Counterparty Credit Risk
–Coding Assignment 3–

Professor L. Andersen

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We continue with the interest rate setup from Coding Assignment 2. That is, we consider a market where we have established at time 0 (e.g., by looking at quoted swap and futures prices) that the risk-free forward interest rate curve is given by

$$f(0,t) = a + b \cdot t$$

where $a = 3\%$ and $b = 0.2\%$. Assume also that we have established that the floating index curve is related to the risk-free curve through the relation

$$f_L(t,T) = f(t,T) + s$$

for any t and T (with $T \geq t$). Assume that $s = 0.5\%$.

The dynamics of the forward curve $f(t,T)$ is as in Coding Assignment 2: a 2-factor Gaussian model with $\sigma_r = 2\%$, $c = 40\%$, $\kappa_2 = 5\%$, $\rho_\infty = 40\%$.

We also consider, as in Coding Assignment 2, a 10-year semi-annual interest rate swap. Let the notional of the swap be USD50 million, and let its coupon be h.

Q1 : In Coding Assignment 2, you established the expected exposure (EE) profile for uncollateralized par-valued payer and receiver swaps, on a weekly grid spanning $[0, 10\text{yrs}]$. Repeat this exercise (for both payer and receiver swaps) for the USD50 million swap, using coupons of $h = 2\%$, $h = 4\%$, $h = 6\%$, $h = 8\%$. Graph these profiles (one figure for payer swaps and one figure for receiver swaps).

Q2 : Repeat Q1, but now do the PVEE profiles, rather than the EE profiles.

In Q1 and Q2 there was no collateral. We now change this to assume that there is full variation margin (but no initial margin). Also assume that the swap is traded on an ISDA Master Agreement, and assume that the Margin Period of Risk (MPoR) is estimated at 2 weeks. You can ignore complications from any unpaid cash flows, i.e. exposure for settlement time t is $E(t) = (V(t) - V(t-\delta))^+$ where δ is two weeks.

Q3 : Compute and graph the EE and PVEE profiles (weekly spacing) for the collateralized payer and receiver swaps.

Now set the coupon on the swap equal to its par rate h_{par} (computed in Coding Assignment 2). In addition to full variation margin, also add dynamic initial margin set at the confidence level p.

Q4 : Using the scaling approximation from Lecture 5, show the EE profile on a weekly grid for $p = 80\%, 90\%, 99\%, 99.9\%$. It suffices to do this for the payer swap.

Assume that the swap is traded between a bank B and client A. Suppose that the default intensity of B is constant at $\lambda_B = 2\%$, and the default intensity of A is constant at $\lambda_A = 4\%$. Assume that B and A both have recovery rates of 40%. We take the perspective of B.

Q5 : Compute B's *unilateral* CVA to A for both payer and receiver swaps, at coupon rates of $h = 2\%$, $h = 4\%$, $h = 6\%$, $h = 8\%$. Do this with i) no collateral; ii) full variation margin; and iii) full variation margin and initial margin at level $p = 99\%$. As before, use a MPoR of 2 weeks. Collect the result in a neat table and write some insightful comments on the magnitudes of the numbers.

Q6 : Repeat Q5, but now for B's *bilateral* CVA.

We now turn to FVA and MVA computations. Let the credit spread of bank B be constant at $s_B = 1.2\%$. We recall that positions with full VM is associated with no FVA, so we only need to compute FVA for the uncollateralized swap; it is zero for the collateralized swaps. MVA is associated with positions that have initial margin.

Q7 : Compute B's FVA for the uncollateralized swap position, for both payer and receiver swaps. Do the calculation for $h = 2\%$, $h = 4\%$, $h = 6\%$, $h = 8\%$. Show results in a table, and comment on the signs of the numbers. Specifically explain why are some of the numbers are negative.

Q8 : Use the scaling results in Lecture 8 to compute MVA for the swap with full VM and IM at level $p = 99\%$. Do this for both payer and receiver swaps, $h = 2\%$, $h = 4\%$, $h = 6\%$, $h = 8\%$. Collect the results in a table and explain whether the drop in CVA from the introduction of IM (can be gleaned from the results of Q5 above) justify the MVA cost to B's shareholders.