

INTEREST RATE OPTIONS (IRO)

	Page
1. Terminology	2
2. Caps	5
2.1 Terminology	6
2.2 Examples	7
3. Floors	9
3.1 Terminology	10
3.2 Example	11
4. Collar	13
5. Swaptions	15
5.1 Terminology	16
5.2 Example	17

INTEREST RATE SWAPS

1. Terminology

An interest rate option is an agreement between two parties. It grants one party (buyer) the right to buy (call option) or sell (put option) a financial instrument at a fixed price at a defined date (or during a defined period of time).

The buyer of an option does not have to exercise this right. For this right, the buyer pays a certain price (premium) to the option seller. On the other hand, the seller has no control on the possible exercise.

Call (option to buy)

With a call option the buyer gets the right to buy a financial instrument at defined conditions. The seller has the obligation to deliver this instrument at the agreed conditions if the buyer exercises the right to purchase.

Put (option to sell)

With a put option the buyer has the right to sell a financial instrument at agreed conditions. The seller has the obligation to receive this instrument at the agreed conditions if the buyer exercises his right to sell.

Underlying

The underlying instrument is the one which is defined in the contract of the option. The underlying has to be delivered or bought at an agreed price or interest rate if the option is exercised.

Strike price / basis price

The strike price is the price that is defined in the option's contract if the option is exercised.



American option

An American option can be exercised any time during the life of the option.

European option

A European option can be exercised only at expiry.

At the money

If an option is "at the money" its strike price is almost the same as the current market price.

In the money

An option is "in the money" if the strike price is either below (call option) or above (put option) the market price of the underlying, i.e. "in this moment" one would exercise the option.

Out of the money

An option is "out of the money" if the strike price is either above (call option) or below (put option) the market price of the underlying, i.e. in this case one would not exercise the option.

Premium

The option's premium is the price the buyer must pay to the seller.

Intrinsic value

The option's intrinsic value is part of the option's premium. For an in the money option, it represents the amount by which the strike price is either below (call option) or above (put option) the price of the underlying.

Time value

The option's time value is part of the option's premium. It is influenced by the life of the option, by the expectations on the volatility of the underlying, and by the ratio between market price and strike price.

This means that the following holds:

$$\text{premium} = \text{inner value} + \text{time value}$$

For the following analysis of interest rate options we will go into the common types of interest rate options and discuss Caps, Floors, and Swaptions.

2. Caps

A Cap is a contract between two parties (OTC) over an interest rate ceiling with regard to the principal.

If at certain dates (fixing dates) the agreed reference rate (usually LIBOR) is above the defined interest rate (strike price) the seller has to settle the difference between reference rate and interest rate ceiling and has to pay the buyer. If at the fixing dates the reference rate is below the strike price no payments are made.

Caps can be used by the buyer of the option as an insurance against rising interest rates. If you choose a floating refinancing expecting that interest rates will fall, then the Cap makes sure that the refinancing will not be more expensive than the rate fixed in the cap. On the other hand, the buyer takes full advantage of the expected fall in the interest rates.

2.1 Terminology

Quotation

The quotation of Caps is usually done on the basis of the premium, which is a single payment when the contract is settled.

If a Cap for 100 Mio is quoted at 2.50 %, the buyer of the option has to pay 2.5 Mio ($100,000,000 \cdot 0.025$) once when the contract is settled.

Pricing

Technically, Caps can be seen as a series of options on a series of FRAs on 3-month or 6-month interest rates. Since an FRA is a forward on a future money market rate and an FRA purchase is a hedge against rising interest rates, a Cap represents a series of options on FRA purchases. The FRA, or rather the series of FRAs, is therefore the underlying for the Cap and is important for determining whether an option is in the money, at the money, or out of the money. According to our rules for FRAs (forward rates) the yield curve is the main factor of influence when determining the future interest rates. The interest rate ceiling that is fixed by the contract has to be compared to the respective forward rates for each interest period (and not to the current money market rates) in order to determine the intrinsic value of the CAP.

2.2 Examples

Example

6-month interest rate:	3.50 %	days:	180
12-month interest rate:	3.75 %	days:	360
6 / 12 forward rate:	3.93 %	days:	180

Under a Cap with an interest rate ceiling of 3.75 % the first term of interest would be in the money with 0.18 % (3.93 % – 3.75 %).

