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Financial Risk Laboratory: Hedging a Swaption with IRS

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1   Questions

We started by implementing the bootstrap from the IRS quotes. The Zero Coupon curve we obtained can be seen in Figure 1.

We proceeded deriving the strike of the swaption by computing the 5y x 3y forward swap rate, using the ZC curve just obtained and got a result of: 0.0355.

To mark to market our portfolio at the mid rate, we computed the approximated price of the interest rate swap (by considering a short 5y fixed rate bond, with coupons assigned by the swap rate and face value equal to the IRS notional, and a long cash position with same amount as the IRS notional) and the price of the receiver swaption (by using the Black and Scholes formula with the forward swap rate as underlying). We then multiplied each price by it's notional and got a result of: $3.0375 * 10^6$.

We then evaluated both analytically (using the delta of the IRS and the duration of the swaption) and numerically (by computing the difference in the shifted and non-shifted NPV) the DV01 of the portfolio and obtained a value of $-1.8495 * 10^2$ and $-1.8411 * 10^3$, respectively. The difference is quite remarkable and we can attribute it to the approximation with delta, which

Figure 1: Zero rates curve

is clearly not the correct way to proceed when dealing with interest rates derivatives.

Lastly, we computed the portfolio bucketed DV01 with the 2, 5 and 10 macro-buckets and got a result of $-1.7520*10^3$, which, as an approximation, is not far from the result we got before for the DV01.
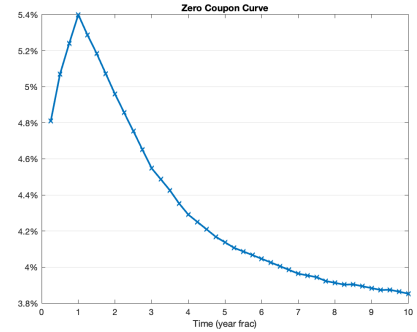
2   Discussion

By inverting the formula used to compute DV01 numerically, we evaluated the notional of the 5 years IRS which would be required to minimize the portfolio DV01, namely the result we got was 38 million. We then tried different strategies to delta hedge the swaption by trying different combinations of IRS - with different maturities and payer/receiver setting. We then settled on the evaluation of two strategies, namely:

- Selling the receiver IRS with maturity 2 years, with a (rounded) notional of -91 million

- Buying a combination of the three payer IRS given, with respective (rounded) notionals of 3, 8 and 15 million

We therefore computed the portfolio bucketed DV01 (as we did for question 6, just changing the composition of the portfolio) for both strategies and obtained, respectively, 1.5355 and -3.6204. These values are, as we expected, close to 0 (not exactly 0 due to the approximation of the notional).

We then simulated a shock (yield curve steepener) in the market by changing the interested rates and evaluated the profits of the aforementioned hedging portfolios, by computing the difference in the mark to market and then scaling by the not-shifted one, and obtained - respectively - 0.9419, 0.2693 and 1.0739.

Since the second portfolio is the one which was less impacted by the shock, we would say that it is the best hedging strategy, even if we can notice that this is probably due to the higher impact of the steepening on the 5 and 10 years rate.

Lastly, the evaluation of the bucketed DV01 can surely help developing the best hedging strategy, being the main sensitivity when dealing with interest rate derivatives (as delta is for equity derivatives). Ensuring that the DV01 is as close as possible to 0 therefore implies that the portfolio is hedged. In particular, evaluating the DV01 bucket at the maturities interested in the steepening and ensuring that this values are as close to 0 as possible, we can choose the best hedging strategy.