

Project — Part I (Bootstrapping Swap Curves)

- 1 In the IR Data.xlsx spreadsheet, OIS data is provided. Bootstrap the OIS discount factor $D_o(0, T)$ and plot the discount curve for $T \in [0, 30]$.
- 2 Using the IRS data provided, bootstrap the LIBOR discount factor $D(0, T)$, and plot it for $T \in [0, 30]$.
 \Rightarrow Assume that the swap market is **collateralized in cash** and overnight interest is paid on collateral posted.
- 3 Calculate the following forward swap rates:
 - $1y \times 1y, 1y \times 2y, 1y \times 3y, 1y \times 5y, 1y \times 10y$
 - $5y \times 1y, 5y \times 2y, 5y \times 3y, 5y \times 5y, 5y \times 10y$
 - $10y \times 1y, 10y \times 2y, 10y \times 3y, 10y \times 5y, 10y \times 10y$

Use linear interpolation on discount factors when necessary.

Project — Part II (Swaption Calibration)

Under the Swaption tab of IR Data.xlsm, swaption implied volatilities (lognormal) are provided.

- ① Calibrate the displaced-diffusion model to the swaption market data, and document
 - a table of σ parameters
 - a table of β parameters
- ② Calibrate the SABR model to the swaption market data using $\beta = 0.9$, and document
 - a table of α parameters
 - a table of ρ parameters
 - a table of ν parameters
- ③ Price the following swaptions using the calibrated displaced-diffusion and SABR model:
 - payer $2y \times 10y$ $K = 1\%, 2\%, 3\%, 4\%, 5\%, 6\%, 7\%, 8\%$
 - receiver $8y \times 10y$ $K = 1\%, 2\%, 3\%, 4\%, 5\%, 6\%, 7\%, 8\%$

Project — Part III (Convexity Correction)

- 1 Using the SABR model calibrated in the previous question, value the following constant maturity swap (CMS) products:
 - PV of a leg receiving CMS10y semi-annually over the next 5 years
 - PV of a leg receiving CMS2y quarterly over the next 10 years
- 2 Compare the forward swap rates with the CMS rate:
 - $1y \times 1y, 1y \times 2y, 1y \times 3y, 1y \times 5y, 1y \times 10y$
 - $5y \times 1y, 5y \times 2y, 5y \times 3y, 5y \times 5y, 5y \times 10y$
 - $10y \times 1y, 10y \times 2y, 10y \times 3y, 10y \times 5y, 10y \times 10y$

Discuss the effect of maturity and tenor on convexity correction (difference between forward swap rates and CMS rates).

Project — Part IV (Decompounded Options)

- ① A *decompounded option* pays the following at time $T = 5y$:

$$\text{CMS } 10y^{1/p} - 0.04^{1/q}$$

where $p = 4$ and $q = 2$. Use static replication to value the PV of this payoff.

- ② Suppose the payoff is now

$$\left(\text{CMS } 10y^{1/p} - 0.04^{1/q} \right)^+$$

Use static replication to value the PV of this payoff.

Project Report

Deadline: 5-Apr-23 (Wednesday) noon.

Please submit

- Project report (no more than 10 pages, including title page and appendix)
- Python codes (1 file for each part, 4 files overall)