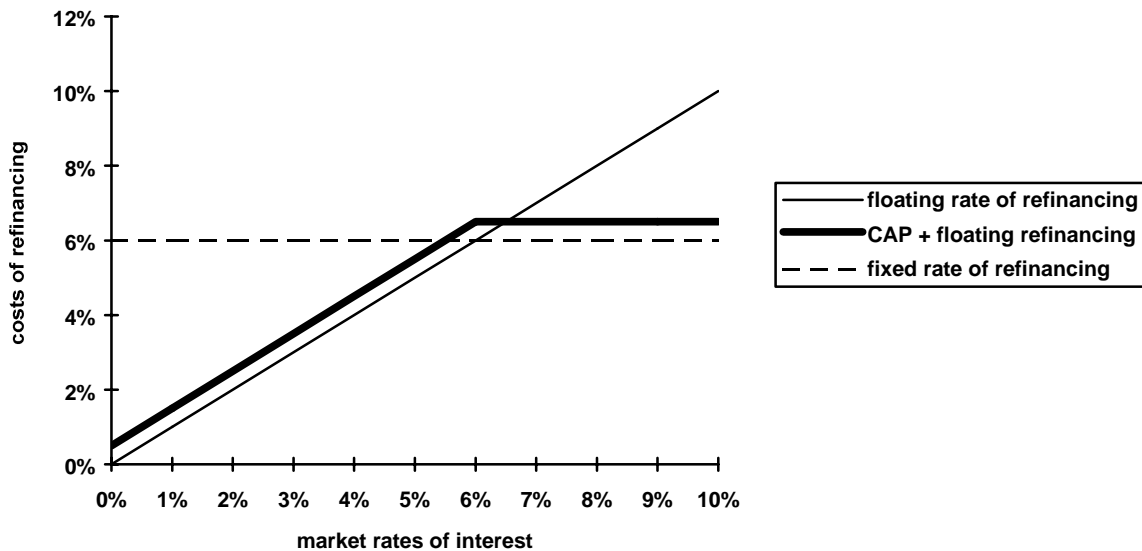
Example

A bank needs a fixed refinancing for 5 years and has the possibility to borrow money at a fixed rate of 6.00 % or at a floating rate of LIBOR. The treasurer in charge expects the interest rates to fall, but is not willing (or able) to take on the whole risk involved in a floating refinancing. He decides to buy a Cap with a strike price of 6.00 % (interest rate ceiling) on the whole volume, for which he has to pay 2.50 % premium.

First, one has to make the option's premium comparable over the years - since it is due only once.

Ignoring compound interest (for reasons of simplicity), the premium of 2.50 % equals an annual cost of 0.50 % p.a. $\left(\frac{2.50\%}{5}\right)$.

The following diagram shows the cost of refinancing for each period.



Graph 1: refinancing rates each period

If the reference rate is below 6.00 % the option expires. The bank just has to bear the cost of refinancing plus the annualised premium of the option. If the reference rate is exactly 6.00 % the total cost of refinancing is 6.50 % (6.00 % LIBOR + 0.50 % annualised premium). For example, if LIBOR is at 5.00 %, the total cost is 5.50 % (5.00 % LIBOR + 0.50 % premium).

Assuming that LIBOR rises above 6.00 % the option will be exercised and the total cost of refinancing consists of the interest rate ceiling and the option's premium. At an assumed LIBOR rate of 7.00 % the effective refinancing cost is 7.00 % but from the Cap one gets the difference of 1.00 % (LIBOR – interest rate ceiling), so the total cost adds up to 6.50 % (7.00 % LIBOR – 1.00 % settlement payment of the Cap + 0.50 % annualised premium of the option). Even if the reference rate rises up to 10%, the total refinancing costs remain at 6.50 % (10.00 % – 4.00 % + 0.50 %).

Thereby, an asymmetric P & L profile develops that is typical for options; it enables the buyer of the Cap to hedge against rising interest rates, whereas he still has an "unlimited" profit potential if the interest rates fall.

3. Floors

A Floor is just the opposite of a Cap. A Floor is a contract between two parties (OTC) over a defined interest rate lower limit for a given principal.

If on certain dates (fixing dates) the agreed reference rate (usually LIBOR) is below the agreed interest rate (strike price), the seller has to settle the difference between interest rate floor and reference rate by paying the buyer. If on the fixing date the reference rate is above the strike price no payments are made.

