Fixed Income Derivatives
Final Exam

Introduction

This exam solution is accompanied by a spreadsheet that contains all the relevant tables and graphs. This also shows at least one way of implementing the required models. Please refer to the spreadsheet for the numerical results.

From the course description:

> *As the course is oriented towards the use of derivatives in practice, students are required to demonstrate a thorough understanding of all aspects surrounding derivatives - from the legal framework to the practical implementation of basic numerical routines using VBA/Excel - to obtain the grade 12.*

For this specific exam, this means that students are required to demonstrate the ability to implement, calibrate and apply the models from the course. Furthermore, successful students are expected to demonstrate some intuition on the pricing and risk management calculation that they perform.

1 The Swap Curve

1.1 Estimating the swap curve

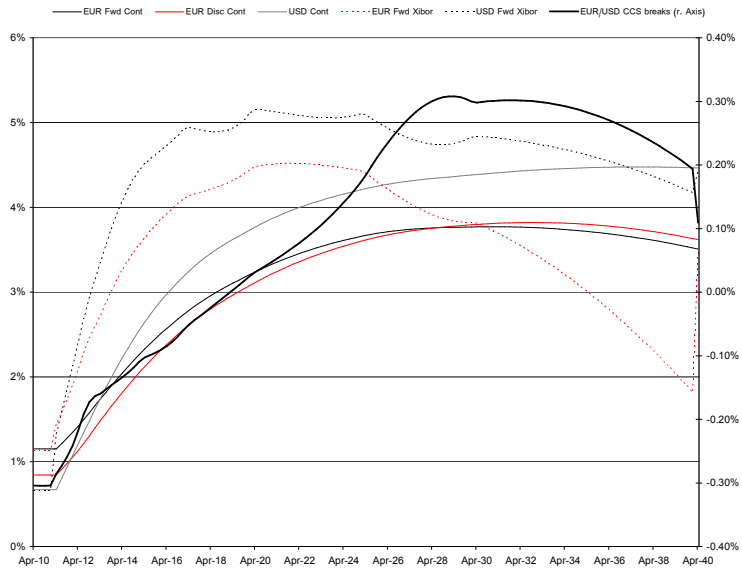
The calibrated zero coupon curves and the requested graphs can be seen found below and in the solution spreadsheet as well. The calibrated rates should be within ±0.5 bps.

Knot Points	EUR Forward	EUR Discounting	USD (Forward + Discounting)
29-Apr-11	1.1522%	0.8444%	0.6715%
30-Apr-12	1.4200%	1.1326%	1.2102%
29-Apr-13	1.7404%	1.4860%	1.7466%
29-Apr-15	2.3290%	2.1216%	2.6451%
28-Apr-17	2.7831%	2.6106%	3.2449%
29-Apr-20	3.2389%	3.1142%	3.7671%
29-Apr-25	3.6691%	3.6170%	4.2212%
29-Apr-30	3.7695%	3.7982%	4.3863%
30-Apr-40	3.5085%	3.6184%	4.4646%

1.2 Terminating interest rate swaps

The mid-market value of the trade is EUR 45,664,506. As differences in the curve calibration from the above question will result in different PVs, a margin of error of up to EUR 325,000 will be accepted (roughly equal to the trade's Dv01).

Figure 1: Yield curves in 3M points.



By using distinct yield curves for calculating foward xIBOR rates and discount factors (in foreign currencies), we ensure that we can price cross currency swaps at market rates and thus set the correct price of liquidity between different currencies. If we used a "classical" pricing system with just a single curve, we would discount net cash flows at different rates (that are higher in this case). Because the swap is significantly off-market, it entails large net cash flows that very sensitive to the choice of discounting curve. This is what causes the client to see a different termination price for the trade.

1.3 Pricing a fixed-for-fixed cross currency swap

The par rate for the fixed-for-fixed cross currency swap is 2.77%. Again, the answer is contingent on having calibrated the curve correctly, a deviation of up to ± 2 bps is accepted.

