Lecture

INSTITUTE OF ACTUARIAL & QUANTITATIVE STUDIES

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Chapter: Unit 2 Chapter 3

Chapter Name: Swaps and Derivatives Revisited

Today's Agenda

1. Interest Rate Parity
2. Currency Swaps
3. Volatility and Variance Swaps
4. LIBOR in arrears Swaps
5. CMS and CMT Swaps
6. Equity Swaps
7. Weather Derivatives
8. Insurance Derivatives

1 Interest Rate Parity

Interest rate parity (IRP) is a theory according to which the interest rate differential between two countries is equal to the differential between the forward exchange rate and the spot exchange rate.

The basic premise of interest rate parity is that hedged returns from investing in different currencies should be the same, regardless of their interest rates.
Parity is used by forex traders to find arbitrage opportunities.

The formula for IRP is:

$$F_0 = S_0 \times \frac{(1+i_c)}{(1+i_b)}$$

where:

F_0 = Forward Rate
S_0 = Spot Rate
i_c = Interest rate in country *c*
i_b = Interest rate in country *b*

2 Currency Swaps

A fixed-for-fixed currency swap involves exchanging principal and interest payments at a fixed rate in one currency for principal and interest payments at a fixed rate in another currency.

Two other popular currency swaps are:

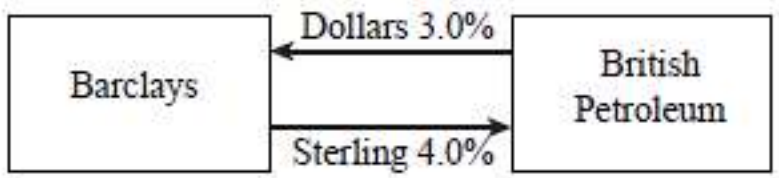
1. Fixed-for-floating where a floating interest rate in one currency is exchanged for a fixed interest rate in another currency.
2. Floating-for-floating where a floating interest rate in one currency is exchanged for a floating interest rate in another currency.

- A currency swap agreement requires the principal to be specified in each of the two currencies.
- The principal amounts in each currency are usually exchanged at the beginning and at the end of the life of the swap.
- Usually the principal amounts are chosen to be approximately equivalent using the exchange rate at the swap's initiation.
- But when they are exchanged at the end of the life of the swap, their values may be quite different.

2 Currency Swaps

Illustration

Consider a hypothetical five-year currency swap agreement between British Petroleum and Barclays entered into on February 1, 2017. We suppose that British Petroleum pays a fixed rate of interest of 3% in dollars to Barclays and receives a fixed rate of interest of 4% in British pounds (sterling) from Barclays.



3 Volatility Swaps

A volatility swap is a forward contract with a payoff based on the realized volatility of the underlying asset. They settle in cash based on the difference between the realized volatility and the volatility strike or pre-determined fixed volatility level. Volatility swaps allow participants to trade an asset's volatility without directly trading the underlying asset.

- Example- Assume that an institutional trader wants a volatility swap on the S&P 500 index. The contract will expire in twelve months and has a notional value of $1 million. Currently, the implied volatility is 12%. This is set as the strike for the contract.
- In twelve month's time, volatility is 16%. This is the realized volatility. There is a 4% difference, or $40,000 ($1 million x 4%). The seller of the volatility swap pays the swap buyer $40,000, assuming the seller is holding the fixed leg and the buyer the floating leg.
- If volatility dropped to 10%, the buyer would pay the seller $20,000 ($1 million x 2%).
- This is a simplified example. Since volatility swaps are over-the-counter instruments (OTC) they can be constructed in different ways.

3 Variance Swaps

A variance swap is a financial derivative used to hedge or speculate on the magnitude of a price movement of an underlying asset. These assets include exchange rates, interest rates, or the price of an index. In plain language, the variance is the difference between an expected result and the actual result.

A variance swap is quite similar to a volatility swap, which utilizes realized volatility instead of variance.

4 LIBOR in arrears Swaps

A plain vanilla interest rate swap is designed so that the floating rate of interest observed on one payment date is paid on the next payment date. An alternative instrument that is sometimes traded is a LIBOR-in-arrears swap. In this, the floating rate paid on a payment date equals the rate observed on the payment date itself.

- LIBOR-in-arrears swaps differ from regular swaps in that each payment is based on the LIBOR at the end of the payment period. For a regular swap it is the beginning-of-period LIBOR that is paid at the end of the payment period. This mismatch in cash flow timing makes the present value of a floating payment in a LIBOR-in-arrears swap not equal to the present value of the forward rate for that date. This difference, known as the convexity adjustment, depends on the volatilities of interest rates.

5 CMS and CMT Swaps

A constant maturity swap (CMS) is an interest rate swap where the floating rate equals the swap rate for a swap with a certain life.

A constant maturity Treasury swap (CMT swap) works similarly to a CMS swap except that the floating rate is the yield on a Treasury bond with a specified life.

- For example, the floating payments on a CMS swap might be made every 6 months at a rate equal to the 5-year swap rate. Usually there is a lag so that the payment on a particular payment date is equal to the swap rate observed on the previous payment date.
- Example, an investor believes that the general yield curve is about to steepen while the six-month LIBOR rate will fall relative to the three-year swap rate. To take advantage of this change in the curve, the investor buys a constant maturity swap paying the six-month LIBOR rate and receiving the three-year swap rate.
- CMT and CMS swaps provide a flexible and market efficient access to long dated interest rates. On the liability side, CMS and CMT swaps offer the ability to hedge long-dated positions.