Floors can be used by the buyer of the option as an insurance against falling interest rates. If one chooses a floating lending operation, expecting that interest rates will rise, then the Floor makes sure that the lending operation will achieve a minimum yield of the lower limit of the Floor. On the other hand, the buyer takes full advantage of the expected rise in interest rates.

3.1 Terminology

Quotation

The quotation of Floors is usually done on the basis of the premium which is a single payment which is made when the contract is settled (just as with Caps).

Pricing

Technically, Floors can be seen as a series of options on a strip of FRAs on 3-month or 6-month interest rates. Since an FRA is a forward on a future money market rate and an FRA sale is a hedge against falling interest rates, a Floor is a series of options on FRA sales. The FRA, or rather the series of FRAs, therefore is the underlying for the Floor and is important when determining whether an option is in the money, at the money, or out of the money. According to our rules for FRAs (forward rates) the yield curve is the main influence factor when determining the future interest rates. The interest rate floor that is fixed by the contract has to be compared to the respective forward rates for each interest period (and not to the current money market rates) in order to determine the intrinsic value of the Floor.

**Example**

6-month interest rate:	3.50 %	days:	180
12-month interest rate:	3.75 %	days:	360
6 / 12 forward rate:	3.93 %	days:	180

Under a Floor program with an interest rate lower limit of 3.75 % the first term of interest would be out of the money with 0.18 % (3.93 % – 3.75 %).

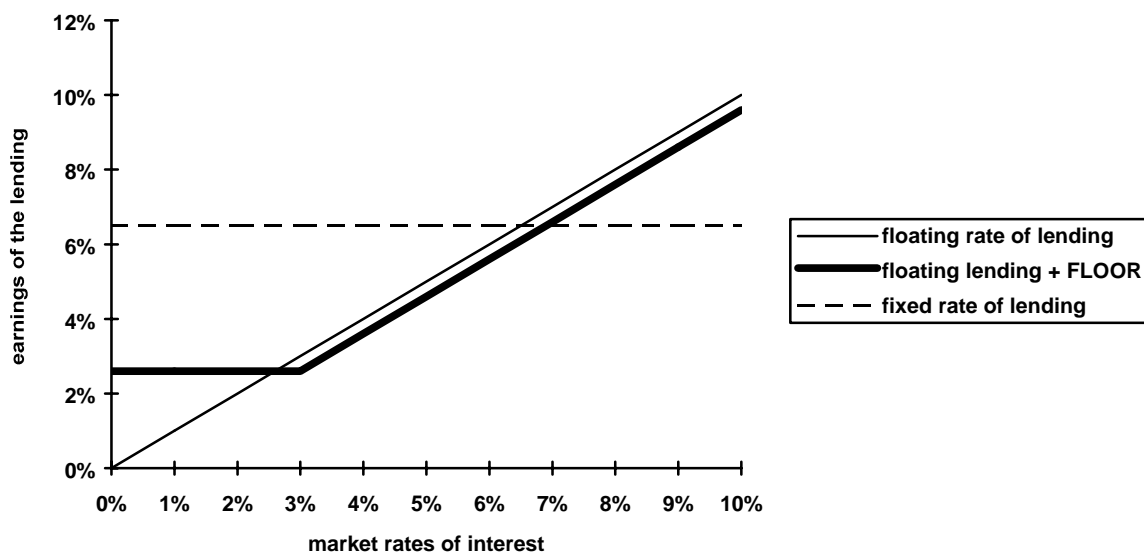
3.2 Example

An insurance company wants to lend money for 5 years and has the possibility to lend at either a fixed rate of 6.50 % or at LIBOR. The treasurer in charge expects the interest rates to rise, but is not willing (or able) to take on the whole risk involved in a floating lending operation. He decides to buy a Floor with a strike price of 3.00 % (interest rate floor) on the whole volume, for which he pays a 2.00 % premium.

First, one has to make the option's premium comparable over the years -since it is due only once. Ignoring compound interest (for reasons of simplicity) the premium of 2.00 % equals an annual cost

$$\text{of } 0.40\% \text{ p.a. } \left(\frac{2.00\%}{5} \right).$$

The diagram below shows the earnings of the lending operation for each period.



