# Certificate Pricing

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# 1 Problem Statement

On the 15th of February 2008 at 10:45 C.E.T., Bank XX considered issuing a certificate with the terms described in Annex 1 and hedging it with a swap described in Annex 2 in the **Appendix**. The aim of this study is to value the upfront X% that the bank should receive under mid-market conditions. Interest rates and EURO STOXX dynamics are assumed to be independent.

# 2 Bootstrap

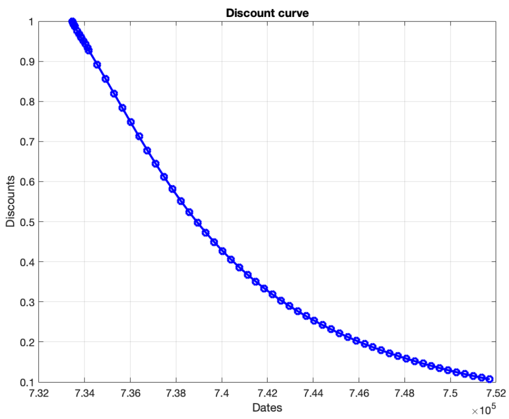
First, it is necessary to retrieve the Discount Factors curve. To do this, I use the Bootstrap technique, a non-parametric approach that exactly reproduces quoted prices of liquid instruments in the IR market.

In order to do this, I consider the interbank (IB) market on the 15th of February 2008 at 10:45 C.E.T. **MktData_CurveBootstrap** contains quoted rates relative to different instruments - Interbank deposits, STIR Futures (short-term interest rate futures), and IR Swaps (interest rate swaps). Among these, I use the most liquid instruments to build the discount factor curve.

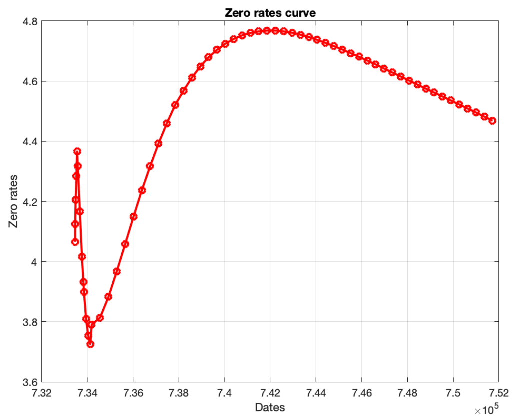
In particular, I construct the curve via IB deposits up to the first STIR Future. Secondly, I refer to Future contracts. These are issued every 3 months, and the first seven contracts are known to be very liquid. Finally, I move to Swaps, whose liquidity is highlighted by a relatively small bid-ask spread.

I interpolate using linear interpolation on zero rates instead of discount factors and use the Act/365 convention whenever exponential argument time-to-maturity.

Figure 1a shows that the obtained discount curve follows a log-linear evolution in time. On the other hand, the zero rates curve could hypothetically be divided into three different sections, each one reflecting the corresponding zero rates curve (zero rates corresponding to IB Deposits, STIR Futures rates, and zero rates of Swaps) after stages of adjustment (figure 1b).




(a) Discount curve




(b) Zero rate curve

Figure 1: Discount and Zero Rate Curves

# 3 Valuation under Mid-Market Conditions

After selling the certificate (likely to a retail client, Annex 1), Bank XX swaps the instrument with an investment bank (IB) (Annex 2). Thus, from the bank's point of view, there are two scenarios depending on the underlying Stoxx50 index.

In the first case, the bank has to pay Euribor 3m + spol for 1 year and receives a coupon of 6% at 1 year if, two days prior to the payment date, the underlying EURO STOXX is lower than the strike (Figure 2; I have already exploited the telescopic to represent the EURIBOR payments - see below).

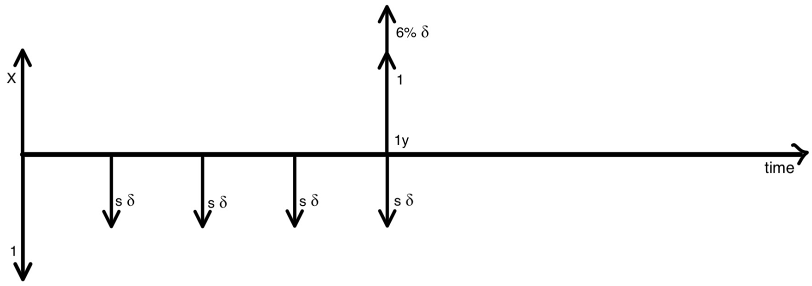



Figure 2: CASE A

Otherwise, the bank receives a coupon of 2% at 2 years and pays Euribor 3m + spol for 2 years (Figure 3).

