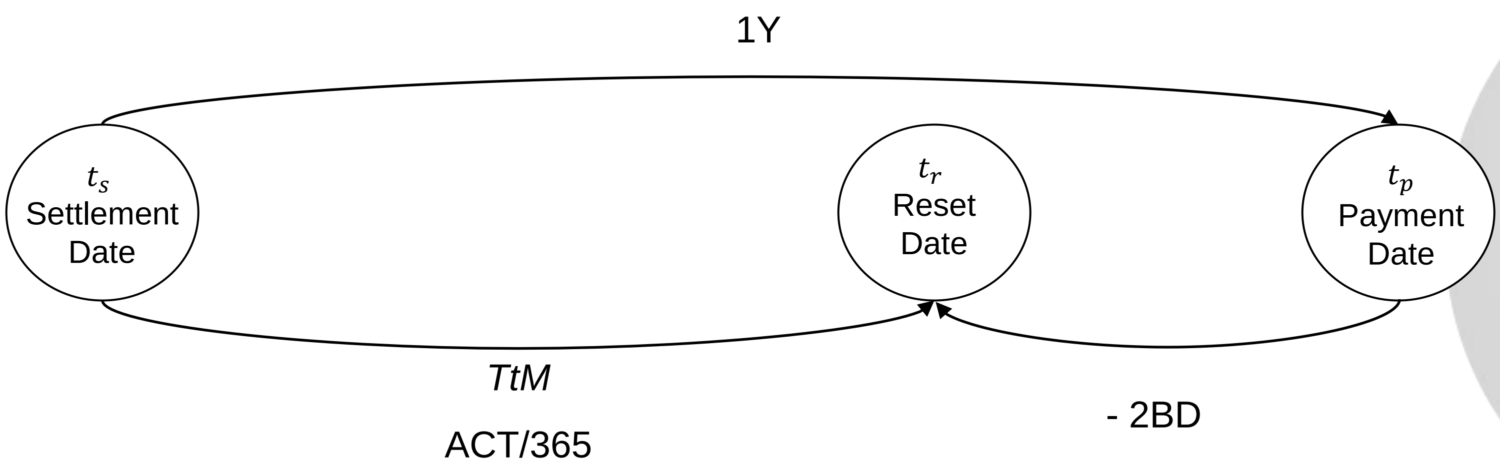
Assignment 7: Take Home Messages

1. Case study: structured bond

✓ Forward price (that refers to payment date t_p) has to be rescaled to first reset date t_r

$$F(t_r) = S \cdot exp\{[r(t_r) - d] \cdot TtM\}$$

Where S is the spot price, whereas dividend yield d is implied from forward value at t_p and spot interest rate $r(t_r)$ is given by discounting curve.



Assignment 7: Take Home Messages

Dealing with Montecarlo methods, you should always produce a report with confidence intervals (at a selected p-value) and computational times!*

Premium in bps, elapsed time in seconds

NSim	Model	IC-	IC+	|IC|	elapsed
1E+3	VG	222.4	273.6	51.2	0.2
	NIG	222.9	274.1	51.2	0.8
	BLACK	134.6	181.1	46.5	0.1
1E+4	VG	239.4	255.6	16.2	0.3
	NIG	240.0	256.2	16.2	1.1
	BLACK	140.8	155.3	14.5	0.0
1E+5	VG	245.7	250.8	5.1	0.6
	NIG	246.1	251.3	5.1	0.9
	BLACK	150.0	154.6	4.6	0.0
1E+6	VG	246.8	248.4	1.6	0.3
	NIG	247.3	248.9	1.6	0.6
	BLACK	153.2	154.6	1.5	0.2
1E+7	VG	247.2	247.7	0.5	0.4
	NIG	248.1	248.6	0.5	0.5
	BLACK	153.6	154.1	0.5	0.6
1E+8	VG	247.7	247.9	0.2	0.2
	NIG	248.8	249.0	0.2	0.4
	BLACK	153.7	153.9	0.1	9.1