Graph 2: earning of the lending operation for each period

If the reference rate is above 3.00 % the option expires. The insurance company is able to lend its liquidity at the prevailing market rate; the total earnings are figured out by LIBOR minus the annualised premium of the option. If the reference rate is exactly 3.00 %, the total earnings from the lending operation are 2.60 % (3.00 % LIBOR – 0.40 % annualised premium). If for example the LIBOR is at 5.00 %, the total earnings are 4.60 % (5.00 % LIBOR – 0.40 % premium of the option).

Assuming that LIBOR falls below 3.00 % the option can be exercised and the total earnings from the lending operation are computed as the floor interest rate minus the annualised premium of the option. At an assumed LIBOR rate of 2.00 %, the earnings from the investment are just 2.00 % but from the Floor the difference of 1.00 % (interest rate floor minus LIBOR) is accrued, so the total earnings add up to 2.60 % (2.00 % LIBOR + 1.00 % settlement payment – 0.40 % annualised premium). Even if LIBOR is at 1.00 % the total earnings will still be 2.60 % (1.00 % + 2.00 % – 0.40 %).

Thereby, an asymmetric P & L profile, as is typical for options, becomes evident; it enables the buyer of the Floor to hedge against falling interest rates, while he still has an "unlimited" profit potential if the interest rates rise.

Note: In general, every option that is used for hedging is bought in the belief that the option will expire. Only in such a case, the additional earnings, speculated for in the underlying deal, can be achieved. Although it can be argued that the option's premium was paid in this case for nothing (since the assurance was not needed), the risk of the speculation could be limited by the option.

4. Collar

A collar is a combined purchased/sold cap and a sold/purchased floor.

The aim of a collar is to reduce the cost (= premium) of the bought cap/floor by selling the floor/cap.

If the cap's interest floor and the floor's interest ceiling are combine in a way that the two premiums are the same, the construction is called a zero-cost collar.

Pricing and Quotation

The price of a collar can be derived from the prices for caps and floors. The collar is usually quoted in a „package“. This means, that the option premium is quoted in % for a collar and not separately as 2 premiums for the used caps and floors.

**Example**

A collar constructed by a cap with a premium of 1.75 % and a floor with a premium of 0.5 % is directly quoted with a premium of 1.25 %.

Since the buyer of the cap simultaneously sells a floor both parties bear a counterparty risk in a collar.

**Example**

A treasurer borrowed money for 5 years at a floating rate, that is LIBOR. Currently LIBOR is 5 %. In order to hedge against rising interest rates the treasurer buys a cap at 6 %. Since the premium of 3.0 % (= 6 % p.a.) seems too high for him he decides to reduce the cost by selling a floor at 4 % for which he receives a premium of 3 %.

The following table shows the borrowing cost of the treasurer:

<i>Premium p.a.</i>	3 %	4 %	5 %	6 %	7 %
p.a					
borrowing cost	- 3 %	- 4 %	- 5 %	- 6 %	- 7 %
Bought					
Cap 6%	- 0.6 %	/	/	/	+1 %
Sold Floor					
6%	+ 0.6 %	- 1 %	/	/	/
Total					
Premium	0 %	0 %	0 %	0 %	0 %
Total result					
Borrowing cost	- 4 %	- 4 %	- 5 %	- 6 %	- 6 %

With the collar you save part or all of the premium but you forgo also to profit from some advantages interest rate movements. In our example, the treasurer has fixed his maximum borrowing rate at 6 % and his minimum borrowing rate at 4 %. If interest rates fall below 4 % he can not profit this development since he would have to pay in the floor.

5. Swaptions

A swaption is a contract between two parties (OTC). It provides the buyer the right to enter at an agreed date into an interest rate swap with defined term, interest rate and principal.

In contrast to Caps and Floors, a swaption is an option on a fixed interest rate at a certain date. While under Caps and Floors a settlement payment has to be made at certain dates, a swaption offers two possible forms of settlement; cash settlement (settlement payment, with which the current present value of the swap is paid off) or physical "delivery" of a real interest rate swap.

For the option buyer, a call swaption bears the right to buy an interest rate swap at a fixed rate in the future (option on a fixed-rate payer swap, commonly known in the market as payer swaption).

For the buyer, a put swaption contains the right to sell an interest rate swap at a fixed rate in the future (option on a fixed-rate receiver swap, commonly known in the market as receiver swaption).

**Example**

Swaptions are commonly used in two business field:

- during the offer phase in project financing; with a swaption, the interest rates for refinancing, that may influence the project at an early stage, can be secured.
- to secure assets and liabilities that are due in the future; in case of non-congruence of interest rates, a swaption guarantees a fixed interest rate for lending or refinancing operations in the future.

