Project

(Structured Products: Normal & Shifted LMM)

Financial Engineering AY 2018-2019

On the 8th of April 2016, consider the portfolio in attach of caps/floors, digital caps/floors and swaps (with an amortized nøtional); all products are in Euro, start on the settlement date and are versus Euribor 3m. The non-linear derivatives are priced/managed according to the Normal-LMM and the Shifted-LMM (with 3% shift) as discussed in the document and in [2]. Bootstrap the curve considering only the 3m Depo and the Swap rates (vs Euribor 3m) starting from the 1y for the part relevant for the project; consider constant zero rates before the first bucket.

Considering first the Normal-LMM and then the Shifted-LMM, using market data (in the file IRVol.xlsm) obtain:

a) Portfolio NPV; pay attention that derivatives have been traded in different dates and some mantain the same amortizing notional for a semester.

b) Build a portfolio that is Delta and Vega flat on the buckets 2y, 4y, 7y & 10y. For hedging purposes use swaps (with NPV equal to zero and constant notional) and ATM plain vanilla Caps/Floors (i.e. with a strike equal to the corresponding swap rate, equal for all caplets/floorlets and constant notional; all vs Euribor 3m).

c) What would be the hedging notionals if the trader decides to leave a 2y-10y steepening position of 4k Euro for bp? (i.e. Long 4k € in the 10y, short for 4k € in the 2y).

d) Is there any digital risk left in the portfolio? How would you manage it? Propose a hedge with 1 cap (or floor) spread.

For hedging purposes use uniquely Swaps and Caps/Floors (versus 3months) with expiries at 2y, 5y, 7y, 10y start spot and the above characteristics.

Questions:

a) Which one of the two models would you select?

b) Is it better to use caps or floors for hedging purposes of the described portfolio?

Hints:

a. Starting from the market conditions provided (Flat Vols) obtain Spot Vols starting from quoted Flat Vols (see e.g. [1], where the technique is described for the lognormal case). If caplet/floorlet vols for the required expiry dates are not provided using market data, interpolate on contracts' expiries (flat extrapolation for dates shorter than the first one obtained from quoted instruments) and strikes, using the proper interpolation rule.

b. Pay attention that in all traded derivatives the first floating leg has already fixed and pays the "full coupon".

c. Obtain the total Vega for each lag (0-2y; 2y-4y; 4y-7y; 7y-10y) of the original portfolio and for each ATM Cap; starting from the last lag determine the ATM cap (and/or floor) with the longest expiry (10y) caplet/floorlet Vega. Then once portfolio Vega is zero, consider swaps in order to match the corresponding bucket deltas.

d. When hedging consider that premia are paid/received.

[1] J. Hull, Option futures and other derivatives.
[2] W. Schachermayer & J Teichmann, How close are the Option pricing formulas of Bachelier and Black-Merton-Scholes?, *Mathematical Finance* 1 (2008), 155-170.

Library in matlab. Opt. Python. Delivery address: financial.engineering.polimi@gmail.com; Deadline: 14 June 2019.