Callable Range Accrual Analytics

A range accrual swap is a swap where in the payoff is dependent on the reference rate falling within a particular range. A callable range accrual swap is a range accrual swap in which the party paying the structured coupon leg has the right to cancel on any coupon date after a lock-out period expires.

Range-accrual interest rate swap has two legs in which one leg is a regular funding leg and the other one, which is called a range accrual leg or a structure leg, consists of range accrual coupons.

A range accrual coupon rate can be (a) a fixed coupon rate, or (b) a floating coupon rate or (c) their linear combinations. In case (c), it can be called hybrid range-accrual coupon.

A range-accrual swaption is a European/Bermudan option on an underlying range-accrual swap. A callable range accrual swap is composed of a range accrual swap and a Bermudan range accrual swaption with an underlying range accrual swap to cancel the original remaining swap.

Pricing range-accrual swaps is index rate model dependent. A single factor HJM Gaussian type interest rate term structure model is applied to price the callable range-accrual swap, in which the PDE approach is used. The weighted average finite difference method is applied to solve the PDE. This interest rate term structure model is calibrated to the swaption market.

A hybrid range accrual swap can be considered as the sum of a fixed range-accrual swap and a floating range-accrual swap with half of the original national. However, an option on the hybrid range-accrual swap can not be trivially decomposed into an option on the fixed range-accrual swap and an option on the floating range-accrual swap due to the non-linearity of the option payoff.

From the viewpoint of the receiver, we can price the callable range accrual swap as the range accrual swap minus the Bermudan option to enter into the receiver range accrual swap.

As the range accrual swap is just a linear sum of each of the digital contributions it is not necessary to use a term structure model. The situation for a callable range accrual swap is not so simple. In this case one may need to use a term structure model to solve for the optimal exercise boundary. The model may be required to be sophisticated enough to match the floorlet smile exactly, as well as the diagonal swaption volatilities.

A so-called range-accrual interest rate is proportional to how many times a specified term index rate is within a pre-set domain during a fixed reset period. Before we elaborate the definition of the range-accrual interest.

Each calendar day in the jth period contributes:

$$\begin{cases} \dfrac{\alpha_j * R_{fix} * 1}{M_j} & if \quad R_{\min j} \le L(t_i) \le R_{\max j} \\ 0 & otherwise \end{cases}$$

If the coupon paid on day t_j, the payoff on day t_i is

$$\begin{cases} \dfrac{\alpha_j R_{fix} DF_{t_j, t_i}}{M_j} & if \quad R_{\min j} \le L(t_i) \le R_{\max j} \\ 0 & otherwise \end{cases}$$

Digital floorlet definition:

$$F_{dig}(t_i, t_j, K) = \begin{cases} DF_{t_i, t_j} & if \quad L(t_i) \\ 0 & otherwise \end{cases}$$

The digital floorlets can be replicated by a “bullish spread” of standard floorlets

$$F_{dig}(t_i, t_j, K) = \lim_{\tau \to \infty} \frac{1}{\varepsilon\beta}[F(t_i, t_j, K + \varepsilon / 2) - F(t_i, t_j, K - \varepsilon / 2)]$$

Reference:

https://finpricing.com/lib/EqLookback.html