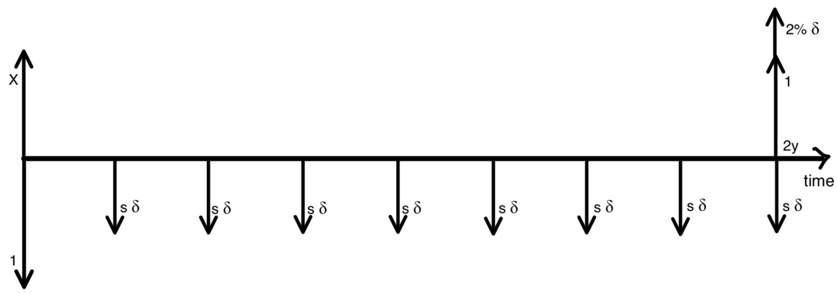



Figure 3: CASE B

To compute the upfront X% that the bank should receive under mid-market conditions, I set the Net Present Value (NPV) equal to 0:

$$\begin{aligned}\mathrm{NPV} = \mathbb{E}^0 \Bigg[ & 1_{\{\mathrm{Stoxx50}(T_{check})<K\}} \left( X + \delta(t_0, t_{1y})c_1 - \sum_{i=0}^{9m} D(t_0, t_{i+1})(s_{\mathrm{spol}} + L(t_i, t_{i+1}))\delta(t_i, t_{i+1}) \right) \\ & + 1_{\{\mathrm{Stoxx50}(T_{check})\geq K\}} \left( X + \delta(t_0, t_{2y})c_2 - \sum_{i=0}^{1y9m} D(t_0, t_{i+1})(s_{\mathrm{spol}} + L(t_i, t_{i+1}))\delta(t_i, t_{i+1}) \right) \Bigg]\end{aligned}$$

Assuming the independence between rates and stock dynamics and by exploiting the linearity of the expectation, the second expression can be written as

$$\begin{aligned}& \mathbb{E}^0 \left[ 1_{\{\mathrm{Stoxx50}(T_{check})<K\}} \right] \left( X + \delta(t_0, t_{1y})c_1 - \sum_{i=0}^{9m} \mathbb{E}^0 \left[ D(t_0, t_{i+1})(s_{\mathrm{spol}} + L(t_i, t_{i+1}))\delta(t_i, t_{i+1}) \right] \right) \\ & + \mathbb{E}^0 \left[ 1_{\{\mathrm{Stoxx50}(T_{check})\geq K\}} \right] \left( X + \delta(t_0, t_{2y})c_2 - \sum_{i=0}^{1y9m} \mathbb{E}^0 \left[ D(t_0, t_{i+1})(s_{\mathrm{spol}} + L(t_i, t_{i+1}))\delta(t_i, t_{i+1}) \right] \right)\end{aligned}$$

Eventually exploiting the following relation:

$$\delta(t_0, t_1)L(t_0, t_1)B(t_0, t_1) = 1 - B(t_0, t_1)$$

and recognizing a telescopic sum, the latter is equivalent to:

$$\begin{aligned}& \mathbb{E}^0 \left[ 1_{\{\mathrm{Stoxx50}(T_{check})<K\}} \right] \left( X - 1 + B(t_0, t_{1y}) + \delta(t_0, t_{1y})c_1 - \sum_{i=0}^{9m} B(t_0, t_{i+1})s_{\mathrm{spol}}\delta(t_i, t_{i+1}) \right) \\ & + \mathbb{E}^0 \left[ 1_{\{\mathrm{Stoxx50}(T_{check})\geq K\}} \right] \left( X - 1 + B(t_0, t_{2y}) + \delta(t_0, t_{2y})c_2 - \sum_{i=0}^{1y9m} B(t_0, t_{i+1})s_{\mathrm{spol}}\delta(t_i, t_{i+1}) \right)\end{aligned}$$

Thus, the main task is to determine the quantities $\mathbb{E}^0\left[1_{\{\text{Stoxx50}(T_{check})<K\}}\right]$ and $\mathbb{E}^0\left[1_{\{\text{Stoxx50}(T_{check})\geq K\}}\right]$. However when knowing how to compute one, the other is for free as will be explained. It is possible to solve the problem both through closed formulas and through Monte Carlo techniques. I will start with the first methods.

