transactions involving the British pounds to make outflow of capital more expensive in order to induce domestic investment. During that period, companies frequently used back-to-back loans to avoid such taxes. The mechanism of back-to-back loans is: they involved two companies domiciled in two different countries. One company agreed to borrow funds in its own country and then to lend those borrowed funds to the other company. The second company, in return, borrowed funds in its own country and then lent them to the first company. By doing so, both companies were able to access the foreign capital market without formal exchanges of currencies and thus avoided paying any foreign exchange taxes.

This simple arrangement later developed into more sophisticated cross currency swaps and interest rate swaps with banks and investment houses as middle men to bridge counterparties who needed these arrangements. (This may be a good example to prove to the free-market advocates, who often complain that there is too much regulation, that regulation could sometimes lead to the best for the market.) The first currency swap was written in London in 1979 between the World Bank and IBM, and was put together by Salomon Brothers. It allowed the World Bank to obtain Swiss Francs and Deutschemarks to finance its operations in Switzerland and West Germany without entering these two countries’ capital markets directly.

Comparative Advantage

Before we get into the mechanism of interest rate swaps, two more concepts need to be established. Companies can exchange something of which they have a comparative advantage over their counterparties. For example, XYZ Insurance Company and ABC Bank both want to borrow $100 million for five years. XYZ wants to borrow floating rate funds and ABC wants to borrow fixed rate funds. XYZ can borrow fixed rate funds at 6 percent and floating rate funds at LIBOR plus 0.5 percent in its own country. ABC can borrow fixed rate funds at 7.5 percent and floating rate funds at LIBOR plus 1.0 percent in its own country. XYZ has an absolute advantage over ABC in both fixed and floating rate markets (probably because XYZ is more credit-worthy and banks are prepared to lend to it at a lower rate or because the markets are imperfect). But the important thing is: ABC has a comparative advantage over XYZ in floating rate markets. This is because the difference between the two fixed rates is 1.5 percent and the difference between the
two floating rates is 0.5 percent. In other words, ABC pays 1.5 percent more than XYZ in fixed rate markets but only pays 0.5 percent more than XYZ in floating rate markets. When we say ABC has a comparative advantage over XYZ in floating rate markets, it does not mean that ABC pays less than XYZ in floating rate markets. What it means is that ABC pays \textit{less more} than XYZ in floating rate markets. On the other hand, XYZ has a comparative advantage over ABC in fixed rate markets because it pays \textit{more less} than ABC in fixed rate markets. What makes a swap work in this situation is that XYZ wants to borrow floating but it has a comparative advantage over ABC in fixed rate markets; and ABC wants to borrow fixed but it has a comparative advantage over XYZ in floating rate markets.

\textbf{Swap Dealers}

The second concept we need to understand is the concept of the middleman - the swap dealer. In the real world, we do not call everybody in the financial market telling them that we have a comparative advantage over them and ask them to make a swap deal. Finding the right counterparties is usually through swap dealers (or brokers). They make the finding of the right counterparties a much easier job and substantially enhance the market liquidity. These middlemen will charge market participants a fee - usually in the form of bid/ask spread. This concept is also important because without swap dealers, the swap market will not develop that fast.

\textbf{Interest Rate Swaps}

Interest rate swaps involve a counterparty paying a floating rate based on an agreed-upon index and the other counterparty paying a fixed rate for the entire term of the contract. In the earlier example, ABC Bank and XYZ Life Insurance Company could swap what they need and what they do not need in order to achieve their asset/liability management goals. We would ignore the transaction cost and the middleman and assume ABC and XYZ negotiate this contract directly. XYZ agrees to pay ABC LIBOR flat and ABC agrees to pay XYZ 6.0 percent fixed on $100 million for five years.

Does this swap benefit both parties? If yes, by how much?

All the relations of this transaction can be seen easily in the following diagram:

\begin{center}
\begin{tikzpicture}
\node (A) at (0,0) {Outside lender};
\node (B) at (2,0) {XYZ};
\node (C) at (4,0) {LIBOR};
\node (D) at (6,0) {ABC};
\node (E) at (8,0) {LIBOR +1.0\%};
\node (F) at (10,0) {Outside lender};
\draw[->,thick] (A) -- (B) node [midway, above] {6.0\%};
\draw[<-,thick] (B) -- (A) node [midway, below] {6.0\%};
\draw[->,thick] (B) -- (C) node [midway, above] {};\draw[<-,thick] (C) -- (B) node [midway, below] {};\draw[->,thick] (C) -- (D) node [midway, above] {};\draw[<-,thick] (D) -- (C) node [midway, below] {};\draw[->,thick] (D) -- (E) node [midway, above] {};\draw[<-,thick] (E) -- (D) node [midway, below] {};\draw[->,thick] (E) -- (F) node [midway, above] {};\draw[<-,thick] (F) -- (E) node [midway, below] {};
\end{tikzpicture}
\end{center}

From the above diagram, we can see that XYZ has three cash flows:

1. It pays 6.0 percent to its outside lender,
2. It pays LIBOR flat to ABC, and
3. It receives 6.0 percent from ABC.

ABC also has three cash flows:

1. It pays LIBOR plus 1.0 percent to its outside lender,
2. It pays 6.0 percent fixed to XYZ, and
3. It receives LIBOR flat from XYZ.