6 Equity Swaps

In an equity swap, one party promises to pay the return on an equity index on a notional principal, while the other promises to pay a fixed or floating return on a notional principal. This is also known as a Total Return Swap.

- Equity swaps enable a fund managers to increase or reduce their exposure to an index without buying and selling stock.
- An equity swap is a convenient way of packaging a series of forward contracts on an index to meet the needs of the market.
- The equity index is usually a total return index where dividends are reinvested in the stocks comprising the index.
- An example of an equity swap is the 6-month return on the S&P 500 exchanged for LIBOR. The principal on either side of the swap is $100 million and payments are made every 6 months.

7 Weather Derivatives

Many companies are in the position where their performance is liable to be adversely affected by the weather. It makes sense for these companies to consider hedging their weather risk in much the same way as they hedge foreign exchange or interest rate risks. The first over-the-counter weather derivatives were introduced in 1997.

To understand how they work, we explain two variables:
HDD: Heating degree days
CDD: Cooling degree days
A day's HDD is defined as: **HDD = max(0, 65 – A)**
and a day's CDD is defined as: **CDD = max(0, A – 65)**
where A is the average of the highest and lowest temperature during the day at a specified weather station, measured in degrees Fahrenheit.

A typical over-the-counter product is a forward or option contract providing a payoff dependent on the cumulative HDD or CDD during a month.
For example, a derivatives dealer could in January 2018 sell a client a call option on the cumulative HDD during February 2019 at the Chicago O'Hare Airport weather station with a strike price of 700 and a payment rate of $10,000 per degree day.

8 Insurance Derivatives

- When derivative contracts are used for hedging purposes, they have many of the same characteristics as insurance contracts. Both types of contracts are designed to provide protection against adverse events. It is not surprising that many insurance companies have subsidiaries that trade derivatives and that many of the activities of insurance companies are becoming very similar to those of investment banks.

- Traditionally the insurance industry has hedged its exposure to catastrophic (CAT) risks such as hurricanes and earthquakes using a practice known as reinsurance.

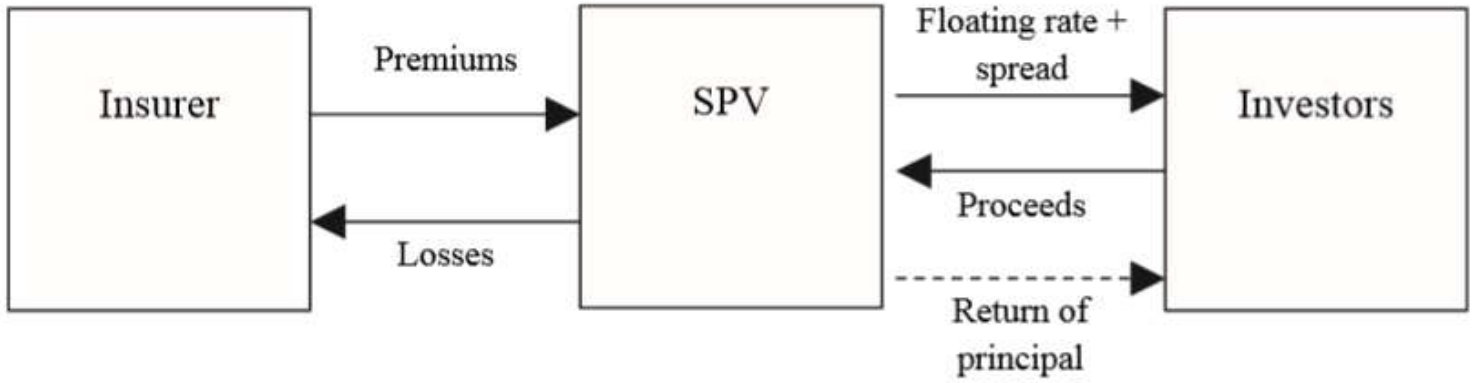
- The over-the-counter market has come up with a number of products that are alternatives to traditional reinsurance. The most popular is a CAT bond.

- This is a bond issued by a subsidiary of an insurance company that pays a higher-than-normal interest rate. In exchange for the extra interest the holder of the bond agrees to provide an excess-of-loss reinsurance contract.

- Depending on the terms of the CAT bond, the interest or principal (or both) can be used to meet claims.

8 Insurance Derivatives

A typical catastrophe bond structure is shown below:



In this diagram, the bondholders purchase their bonds from the SPV and will receive the risk-free rate plus a risk premium for taking on the risk of the catastrophe being insured.

8 Insurance Derivatives

The process for creating a catastrophe bond is as follows:

1. The ceding insurance company establishes a special purpose vehicle in a tax efficient jurisdiction.
2. The SPV establishes a reinsurance agreement with the sponsoring insurance company.
3. The SPV issues a note to investors; this note has default provisions that mirror the terms of the reinsurance agreement.
4. The proceeds from the note sale are invested in money market instruments within a segregated collateral account.
5. If no trigger events occur during the risk period, the SPV returns the principal to investors with the final coupon payment. If trigger events occur, the assets of the SPV are first used to meet the insurer's losses, before any return of principal (if any).