# 4 Lewis' Closed Formula

When using analytical methods, which provide a pointwise result, it can be immediately observed that $\mathbb{E}^0\left[1_{\{\text{Stoxx50}(T_{check})<K\}}\right]$ is equivalent to the probability of being in the first scenario described above. Consequently, the event $\{\text{Stoxx50}(T_{check}) \geq K\}$ is the complementary event, thus

$$\mathbb{E}^0\left[1_{\{\text{Stoxx50}(T_{check})\geq K\}}\right] = 1 - \mathbb{E}^0\left[1_{\{\text{Stoxx50}(T_{check})<K\}}\right]$$

I start by examining the forward dynamics and leveraging a revised version of Lewis' formula.

Expressing $S_t$ in terms of the forward dynamics, I have:

$$S_t = F(t,t) = F_0 e^{f_t}$$

Specifically,

$$S_t \geq k \iff f_t \geq -\log(F_0/k) \equiv -x$$

Let $p$ and $\Phi$ be the density and characteristic function of $f_t$, respectively. From now on I will indicate with abuse of notation $f_t$ as a specific point.

Recall that for a function $\omega(\cdot)$, its Fourier transform is defined as:

$$\hat{\omega}(\xi) = \int_{-\infty}^{+\infty} e^{-i\xi f_t}\omega(f_t)df_t$$

The inverse Fourier transform of $\hat{\omega}$ is given by:

$$\omega(f_t) = \frac{1}{2\pi}\int_{-\infty}^{+\infty} e^{i\xi f_t}\hat{\omega}(\xi)d\xi$$

In general, I can compute $\mathbb{E}^0[\omega(f_t)]$ as:

$$\mathbb{E}^0[\omega(f_t)] = \int_{-\infty}^{+\infty} df_t\omega(f_t)p(f_t) = \frac{1}{2\pi}\int_{-\infty}^{+\infty} df_t p(f_t)\left[\int_{-\infty}^{+\infty} d\xi\hat{\omega}(\xi)e^{i\xi f_t}\right]$$

I can use Fubini-Tonelli's theorem if $\omega(\cdot)$ is bounded (and since in this case $\omega(f_t) = 1_{f_t\geq -x}$, thus boundedness is guaranteed) and exchange the integration order:

$$= \frac{1}{2\pi}\int_{-\infty}^{+\infty} d\xi\hat{\omega}(\xi)\left[\int_{-\infty}^{+\infty} df_t p(f_t)e^{i\xi f_t}\right]$$

where I notice that the second integral is the definition of the characteristic function of $f_t$:

$$\Phi(\xi) = \int_{-\infty}^{+\infty} df_t p(f_t)e^{i\xi f_t}$$

So eventually:

$$\mathbb{E}^0[\omega(f_t)] = \frac{1}{2\pi}\int_{-\infty}^{+\infty} d\xi\hat{\omega}(\xi)\Phi(\xi) = \frac{1}{2\pi}\int_{-\infty}^{+\infty} d\xi\Phi(\xi)\left[\int_{-\infty}^{+\infty} e^{-i\xi f_t}\omega(f_t)df_t\right]$$

In this case, $\omega(f_t) = 1_{f_t\geq -x}$. Thus:

$$\mathbb{E}\left[1_{f_t\geq -x}\right] = \frac{1}{2\pi}\int_{-\infty}^{+\infty} d\xi\Phi(\xi)\left[\int_{-\infty}^{+\infty} e^{-i\xi f_t}1_{f_t\geq -x}df_t\right] = \frac{1}{2\pi}\int_{-\infty}^{+\infty} d\xi\Phi(\xi)\left[\int_{-x}^{+\infty} e^{-i\xi f_t}df_t\right]$$

$$= \frac{1}{2\pi}\int_{-\infty}^{+\infty} d\xi\Phi(\xi)\frac{e^{i\xi x}}{i\xi}$$

where I supposed that

$$\lim_{f_t \to +\infty} e^{-i\xi f_t} = 0$$

obtained by requiring $Im(\xi) < 0$.