For XYZ Life Insurance Company, its net funding cost in this transaction is LIBOR flat, which is lower than LIBOR plus 0.5 percent at which it can borrow in its own country. It also has achieved its objective by modifying its asset/liability structure using derivatives. In this case, XYZ has shortened its liability duration by entering the swap. Instead of paying 6.0 percent fixed, XYZ now pays LIBOR flat.

For ABC Bank, its net funding cost in this transaction is 7.0 percent, which is also lower than the rate of 7.5 percent at which it can borrow in its own country. It also has achieved its objective by modifying its asset/liability structure using derivatives. In this case, ABC has extended its liability duration by entering the swap. Instead of paying LIBOR plus 1.0 percent, ABC now pays 7.0 percent fixed for 5 years. (You may assume that ABC has a $100 million fixed rate five year loan portfolio and a $100 million 7-day deposit portfolio. By entering into this swap, its interest rate risk or asset/liability maturity mismatch has largely reduced.)

Coincidentally, both ABC and XYZ reduce their funding cost by 0.5 percent.

**Cross Currency Swaps**

The main difference between interest rate swaps and cross currency swaps is that cross currency swaps usually involve exchange and re-exchange of principals whereas interest rate swaps do not. A typical cross currency swap has three sets of cash flows: the initial exchange of principals at the beginning, the exchange of interest payments during the contract period, and the re-exchange of principals at the end. The following diagrams illustrate the three sets of cash flows of a cross currency swap:
At inception

Counterparty A  💴  ￥10 billion  ➔  Counterparty B

US$100 million  ➔

On each settlement date (including maturity)

Counterparty A  💴  ￥fixed @ 6.0%  ➔  Counterparty B

US$ @ LIBOR  ➔

At maturity

Counterparty A  💴  ￥10 billion  ➔  Counterparty B

US$100 million  ➔

There are also cross currency swaps which do not involve exchange of principals.

Valuation of Swaps

As an example, please consider an interest rate swap with the following conditions:

- the notional amount is US$100 million;
- the term of the contract is five years;
- ABC pays XYZ 6 percent fixed and receives 6-month LIBOR;
- XYZ pays ABC 6-month LIBOR and receives 6 percent fixed; and
- interest payments are settled semi-annually.

We can make the above example a bit closer to our traditional banking business. If we assume exchange and re-exchange principals do exist (similar to cross currency swaps), the above example is the same as the following:

ABC lends to XYZ US$100 million at 6-month LIBOR for five years; and
XYZ lends to ABC US$100 million at a fixed rate of 6 percent for five years.

You can even consider that ABC has purchased a $100 million floating rate bond from XYZ and sold to XYZ a $100 million fixed rate bond for the same terms.

Assuming that there is no transaction cost, at the inception of a swap transaction, the market value of both sides of the transaction is zero. The reason is obvious - in a liquid and generally efficient market, nobody can take advantage of its counterparty or else the counterparty will transact the deal with someone else. Swap pricing is the process of setting the fixed rate so that the present value of cash flows of the swap is initially zero. Credit spread will then add to one side of the swap to reflect the credit quality of the counterparty.

During the life of the swap, if the yield curve (in particular, this implied forward rates) remains unchanged, the market values for both sides are always zero. However, say, after one year, the current market fixed rate for a new four year interest rate swap is 7 percent. The swap would have a negative mark-to-market (M-T-M) value to XYZ and a positive M-T-M value to ABC. This is because XYZ has a contract with ABC to receive fixed rate of 6 percent and pay LIBOR for four more years while everyone else in the market can enter into a swap contract to receive fixed rate at 7 percent and pay LIBOR for four years. But unless XYZ defaults, its contract with ABC remains legally binding for four more years.

Using the present value cash flow concept, we can calculate the loss for XYZ:

$$\sum_{t=1}^{8} \frac{3,500,000}{(1 + 0.035)^t} - \sum_{t=1}^{8} \frac{3,000,000}{(1 + 0.035)^t} = 3,436,978$$

(There are 8 settlements remaining in the contract. $3,500,000 and $3,000,000 are the semi-annual fixed interest payments at 7 percent and 6 percent respectively.)

