# Credit Risk: Coursework XVA

Jeroen Kerkhof

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# Coursework: Introduction

- The aim of the coursework is to get familiar with xva valuations. It is recommended that you read the slides of Lecture $4$ before you do the coursework.
- The results can be obtained using Python, matlab, R or other software packages.
- The results should be uploaded on the blackboard no later than 14 July 2020.
- Please make sure the answers are to-the-point and concise. The results should be summarised on no more than $2/3$ pages.

# Analytical valuation of CVA / DVA equity swap

Use the Black-Scholes Model with $\mu = 8\%$, $r = 4\%$, $\sigma = 16\%$, $q = \lambda = 2\%$, and $T = 5$. Total notional on the swap equals $100m$ and recovery equals $40\%$. The bank is paying the fixed leg with a fixed rate equal to $4\%$. For these computations you may assume a discrete time grid.

- Compute the analytical value of an annual equity swap using the Black-Scholes model.
- Compute the Expected Exposure.
- Compute the Expected Positive Exposure.
- Compute the Expected Negative Exposure.
- Compute the Potential Future Exposure with $95\%$.
- Compute the CVA and DVA.

# Analytical valuation of CVA / DVA equity swap portfolio

Use the Black-Scholes Model with $\mu = 8\%$, $r = 4\%$, $\sigma = 16\%$, $q = 2\%$, and $T = 5$. We now consider a portfolio of 5 independent equity swaps (i.e. for 5 different stocks) with a notional of $20$ each. Again the bank is paying the fixed leg. For these calculations you may assume a discrete time grid.

- Compute the analytical value of an equity swap using the Black-Scholes model.
- Compute the Expected Exposure.
- Compute the Expected Positive Exposure.
- Compute the Expected Negative Exposure.
- Compute the Potential Future Exposure with $95\%$.
- Compute the CVA and DVA.
- Compare the numbers to the numbers for the single equity swap. As a bank, which position would you prefer.

# Monte-Carlo valuation of CVA / DVA equity swap portfolio

Use the Black-Scholes Model with $\mu = 8\%$, $r = 4\%$, $q = 2\%$, and $\sigma = 16\%$. We now consider a portfolio of 5 independent equity swaps (i.e. for 5 different stocks) with a notional of $20$ each. Again the bank is paying the fixed leg.

- Same as before, but now use Monte-Carlo simulation.
- Use $2^{17}$ simulations.

# Monte-Carlo valuation of CVA / DVA equity swap portfolio

Use the Black-Scholes Model with $\mu = 8\%$, $r = 4\%$, $q = 2\%$, and $\sigma = 16\%$. We now consider a portfolio of 5 independent equity swaps (i.e. for 5 different stocks) with a notional of $20$ each. Again the bank is paying the fixed leg.

- Same as before, but now use Monte-Carlo simulation with a monthly time grid (e.g. cash flows are still the same, but default can happen at the end of every month instead of every year).

# Equity Swap

- An equity swap exchanges equity returns vs a fixed coupon on regularly set intervals.
- The fixed coupon equals $K$.
- The floating coupon equals $\log(S(T_i)/S(T_{i-1}))$.

Black-Scholes model under physical measure:

$$\frac{dS(t)}{S(t)} = \mu dt + \sigma dW(t) \tag{1}$$

$$\frac{dB(t)}{B(t)} = r dt \tag{2}$$

Hint: For the equity swap the Bachelier Model option pricing formula is going to be useful.

# Bachelier Formula

Let's consider a Normally distributed random variable, $X \equiv \mathcal{N}(\mu, \sigma^2)$. Then we have that

$$\mathbb{E}\left[(X-K)_+\right] = (\mu - K)\Phi\left(\frac{\mu - K}{\sigma}\right) + \sigma\phi\left(\frac{\mu - K}{\sigma}\right), \quad (3)$$

with $\phi$ denoting the pdf of the standard Gaussian distribution and $\Phi$ denoting the cdf of the standard Gaussian distribution.

$$\mathbb{E}\left[(K-X)_+\right] = (K - \mu)\Phi\left(\frac{K - \mu}{\sigma}\right) + \sigma\phi\left(\frac{\mu - K}{\sigma}\right). \quad (4)$$

I leave the discounting to you.