Let $\xi' = -\xi$. The latter integral becomes:

$$\lim_{R\to+\infty} \frac{1}{2\pi} \int_{-R}^{+R} d\xi' \Phi(-\xi') \frac{e^{-i\xi' x}}{-i\xi'}$$

By defining $\xi'' = \xi' - i\frac{1}{2}$ , I have:

$$\lim_{R\to+\infty} \frac{1}{2\pi} \int_{-R-i\frac{1}{2}}^{+R-i\frac{1}{2}} d\xi'' \Phi(-\xi'' - i\frac{1}{2}) \frac{e^{\frac{1}{2}x - ix\xi''}}{\frac{1}{2} - i\xi''}$$

And by exploiting integration rules in the complex plane (imposing the circuitation equal to zero and neglecting the integral on the vertical lines as $R \to \infty$), it is equivalent to:

$$\lim_{R\to+\infty} \frac{1}{2\pi} \int_{-R}^{+R} d\xi'' \Phi(-\xi'' - i\frac{1}{2}) \frac{e^{\frac{1}{2}x - ix\xi''}}{\frac{1}{2} - i\xi''} = \frac{1}{2\pi} \int_{-\infty}^{+\infty} d\xi'' \Phi(-\xi'' - i\frac{1}{2}) \frac{e^{\frac{1}{2}x - ix\xi''}}{\frac{1}{2} - i\xi''}$$

Which now is an integral on $\mathbb{R}$, thus only the real part of the integral is considered. I remind that $x = \log\left(\frac{F}{K}\right)$, i.e. the log-moneyness.
It can be proven that this result is also equal to

$$\frac{1}{\pi} \int_0^\infty \text{Re}\left[e^{iu\xi} \Phi(u)/iu\right] \, du - \frac{1}{2}$$

For further insights, see **A Simple Option Formula for General Jump-Diffusion and Other Exponential Levy Processes, Alan L. Lewis, 2001**. Briefly, it is the second term of the European Call formula, equivalent to the expectation of interest.

At this point, a choice has to be made on how to model the log return of the forward dynamics, which will lead to the expression of the characteristic function. A common choice is a Normal Mean-Variance Mixture:

$$f_t = \sqrt{(t-t_0)}\sigma\sqrt{G}g - \left(\frac{1}{2} + \eta\right)(t-t_0)\sigma^2 G - \ln(L(\eta))$$

where $g$ is a standard normal random variable, $G$ is a positive random variable with unitary mean and variance $k/(t-t_0)$, and the two random variables are independent; the remaining are parameters. In particular, $G$ is chosen to be a normal tempered stable positive random variable (N.T.S).

In this case the characteristic function of $f_t$ is given by

$$\Phi(\xi) = \exp\left\{-i\xi \ln L[\eta]\right\} L\left[\frac{\left(\eta^2 + i(1+2\eta)\xi\right)}{2}\right]$$

where $L(\cdot)$ is the Laplace transform of $G$. The Laplace exponent is

$$\ln(L(w)) = \frac{\Delta t}{k}\frac{1-\alpha}{\alpha}\left(1 - \left(1 + \omega k\sigma^2/(1-\alpha)\right)^\alpha\right)$$

with $\alpha \in (0, 1]$.

I opt to select $\alpha = \frac{1}{2}$ as a benchmark, i.e., the N.I.G. case.

## 4.1 Calibration

Given the previous results, it is necessary to calibrate the three parameters $\sigma$, $\eta$, and $\kappa$. These represent respectively the average, the asymmetry and the convexity of the implied volatility curve. I do this both for the benchmark $\alpha = \frac{1}{2}$ (NIG case) and for $\alpha = \frac{1}{3}$. To achieve this, I consider the SP500 volatility surface on February 15, 2008.

First, I compute the market prices given the volatility surface.

Second, using Lewis' formula for a European call

$$c(x) = B(t_0, t)F_0 \left(1 - e^{-x/2} \int_{-\infty}^{\infty} \frac{d\xi}{2\pi} e^{-i\xi x} \Phi(-\xi - \frac{i}{2}) \frac{1}{\xi^2 + \frac{1}{4}}\right)$$

where $\Phi(\xi)$ is defined as above, I compute this integral as a function of the parameters $\sigma$, $\kappa$, and $\eta$ using built-in quadrature integration techniques.