If you have an HP 12C financial calculator, you can do the following to calculate the M-T-M loss for XYZ in the above transaction:

$100 million : FV
8 : N
3 : PMT
3.5 : i
PV = -96,563,022
Loss = $100,000,000 - $96,563,022 = $3,463,978
The loss for XYZ is the gain for ABC. You can easily see that ABC is at a position just opposite to XYZ. It has the benefit of paying 6 percent fixed for four more years while the market rate for a similar transaction is 7 percent.

In the above example, a simple approach is used to demonstrate the M-T-M calculation. Sophisticated market participants would create a new zero coupon curve to discount the cash flows at each settlement point. Nevertheless, the concept of present value cash flow is still the same.

**Credit Risk of Swaps**

The principles that govern the management of credit risk of swaps are the same as other traditional banking business. Nevertheless, the measurement of the exposure of a swap is more complicated.

The credit risk of a swap is the swap's current exposure, which is the replacement cost or the current M-T-M value, if positive, plus its future replacement cost. This is the so-called "current exposure method". The current exposure method is not just an appropriate method for measuring credit risk of swaps. It is recommended by the Basle Committee and the G-30 for measuring credit risk of all derivatives.

The current exposure is straightforward. It is just the current M-T-M value of a swap position if positive. If the M-T-M value is negative, the holder of the position does not have current credit exposure. This is because credit default occurs when a counterparty does not fulfill its financial obligation. It will not default if it has a financial instrument with a positive market value.

Conservative market participants usually assign a zero value for an instrument whose M-T-M value is negative unless there is a bilateral netting agreement.

The measurement of the future replacement cost or the "potential exposure" of a swap or a derivative instrument is quite complicated. It usually needs simulation techniques and mathematical models to derive a meaningful measurement result. The analysis generally involves modelling the volatility of the underlying variables and the effect of movements of these variables on the value of the derivatives. For interest rate swaps, the variable is interest rates.

Because it does not involve exchange and re-exchange of principals, the risk profile of a typical interest rate swap is shown in the diagram\(^1\) below:

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\(^1\) This diagram is adopted from "Derivatives: Practices and Principles" by the Group of Thirty.
(The scale on the left is the percentage of notional amount at risk.)

The expected exposure is the mean of all possible probability-weighted replacement costs. The maximum potential exposure is an estimate of the "worst case" exposure at any point in time.

The so-called "hump-back" profile is due to two offsetting effects: diffusion effect and amortisation effect. The diffusion effect says that due to the passage of time, there is an increase of probability that the value of the underlying instrument will drift substantially away from its original value. The amortisation effect is the reduction in the number of settlements as time elapses.

For an interest rate swap, its peak exposure for default is when sufficient time has passed, the counterparty finds itself at an adverse position, and there is sufficient time remaining for this adverse position to continue. This usually happens at about the intermediate point during the life of a contract. Because there is no final exchange of principals, the risk exposure drops gradually to zero at maturity after it reaches the maximum.

For cross currency swaps, the risk profile is different because the re-exchange of principals at the end increases the diffusion effect and reduces the amortisation effect:
How do you aggregate the maximum exposure of these two swaps? It is incorrect to simply add the two notional amounts together or add the two maximum exposure amounts together and say that is the maximum exposure. Why? It is easy to see it if you stagger the two above diagrams together. The maximum exposure of the interest rate swap happens at about the mid-point of the transaction while the maximum exposure of the currency swap is still increasing. The maximum exposure for the currency swap is at the end of the transaction. At that time, the exposure for the interest rate swap has reduced to zero. For a portfolio of two swaps, you can still manage to aggregate the risk manually. If there is a portfolio of hundreds or thousands of swaps, it is necessary to use simulation technique to aggregate counterparty credit risk.

The calculation of credit risk process has not finished yet. So far, we have only measured the potential current and future exposures if a counterparty defaults. But what is the probability this counterparty will default? The probability of default is generally viewed to be a function of credit ratings and of the maturity of the transaction. The lower the credit rating and the longer the maturity, the higher the probability of default. The maturity factor is straightforward and does not need any explanation. Credit analysis for swaps, however, is more a qualitative analysis than quantitative analysis, and is an art rather than a science. Again, it is no different from credit analysis for regular loans or for any other banking products.

After a reasonable probability of default factor is derived, the simplest way to estimate credit loss for a swap is to multiply the expected or maximum exposure by the specified probability of default factor. Others use more sophisticated simulation analyses.