The fixed rate will differ for several reasons. First of all, note that we could in principle use two fixed-for-floating IRSs (in EUR and in USD) to convert a plain vanilla EUR/USD CCS into a fixed-for-fixed CCS. The resulting fixed EUR rate from doing this, would roughly be equal to the plain vanilla fixed-for-float EUR rate plus the EUR/USD CCS spread (which is negative in this case). Compared to such a benchmark, we still see a difference to our computed par-rate because the fixed rate on the USD leg is off-market and because the notionals are not set using the current spot FX rate. Students should be able to identify that both the USD fixed rate and the implicit off-market FX rate plays a role.

The fixed-for-fixed CCS can be hedged in several ways. Either by using a combination of EUR/USD CCSs and IRSs in each currency or by using FX forwards (converting all future EUR payments into USD) and subsequently hedging the interest rate risk with a USD IRS.

1.4 Pricing long FX forwards

See below as well as the solution spreadsheet.

Maturity	Date	Fx Fwd	Pips
1Y	29-Apr-11	1.3608	-24
2Y	30-Apr-12	1.3653	21
5Y	29-Apr-15	1.3994	362
10Y	29-Apr-20	1.4552	920
30Y	30-Apr-40	1.7575	3,943

2 A leveraged CMS note

This section involves many more steps — that can possibly go wrong — relative to the first section. Greater leniency for numerical deviations should thus be applied.

2.1 Pricing a structured note

The pricing is solved by calculating the value of the zero coupon bond that repays the notional (EUR 8,753,822) the value of the coupon stream $\text{CMS}_{10Y} - \text{CMS}_{2Y}$ at a gearing of 1 (EUR 629,052). Since the note is issued at par, the purchase of the zero coupon bond leaves us with a 10,000,000-8,753,822=1,246,178 to pay as coupons, implying that the note can be geared 1.98 times. Any gearing within the range 1.90-2.10 should be considered acceptable given the many steps that can go wrong in this calculation.

When adding a structuring fee of EUR 50,000 (0.5% of the notional), the possible gearing drops to 1.90.

2.2 Risk managing a structured note

The risk profile of the structured note:

- Parallel shifts in the forward and discounting curve? The coupon cash flow is relatively immune towards parallel shifts in the (forward and discount) yield curves since it is a spread between two interest rates. The zero coupon bond that guarantees the the notional repayment is however positioned for lower rates. On a net basis, the structured is thus positioned for lower rates with a Dv01 of EUR -4,841. The allowable numerical deviation here is EUR ±500

- A steepening/flattening of the forward and discounting curve? As the note pays a leveraged coupon relative to the slope of the yield curves, it is on a net basis positioned for a steeper yield curve. See the solution spreadsheet for deltavector — answers should be within EUR ±500 in each bucket to be accepted.

- Changes in (ATM) implied swaption volatility. The Black'76 vega for the structured note is EUR 6,340 per 1% increase in the ATM Black'76 implied swaption volatilities. The holder of the structured note is thus positioned for swaption volatilities to rise. The acceptable numerical deviation here is EUR ±500

- Which swaptions in the swaption matrix is the product sensitive to? The product is sensitive towards the options written on 2Y and 10Y swaps with expiries ranging from 3M to 57M across all strikes. This comes from the convexity correction of the CMS swaplets.

Maturity bucket	Delta vector risk
29-Oct-10	88
29-Apr-11	1,259
30-Apr-12	-1,107
29-Apr-15	-11,778
28-Apr-17	-4,211
29-Apr-20	2,240
29-Apr-22	6,579
29-Apr-25	2,089
Net Dv01	-4,841

The credit risk of the structured product could be analyzed by looking at the discounting risk. We know that we can think of credit risky claims as being priced simply by discounting the associated expected cash flows harder. By measuring the discounting risk, we can thus quantify the impact of decreasing the credit worthiness of the issuer of the structured note.

3 Single Name Credit Risk

3.1 Building an ASW VBA function

See the solution spreadsheet for an example of how this can be implemented. The question can obviously be solved in multiple ways, but students should show demonstrate some knowledge of VBA and the ability to develop on top of existing functions.