I then minimize the following expression over the set of the three parameters:

$$\sum_{i=1}^{N} w_i \left(C^{\text{model}}(\sigma, \kappa, \eta) - C^{\text{market}}\right)^2$$

under the following constraints:

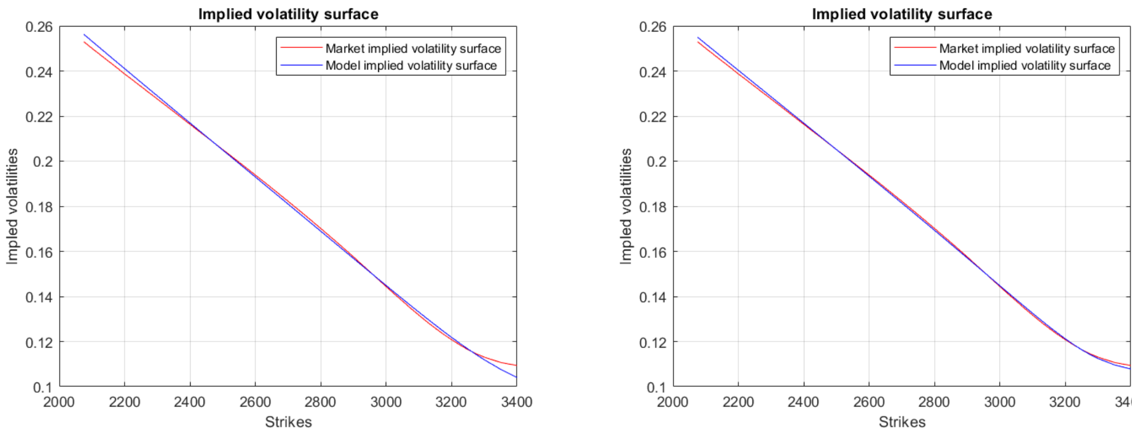
$$\kappa \geq 0; \sigma \geq 0; \eta > -\frac{1-\alpha}{\kappa\sigma^2}$$

To achieve this result, I use the built-in MATLAB function **fmincon**, which finds the minimum of a constrained nonlinear multivariable function. The results are reported in Table 1.

| | $\sigma$ | $\eta$ | $\kappa$ |
|---|---|---|---|
| $\alpha = \frac{1}{2}$ | 0.1040 | 12.7326 | 1.3161 |
| $\alpha = \frac{1}{3}$ | 0.1242 | 7.0422 | 1.6725 |

Table 1: Calibrated parameters

Figures 4a and 4b show the market and the calibrated model implied volatility surfaces compared.




(a) Model/Market implied volatility surface using quadrature integral computation for $\alpha = \frac{1}{2}$

(b) Model/Market implied volatility surface using quadrature integral computation for $\alpha = \frac{1}{3}$

Figure 4: Comparison of market and calibrated model implied volatility surfaces

It can be observed that the error (in terms of implied volatility) is higher for deeper in-the-money (ITM) and out-of-the-money (OTM) calls, whereas it is generally lower as the strike price approaches today's stock value. The strikes which correspond to the three highest and lowest errors are reported in Tables 2 and 3, along with the corresponding errors (in bps). The errors are computed using the $\mathbb{L}^\infty$ norm and have been normalized.

| | Max Error | | | Min Error | | |
|---|---|---|---|---|---|---|
| Strike | 3400 | 3350 | 2075 | 2475 | 2450 | 2500 |
| Error (bps) | 487.4200 | 274.6794 | 129.8927 | 0.3410 | 7.2000 | 9.0175 |

Table 2: Strikes with Maximum and Minimum Errors and Corresponding Error Values (in bps) for $\alpha = \frac{1}{2}$

| | Max Error | | | Min Error | | |
|---|---|---|---|---|---|---|
| Strike | 3400 | 3350 | 2100 | 2500 | 3250 | 2950 |
| Error (bps) | 141.5645 | 96.3112 | 78.7514 | 0.5881 | 4.4446 | 4.9226 |

Table 3: Strikes with Maximum and Minimum Errors and Corresponding Error Values (in bps) for $\alpha = \frac{1}{3}$

In particular, the average error is given by:

| | Average Error | |
|---|---|---|
| Alpha | $\frac{1}{2}$ | $\frac{1}{3}$ |
| Error (bps) | 75.1702 | 42.5714 |

Table 4: Average Errors for Different Values of $\alpha$

## 4.2 Results of the approach

Having calibrated the parameters, it is possible to compute the expectation using the closed formula deduced above and finally to find the upfront by setting the previous NPV to 0. I opt for quadrature methods since it is not computationally expensive in this case. The results are as follows (table 5):

| | $\alpha = \frac{1}{2}$ | $\alpha = \frac{1}{3}$ |
|---|---|---|
| Contract's Upfront (bps) | 248.9049 | 245.0882 |
| I.B. Payment at Start Date (EUR) | 248,904.9196 | 245,088.2207 |

