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A Semi-Explicit Approach to Canary Swaptions in HJM One-Factor Model

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Abstract

Leveraging the explicit formula for European swaptions and coupon-bond options in the HJM one-factor model, a semi-explicit formula for 2-Bermudan options (also called Canary options) is developed. The European swaption formula is extended to future times. So equipped, one is able to reduce the valuation of a 2-Bermudan swaption to a single numerical integration at the first expiry date. In that integration the most complex part of the embedded European swaptions valuation has been simplified to perform it only once and not for every point. In a special but very common in practice case, a semi-explicit formula is provided. Those results lead to a significantly faster and more precise implementation of swaption valuation. The improvements extend even more favourably to sensitivity calculations.

Keywords:

Bermudan swaption | HJM one-factor model | Hull–White model | explicit formula | numerical integration

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Notes

1. Bounded is too strong for the proof we use, some L^1 and L^2 conditions are enough, but as all the examples we present are bounded, we use this condition for simplicity.

2. See Hunt and Kennedy (2000) for the definition of a numeraire pair. Note that here we require that the bonds of all maturities are martingales for the numeraire pair (N, N).

3. Matlab code available from the author.

4. There is nothing special about that date, except it is my sister's birthday!

5. As the second step is shorter (6m), the distance between points is also smaller and more than 4n+1 final points are used.

6. It took around four hours on my computer to run the (non-optimized) code to compute 3×401 yield curves and the prices for the 4 implementations using 200 steps precisions. As can be inferred from figure 2, most of the time was devoted to the tree computations.