Premium in bps, elapsed time in seconds

NSim	Model	IC-	IC+	|IC|	elapsed
1E+3	VG	292.8	363.5	70.7	0.6
	NIG	296.9	368.0	71.1	1.2
	BLACK	184.8	248.2	63.4	0.0
1E+4	VG	316.2	338.6	22.3	0.4
	NIG	319.6	342.0	22.4	1.0
	BLACK	196.5	216.3	19.7	0.0
1E+5	VG	325.9	333.0	7.1	0.4
	NIG	327.2	334.3	7.1	1.1
	BLACK	201.0	207.2	6.2	0.0
1E+6	VG	327.8	330.1	2.2	0.5
	NIG	331.3	333.5	2.2	1.1
	BLACK	202.9	204.9	2.0	0.2
1E+7	VG	327.3	328.0	0.7	0.4
	NIG	331.5	332.2	0.7	1.0
	BLACK	203.2	203.9	0.6	1.3
1E+8	VG	327.7	327.9	0.2	0.3
	NIG	331.8	332.0	0.2	1.0
	BLACK	203.7	203.9	0.2	14.2

Assignment 7: Take Home Messages

Upfront empirical normal distribution changing Montecarlo number of samples (from left to right, Black, NIG and VG)

Assignment 7: Take Home Messages

Considering option log-moneyness $x = \log \frac{F}{K}$, closed formula solution for digital call price $dc(x)$, as an example for NIG or VG processes with parameters $\{\sigma, \eta, k\}$, are two-folds:

1. Given the return's characteristic function $\Phi_{\Delta t,\sigma,k,\eta}(\xi), \{\xi \in \mathbb{C}, -1 \leq Im(\xi) \leq 0\}$

$$dc(x) = B(t_0,t) \cdot e^{\frac{x}{2}} \int_{-\infty}^{\infty} \frac{d\xi}{2\pi} \cdot \frac{e^{-i \cdot x \cdot \xi}}{\frac{1}{2} - i \cdot \xi} \cdot \Phi_{\Delta t,\sigma,k,\eta}\left(-\xi - \frac{i}{2}\right)$$

2. Given the return's probability density $\mathcal{P}(G; k, \Delta t)$ and Laplace exponent $\log \mathcal{L}_{\Delta t,\sigma,k}[\eta]$

$$dc(x) = B(t_0,t) \cdot \int_{0}^{\infty} dG \cdot \mathcal{P}(G; k, \Delta t) \cdot N\left(\frac{x - \eta\Delta t\sigma^2 G - \log \mathcal{L}_{\Delta t,\sigma,k}[\eta]}{\sqrt{\Delta t\sigma^2 G}} - \frac{1}{2}\sqrt{\Delta t\sigma^2 G}\right)$$

Assignment 7: Take Home Messages

Considering option log-moneyness $x = \log\frac{F}{K}$, digital call price $dc(x)$, with Black correction

$$dc_{BLACK\_corr} = N(d2) - \frac{\partial\sigma}{\partial K} Vega = \lim_{\epsilon\to 0}(c_{BLACK}(K) - c_{BLACK}(K+\epsilon))/\epsilon$$

If your calibration works: $dc_{BLACK\_corr} \sim dc_{NIG}$

$\Downarrow$

If your calibration works for the two years certificate: $\boldsymbol{X_{BLACK\_corr} = X_{NIG}}$

The same does not hold for the three year case because you cannot write it in terms of digital options.

Assignment 7: Take Home Messages

 # Time Steps = 100

Model	Price [bps]
Upper Bound	886.5
Trinomial Tree	218.0
Lower Bound	148.0
Jamshidian 2Y-8Y	81.8
Jamshidian 3Y-7Y	120.3
Jamshidian 4Y-6Y	142.3
Jamshidian 5Y-5Y	148.0
Jamshidian 6Y-4Y	140.1
Jamshidian 7Y-3Y	119.2
Jamshidian 8Y-2Y	87.5
Jamshidian 9Y-1Y	47.3


The End