Table 5: Contract Upfront for Different Values of $\alpha$

# 5 Black's closed formula (digital risk)

Another option to compute the expectation is by recognizing, as before, that it is strictly related to the payoff of a digital option, thus Black's formula can be applied. I use the corrected version since it takes into account the digital risk (the impact related to the dependence of $\sigma$ on $K$):

$$B(t_0,t)\mathbb{E}[\mathbf{1}_{S_t \geq K}] = dc_B(K) = -\frac{\partial c_B(K)}{\partial K} = B(t_0,t)N(d_2) - \frac{\partial \sigma(K)}{\partial K}\frac{\partial c_B[K,\sigma(K)]}{\partial \sigma}$$

By dividing by $B(t_0,t)$ I obtain the quantity of interest. In order to do so I evaluate the slope impact $\frac{\partial \sigma(K)}{\partial K}$ as the slope of the straight line passing by the 2 closest points at K, whereas I recognize $\frac{\partial c_B[K,\sigma(K)]}{\partial \sigma}$ as the $\nu$ of the call option.

This approach leads to the following result (table 6):

| | Value |
|---|---|
| Contract's Upfront (bps) | 236.3981 |
| Party B Payment at Start Date (EUR) | 236,398.0523 |

Table 6: Contract Upfront

The absolute and the relative errors compared to the previous approaches are (table 7):

| Approach | Absolute Error (bps) | Relative Error (%) |
|---|---|---|
| Lewis' closed, $\alpha = \frac{1}{2}$ | 12.5069 | 5.0248 |
| Lewis' closed, $\alpha = \frac{1}{3}$ | 8.6902 | 3.5457 |

Table 7: Absolute and Relative Errors

# 6 Monte Carlo

Another possible approach is to use Monte Carlo methods instead of relying on closed formulas. Specifically, I simulate EURO STOXX dynamics using Monte Carlo, assuming the log-forward dynamics as described in the section **Lewis' Closed Formula** and utilizing the calibrated parameters from earlier.

- I compute the initial forward condition as

$$F_0 = S_0 e^{((r(t_0,T_{\text{check}})-d)(T_{\text{check}}-t_0))}$$

  where $T_{\text{check}} - t_0$ is computed using Act365.

- I simulate the forward according to the dynamics discussed above:

$$F(t_{\text{check}}, T_{\text{check}}) = F_0 e^{f_{T_{\text{check}}}}$$

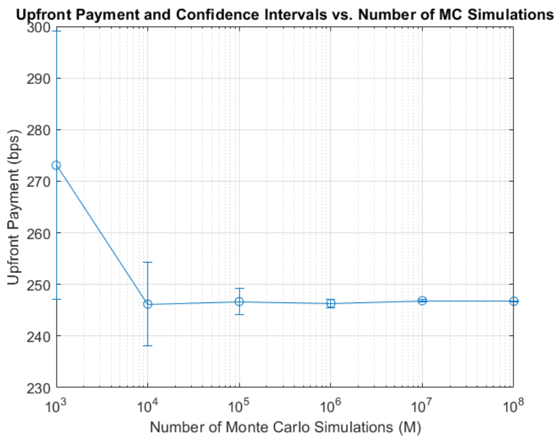
$$f_{T_{\text{check}}} = \sqrt{T_{\text{check}} - t_0}\sigma\sqrt{G}g - \left(\frac{1}{2} + \eta\right)(T_{\text{check}} - t_0)\sigma^2 G - \ln L$$

- Knowing that $S(T_{\text{check}}) = F(T_{\text{check}}, T_{\text{check}})$, it is possible to assess whether $Stoxx50(T_{check}) < K$ (case A) or not (case B). For each simulation I compute the upfront X by setting the total NPV to 0.

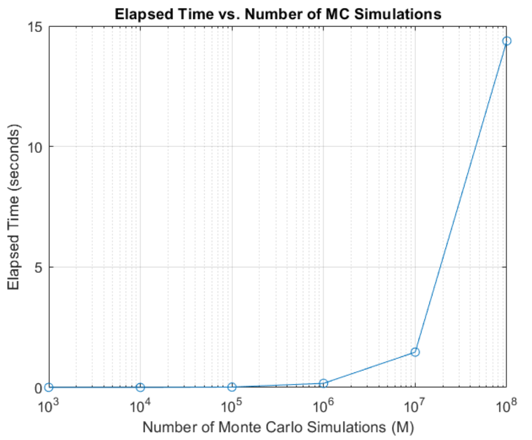
Table 8 and figures 5a, 5b report the 95% confidence interval and the Monte Carlo simulation computational times for $\alpha = \frac{1}{2}$ as a function of the number of Monte Carlo simulations M.

