

Session 4: pricing of standard and barrier options on interest rates

When implementing the options below, you can assume that all the barrier and exercise times are strictly greater than the initial time. The issue time coincides with the initial time.

Interest rate floor

N : notional

F : floor rate

δt : interval of time between the payments given as year fraction.

m : total number of payments

Assume that today is the issue time of the floor. Denote this time by t_0 . The payment times of the floor are given by

$$t_i = t_0 + i\delta t, \quad 1 \leq i \leq m.$$

At payment time t_i the owner of the floor *receives* the payment

$$N \max(F\delta t - L(t_{i-1}, t_i)\delta t, 0),$$

where $L(s, t)$ is the float (LIBOR) rate computed at s for maturity t , $s < t$.

Put on forward rate agreement

N : notional amount

R : fixed rate

δt : time interval for loan as year fraction

T : maturity

At maturity T the owner of the option has the right to sell the forward rate agreement. In this case

1. at maturity T he receives notional N .
2. at time $T + \delta t$ he pays notional plus fixed interest, that is, the amount $N(1 + R\delta t)$.

Cap on swap rate

Parameters of cap:

N : notional.

C : cap rate.

δt : interval of time between the payments given as year fraction.

m : total number of payments.

Parameters of swap rate:

δs : interval of time between the payments given as year fraction.

l : total number of payments

Assume that today is the issue time of the contract. Denote this time by t_0 . The payment times of the cap are given by

$$t_i = t_0 + i\delta t, \quad 1 \leq i \leq m.$$

At payment time t_i the owner of the option *receives* the payment

$$N \max(R(t_{i-1})\delta t - C\delta t, 0),$$

where $R(t_{i-1})$ is the *swap rate* computed at the *previous* time t_{i-1} in the swap contract with the interval between payments δs and the number of payments l .

Cancellable interest rate swap, where LIBOR rate is set in arrears

N : notional

R : fixed rate in the swap

δt : interval of time between the payments given as year fraction.

m : total number of payments

side: this parameter defines the side of the swap contract, i.e. whether one pays “fixed” and receives “float” or otherwise.

Brief description: the holder of the option has the right to cancel the swap at any payment time (after the payments). The fixed payments are as in the usual swap. However, the float payments are set in *arrears*. This means that the float payment at a given payment time is determined by the LIBOR rate computed at *this* payment time (in the case of standard swap the float payment is set at the *previous* payment time).

Denote by $(t_i)_{1 \leq i \leq m}$ the payment times of the swap:

$$t_i = t_0 + i\delta t, \quad 1 \leq i \leq m.$$

At payment time t_i , the following events take place:

1. One side pays “float” interest $NL(t_i, t_i + \delta t)\delta t$, where $L(t_i, t_i + \delta t)$ is the float (LIBOR) rate at t_i for the period of δt years.
2. Another side pays “fixed” interest $NR\delta t$.
3. After the payments, the option holder can terminate the contract.

Note that the first payment of the swap always takes place. In other words, the swap can not be canceled at issue time.