3.2 Estimating an ASW curve

The par-par ASW spreads for the bonds can be found and the associated graph can be found below and in the solution spread sheet.

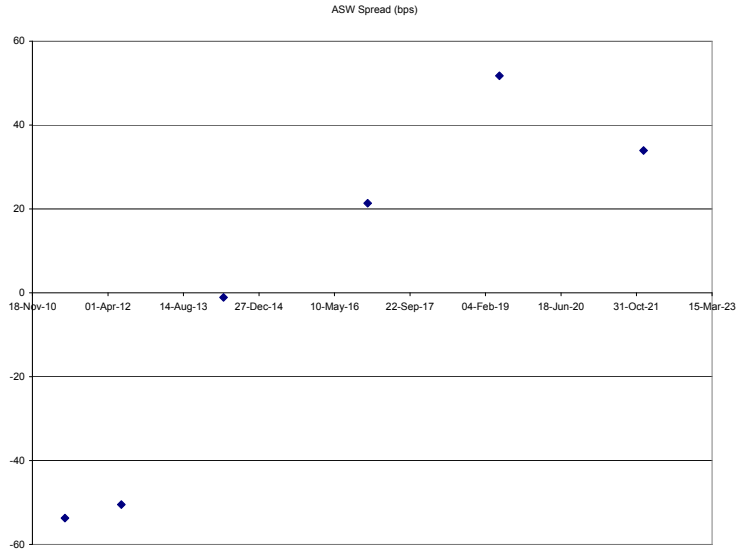
Bond Description	ASW spread
DANGAS 4.625 11	-53.72
DANGAS 3.5 12	-50.52
DANGAS 4.875 14	-1.11
DANGAS 4 16	21.39
DANGAS 6.5 19	51.76
DANGAS 4.875 21	33.94

For the shortest dated bonds (with a remaining maturity of up to 4 years) the credit quality of the issuer is better than the swap curve since their ASW spreads are negative. For the longer dated bonds, the credit quality is worse than the swap curve's since the ASW levels are positive.

3.3 Foreign currency funding

The supplied EUR curve allows us to calculate the 4Y year par EUR/USD CCS spread. This spread is -22 bps. By issuing bonds at USD LIBOR flat, the issuer could use the EUR/USD CCS to swap the proceeds from an USD denominated issue into EUR. The issuer should thus pay the USD notional in the initial exchange (that is received from the bond issue) of swap and simultaneously receive the EUR notional. Against this, the issuer would pay EURIBOR-22bps and receive USD LIBOR flat. These USD LIBOR payments

Figure 2: Yield curves in 3M points.



could then be passed on in a liability swap of the USD bond issue. Effectively, the issuer would thus pay EURIBOR - 22 bps.

Since the issuer's existing 4Y bond is trading roughly flat to the EURIBOR curve, it would be attractive to issue the 4Y USD bond.

3.4 Calibrating a CDS curve

The par spread for an odd-date CDS maturing on 16 December 2016 is 67.6 bps. The value of paying 67.6 bps in a CDS on a EUR 50m notional on the calibrated intensity curve is 2,017,191. The value of paying 100 bps is EUR 2,984,541. For the CDS to be fair (paying a fixed coupon of 100 bps), the protection buyer should thus receive 2,984,541-2,017,191=967,350 upfront. The acceptable numerical deviation is EUR $\pm 30,000$.

3.5 The cash-CDS basis

No, it does not represent an arbitrage opportunity. The cash-CDS basis arises from several factors. Students should be able to recognize this from the lecture notes and point towards at least differences funding liquidity and counter party risk as being as drivers of the cash-CDS basis.

4 Risk management

4.1 Calculating VaR and ES on a bond position

The task is simply to calculate some basic descriptive statistics on the 1-day changes in ASW spreads and relate these to the indicated Dv01's.

- Estimated 1-day VaR(95%) -725,648 (2Y) and -1,736,825 (10Y)
- Estimated 1-day ES(95%) -1,510,234 (2Y) and -2,676,344 (10Y)

The 10Y bond position is thus more risky — both when looking at the ”normal” events (VaR) and the extreme events (ES).