5.1 Terminology

Quotation

The quotation is done on the basis of the premium which is a single payment when the contract is settled (just as with Caps and Floors).

Pricing

Since the basic value of a swaption is an interest rate with a delayed starting date (or rather a forward start swap), the agreed interest rate of the swaption has to be compared to the respective forward swap. Thus, the difference represents the intrinsic value, or the amount by which the swaption is in the money. Additional factors of influence are -as with all types of options- the time to expiry as well as the respective volatility in the market.

**Example**

current 2-year swap rate:	4.25 %
current 7-year swap rate:	4.75 %
forward swap 2 + 5:	4.95 % (without compound interest)

A payer swaption (option on a fixed-rate payer swap), starting in 2 years with a term of 5 year, strike price of 4.50 %, would be in the money with 0.45 % (4.95 % – 4.50 %).

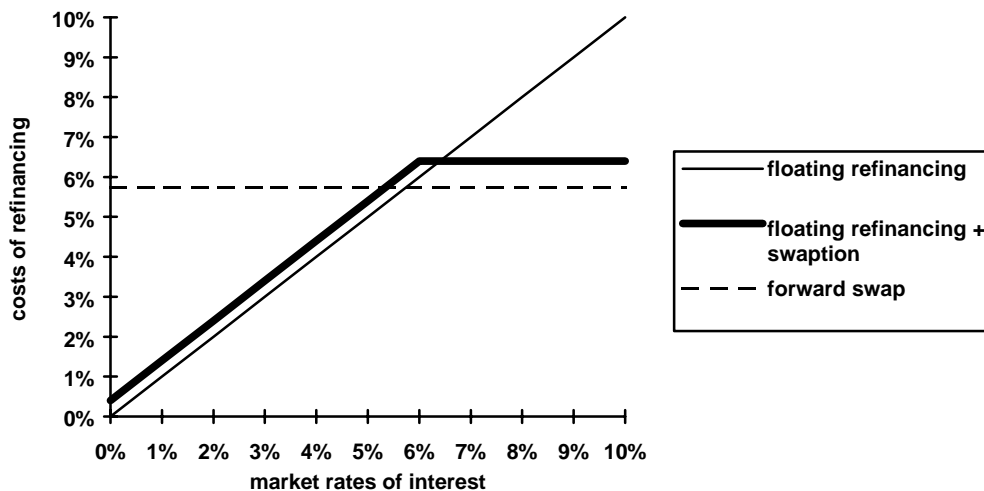
A receiver swaption (option on a fixed-rate receiver swap), starting in 2 years with a term of 5 years at a strike price of 4.50 %, would be out of the money with 0.45 % (4.95 % – 4.50 %).

5.2 Example

A bank has made a fixed-rate issue for 5 years. The treasurer in charge wants to keep the profit potential of falling interest rates, but also wants to secure a minimum interest rate of 6.00 % for 5 more years. Therefore, he decides to buy a payer swaption (strike price is 6.00 %) at a premium of 2.00 % (option on a fixed-rate payer swap). An alternative forward rate swap would cost a fixed rate of 5.75 %.

First, the single payment of the premium must be converted on the basis of the underlying's term. In this case, the premium of 2.00 % must be split over the last 5 years of the term: this give an annualised premium of 0.40 % (ignoring the fact that the premium has to be paid at the trading date).

The following diagram shows the possible refinancing between years 5 and 10



Graph 3: possible refinancing between years 5 and 10

If the rate of the 5-year swap is below 6.00 % in 5 years time, the expectations of the treasurer turned out to be true and he can take full advantage of the conditions of refinancing in the market. His costs of refinancing are made up of the current market rate minus the annualised premium. In this case, he will not exercise the swaption. With an assumed 5-year rate of 5.00 %, the refinancing costs(ignoring the credit margin) are 5.40 % (5.00 % market interest rate + 0.40 % premium for the option).

If the market rate is above 6.00 %, he will exercise the option and can enter a fixed-rate payer swap at 6.00 %. Thereby, his costs of refinancing (without the credit's spread) will be 6.40 %, no matter how high the effective market interest rates are going to be. Above a market rate of 6.00 %, the basis of his refinancing costs is determined by adding strike price and annualised premium of the option.