| $M$ | Upfront Payment | CI Lower | CI Upper | Elapsed Time |
|---|---|---|---|---|
| $10^3$ | 273.0761 | 247.0810 | 299.0713 | 0.0054 |
| $10^4$ | 246.1623 | 238.0838 | 254.2408 | 0.0028 |
| $10^5$ | 246.6696 | 244.1141 | 249.2250 | 0.0178 |
| $10^6$ | 246.3136 | 245.5057 | 247.1215 | 0.1714 |
| $10^7$ | 246.8428 | 246.5873 | 247.0984 | 1.4672 |
| $10^8$ | 246.7404 | 246.6596 | 246.8213 | 14.3774 |

Table 8: Upfront Payments, Confidence Intervals (in bps), and Elapsed Time (in seconds) for Different Values of $M$ for $\alpha = \frac{1}{2}$




(a) Upfront 95% confidence intervals (in bps) as a function of M



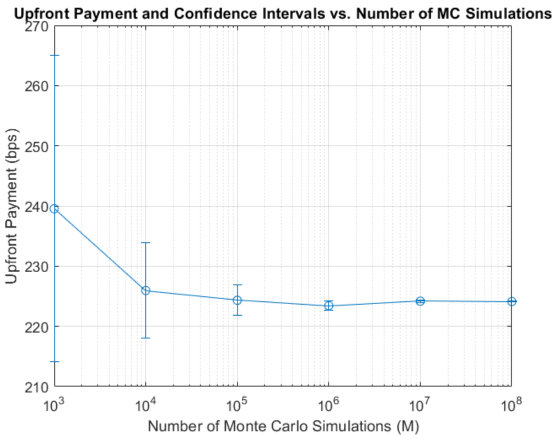

(b) Elapsed times (in seconds) as a function of M

Figure 5: Monte Carlo result for $\alpha = \frac{1}{2}$

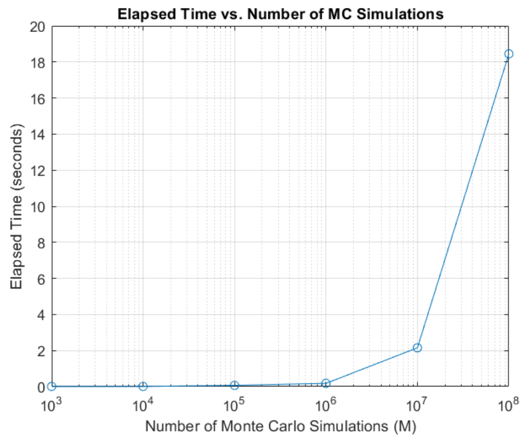
It can be observed that, as expected, as the number of Monte Carlo simulations increases, the pointwise upfront payment stabilizes, and the length of the confidence intervals narrows. However, the drawback is that the elapsed times increase. Results for $\alpha = \frac{1}{3}$ are reported in table 9 and figures 6a and 6b.

| $M$ | Upfront Payment | CI Lower | CI Upper | Elapsed Time |
|---|---|---|---|---|
| $10^3$ | 239.5413 | 214.1088 | 264.9737 | 0.0079 |
| $10^4$ | 225.9554 | 218.0052 | 233.9055 | 0.0085 |
| $10^5$ | 224.3302 | 221.8198 | 226.8406 | 0.0687 |
| $10^6$ | 223.4359 | 222.6427 | 224.2292 | 0.1802 |
| $10^7$ | 224.1864 | 223.9354 | 224.4374 | 2.1519 |
| $10^8$ | 224.1242 | 224.0449 | 224.2036 | 18.4458 |

Table 9: Upfront Payments, Confidence Intervals (in bps), and Elapsed Time (in seconds) for Different Values of $M$ for $\alpha = \frac{1}{3}$




(a) Upfront 95% confidence intervals (in bps) as a function of $M$




(b) Elapsed times (in seconds) as a function of $M$

Figure 6: Monte Carlo results for $\alpha = \frac{1}{3}$

The same considerations above hold here. However, in this case, the results differ somewhat compared to the other cases. Comparing the case with $10^8$ simulations with the closed-form formula for $\alpha = \frac{1}{3}$, there is an absolute error of 20.964 bps and a relative error of 8.55%. This is much higher than what is obtained in the case of $\alpha = \frac{1}{2}$ — an absolute error of 2.1645 bps and a relative error of 0.87%. This critical issue needs to be considered carefully, as it suggests that for $\alpha = \frac{1}{3}$, the Monte Carlo method may introduce significant discrepancies when compared to the closed-form solution.

