

Assignment 5

Structured Products

1. Case Study: Structured bond

On the 31st of January 2023 at 10:45 C.E.T., the Bank XX issues a structured bond, whose hedging termsheet is described in the annex. Consider the Structured bond issue in a single-curve interest rate modeling setting and neglecting the counterparty risk. Market parameters for (flat) Cap Volatilities are:

EUR Caps/Floors - Implied Volatilities													
Please call +44 (0)20 7532 3080 for further details													
	1.50	1.75	2.00	2.25	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	10.0
1Y	14.0	13.0	12.9	12.1	13.3	13.8	14.4	15.0	17.2	19.1	20.2	21.6	23.9
2Y	22.4	19.7	17.5	18.0	19.2	20.4	21.0	21.4	22.3	23.6	24.9	26.1	28.1
3Y	23.8	21.7	20.0	19.8	20.3	20.5	20.8	21.4	22.9	24.3	25.6	26.7	28.2
4Y	24.2	22.4	20.9	20.4	20.4	20.2	20.2	20.5	21.7	22.9	24.0	25.0	26.6
5Y	24.3	22.6	21.2	20.6	20.4	19.8	19.5	19.6	20.5	21.5	22.6	23.5	25.0
6Y	24.3	22.7	21.4	20.7	20.2	19.4	18.9	18.8	19.3	20.2	21.2	22.0	23.5
7Y	24.1	22.6	21.4	20.7	20.1	19.1	18.4	18.1	18.4	19.1	20.0	20.8	22.2
8Y	23.9	22.5	21.4	20.6	20.0	18.8	18.0	17.6	17.6	18.2	19.0	19.8	21.1
9Y	23.7	22.4	21.3	20.5	19.8	18.5	17.6	17.1	17.0	17.6	18.3	19.0	20.3
10Y	23.5	22.2	21.2	20.4	19.6	18.3	17.3	16.8	16.5	16.9	17.6	18.3	19.5
12Y	23.0	21.7	20.8	20.0	19.3	17.9	16.9	16.2	15.8	16.0	16.5	17.1	18.1
15Y	22.3	21.2	20.3	19.5	18.7	17.3	16.3	15.5	15.0	15.1	15.5	16.0	16.9
20Y	21.6	20.4	19.5	18.8	18.0	16.6	15.5	14.7	14.1	14.1	14.5	15.0	15.9

It is required to

- Compute the LMM spot vols on the same grid of Flat Vols. [Calibration]
- Determine the upfront X% [Pricing].
Hint: Use (if possible) the LMM spot vols on the same strike of derivative's payoff (spline interpolation on strike).
- Compute Delta-bucket sensitivities for all buckets [Risk measurement].
- Compute total Vega. [Risk measurement]
- Consider the course-grained buckets (0-2y; 2y-6y; 6y-10y). Completely hedge with swaps the Delta risk. [Portfolio risk management]
Hint: Select 3 swap notionals (2y, 6y, 10y) s.t. the corresponding coarse-grained bucket deltas are zero in the hedged portfolio.
Hint: Start with the longest swap. Why?
- Hedge the Vega. Consider the buckets for the vega (0-6y and 6y-10y) hedge the bucketed Vega with a 6y ATM Cap (strike = ATM 6y Swap rate same conventions for the two legs) and 10y ATM Cap. [Portfolio risk management]
Hint: Start hedging the longest cap. Why?
- [Facultative] Is there any digital risk? If yes, can you correct the price? [Pricing]

2. Case Study: Exotic cap [Calibration & Pricing]

On the same date, price with a BMM the option, whose quarterly payoff is at reset date T_{i+1}

$$\delta(T_i, T_{i+1})[L(T_i, T_{i+1}) - L(T_{i-1}, T_i) - 5 \text{ bps}]^+$$

First payment quarter: 6m after the Start date.

Maturity Date: 4y (last payment date).

Vol: BMM spot vol for the i^{th} term corresponding to the strike $K_i = L(t_0; T_i, T_{i+1})$

Correlation: $\rho_{ij} = e^{-\lambda \delta(T_i, T_{i+1})}$ with $\lambda = 0.1$ and δ with an Act/365 yearfrac.

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Exercise Annex:

Indicative Terms and Conditions as of 31st of January 2023

Swap Termsheet

Principal Amount (N):	50 MIO EUR
Party A:	Bank XX
Party B:	I.B.
Trade date:	today
Start Date:	2 Feb 2023
Maturity Date (t):	10 years after the Start Date, subject to the Following Business Day Convention.

Party A pays:	Euribor 3m + 2.00%
Party A payment dates:	Quarterly, subject to Modified Business Convention
Daycount:	Act/360

Party B pays @ Start Date:	X% of the Principal Amount
Party B pays @ payment dates:	Coupon
Party B payment dates:	Quarterly, subject to Modified Business Convention
First Quarter Coupon:	3%
Next Quarter Coupons:	<p>[Up to (and including) the 3rd year] uptil the 3rd year euribor € 3m+ 1.10% if € 3m ≤ 4.30% else 4.50%</p> <p>[After 3y and up to (and including) the 6y] € 3m+ 1.10% if € 3m ≤ 4.60% from 3rd year - 6th year else 4.80%</p> <p>[After 6y] € 3m+ 1.10% capped at 5.10% € 3m+ 1.10% if € 3m ≤ 5.20% else 5.40% from 6th to the 10th year & the cap rate is 5.10%(strike rate)</p>