Swaption Product and Vaulation

FinPricing

Summary

- Interest Rate Swaption Introduction
- The Use of Swaption
- Swaption Payoff
- Valuation
- Practical Guide
- A real world example

Swaption Introduction

- An interest rate (European) swaption is an OTC option that grants its owner the right but not the obligation to enter the underlying swap.
- There are two types of swaptions: a payer swaption and a receiver swaption.
- A payer swaption is also called a right-to-pay swaption that allows its holder to exercise into a swap where the holder pays fixed rates and receives floating rates
- A receiver swaption is also called right-to-receive swaption that allows its holders to exercise into a swap where the holder receives fixed rates and pays floating rates.
- Swaptions provide clients with a guarantee that the fixed rate of interest they will pay or receive at some of future time will not exceed certain level.

Swaption

The Use of Swaption

- Market participants use swaptions to manage interest rate risk arising from their business.
- A firm might buy a payer swaption if it wants protection from rising interest rates.
- A corporation holding a mortgage portfolio might buy a receiver swaption to protect against decreasing interest rates that might lead to mortgage prepayment.
- A company believing that interest rates will not increase much might sell a payer swaption to earn the premium.
- An institution believing that interest rates will not decrease much might sell a receiver swaption to earn the premium.

Swaption

Swaption Payoff

- For a payer swaption, the payoff at payment date T is given by

$$Payff_{payer} = \max(0, NA(S_T - S_0))$$

where

N- the notional;

A – the annuity or forward basis point value

S_0 – the fixed rate or contract swap rate at inception

S_T – the swap rate at time T

- From a receiver swaption, the payoff at payment date T is given by

$$Payff_{payer} = \max(0, NA(S_0 - S_T))$$

Swaption

Valuation

- The present value of a payer swaption is given by

$$PV_{payer}(t) = NA[S\Phi(d_1) - K\Phi(d_2)]$$

where

t – the valuation date

N – the notational principal amount

$A = \sum_{i=1}^{n} \tau_i D_i$ – the annuity factor or forward basis point value

$S = [D_1 - D_n]/A$ - the forward swap rate

Φ - the cumulative standard normal distribution function

i – the i^{th} cash flow (swaplet) of the underlying swap from 1 to n

$\tau_i = \tau(T_{i-1}, T_i)$ – the accrual period (,) of the i^{th} cash flow.

$D_i = D(t, T_i)$ – the discount factor

Swaption

Valuation (Cont)

- The present value of a receiver swaption can be expressed as

$$PV_{payer}(t) = NA[K\Phi(-d_2) - S\Phi(-d_1)]$$

where all notations are the same as (1)

Swaption

Practical Guide

- A swaption contract contains terms and conditions of the swaption and the underlying swap. For example, it specifies two maturities: swaption maturity and underlying swap maturity.
- The valuation model for pricing a swaption is the Black formula that assumes the underlying swap rate follows a log-normal process.
- First, one needs to generate the cash flows of the underlying swap. The generation is based on the start time, end time and payment frequency of each leg, plus calendar (holidays), business convention (e.g., modified following, following, etc.) and whether sticky month end.

Practical Guide

- The accrual period is calculated according to the start date and end date of a cash flow plus day count convention
- Any compounded interest zero rate curves can be used to compute discount factor, of course the formulas will be slightly different. The most common used one is continuously compounded zero rates.
- The other key for accurately pricing an outstanding swaption is to construct an arbitrage-free volatility surface. Unlike a cap/floor volatility surface that is 3 dimensional (maturity – strike – volatility), a swaption volatility surface is 4 dimensional (swaption maturity – underlying swap tenor – strike – volatility).

Swaption

A Real World Example

Swaption Specification		Underlying Swap Specification			
Buy Sell	Buy	Leg 1 Specification		Leg 2 Specification	
Pay Receive	Pay	Currency	USD	Currency	USD
Notification Lag	2	Day Count	dc30360	Day Count	dcAct360
Settlement	Cash	Leg Type	Fixed	Leg Type	Float
Exercise Type	Call	Notional	25000000	Notional	25000000
Notification Date	4/30/2020	Pay Receive	Pay	Pay Receive	Receive
Settlement Date	5/5/2020	Payment Freq	6	Payment Freq	3
Forward Premium Amount	3375000	Start Date	5/5/2020	Start Date	5/5/2020
Premium Pay Receive	Pay	End Date	5/5/2030	End Date	5/5/2030
Forward Premium Date	5/5/2020	Fixed Rate	0.02855	Spread	0
				Index Specification	
				Type	LIBOR
				Tenor	3M
				Day Count	dcAct360

Thanks!

Reference:
https://finpricing.com/lib/EqBarrier.html