# 7 Final Remarks

As discussed in the preceding sections, the different approaches I have utilized produce similar results, with higher errors in some cases compared to others. The ability to use so many approaches is due to the fact that the payoff could be expressed in terms of digital options, making it relatively straightforward to apply closed-form formulas. If this had not been the case, for example, if the structured bond had a three-year expiry with an early redemption option at the end of the first two years, it would not have been possible to express the payoff in terms of digital options, and only Monte Carlo methods would have been used.

# A Annex 1: Certificate Termsheet

**Indicative Terms and Conditions as of 15th February 2008**

**Issue Termsheet**

| | |
|---|---|
| Principal Amount: | 100 MIO EUR. |
| Issue date: | 15 Feb 2008 |
| Issue price: | At par |
| Start Date: | 19 Feb 2008 |
| Maturity Date: | 2 years after the Start Date. |
| Bank XX pays: | Coupon |
| Coupon: | Payable annually on a 30/360 (mod. foll. adjust.) day basis:<br>Year 1: 6% if Stoxx50 is less than Strike at Coupon Reset Date<br>Last Year: 2%.<br>The Coupon shall be subject to the Early Redemption and Final Coupon clauses. |
| Coupon Reset Dates: | 2 Business Days prior to the respective Coupon Payment Date (i.e. in arrears). |
| Strike: | 3200 |
| Coupon Payment Dates: | Annually, subject to the Following Business Day Convention. |
| Early Redemption: | If on a respective Coupon Reset Date, the Coupon reset is such that the Cumulative Coupon Accrual would be equal or above the Trigger Level, the Notes will automatically redeem early on the respective Coupon Payment Date at a price of 100% of Par. |
| Trigger Level: | 6%. |
| Cumulative Coupon Accrual: | The Previously Paid Coupon Percentage plus the originally scheduled Coupon payment based off the respective Coupon reset on the respective Coupon Reset Date ignoring the Trigger Level clause (expressed as a percentage of the Principal Amount). |
| Previously Paid Coupon Percentage: | For a respective Coupon period, the sum of all previously paid Coupon payments on the previous Coupon Payment Dates expressed as a percentage of the Principal Amount. |

## B Annex 2: Swap Termsheet

**Indicative Terms and Conditions as of 15th February 2008**

**Swap Termsheet**

| | |
|---|---|
| Principal Amount: | 100 MIO EUR. |
| Party A: | Bank XX |
| Party B: | I.B. |
| Trade date: | today |
| Start Date: | 19 Feb 2008 |
| Maturity Date: | 2 years after the Start Date. |
| Party A pays: | Euribor 3m + 1.30%<br>The Swap shall be subject to the Early Redemption and Final Coupon clauses. |
| Party A payment dates: | Quarterly, subject to Modified Business Convention |
| Daycount: | Act/360 |
| Party B pays @ Start Date: | X% |
| Party B pays: | Coupon |
| Coupon: | Payable annually on a 30/360 (mod. foll. adjust.) day basis:<br>Year 1: 6% if Stoxx50 is less than Strike at Coupon Reset Date<br>Last Year: 2%.<br>The Swap shall be subject to the Early Redemption and Final Coupon clauses. |
| Coupon Reset Dates: | 2 Business Days prior to the respective Coupon Payment Date (i.e. in arrears). |
| Strike: | 3200 |
| Coupon Payment Dates: | Annually, subject to the Following Business Day Convention. |
| Early Redemption: | If on a respective Coupon Reset Date, the Coupon reset is such that the Cumulative Coupon Accrual would be equal or above the Trigger Level, the Swap will be automatically cancelled. |
| Trigger Level: | 6%. |
| Cumulative Coupon Accrual: | The Previously Paid Coupon Percentage plus the originally scheduled Coupon payment based off the respective Coupon reset on the respective Coupon Reset Date ignoring the Trigger Level clause (expressed as a percentage of the Principal Amount). |
| Previously Paid Coupon Percentage: | For a respective Coupon period, the sum of all previously paid Coupon payments on the previous Coupon Payment Dates expressed as a percentage of the Principal Amount. |