Homework 5: IMC assignment

Francisco García Flórez, Joris van Lammeren, Wouter Varenkamp

Abstract. In this homework we solve several exercises related to option trading proposed in the IMC guest lecture.

Exercise 1

To check when are the Q1 results for ING going to be published we checked the website `https://www.ing.com/Investor-relations.htm`, where it shows that the date is 10th of May, in 20 natural days (15 business days) as of 20th of April.

Exercise 2

Now, looking on Euronext (data attached at the end) we see the books for options expiring in April and May, right before and after the publication of the Q1 results. Since they expire the third Friday of each month, the ones in April will be done by the 21st (1 business day from today) and the ones in May by the 19th (21 business days from today).

So, using the put-call parity

$$S = C - P + Ke^{-rT} \quad ,$$

we can compute the asset price S at each time. Using only ask prices for the options (taking the point of view of someone wanting to buy) shown in the appendix, and taking the average over the strike prices, we get

$$\begin{aligned} S_c &= 14.12 \\ S_1 &= 14.11 \\ S_2 &= 13.847 \end{aligned} \quad .$$

Here we used $r = -10bps$ per year, and we can make a few remarks. In the first place, S_1 is very similar to the current asset price since it expires in one day, but in S_2 we can see the effect of the Q1 results.

Exercises 3 & 4

Using S_1 and S_2 we can now compute the implied volatility, again using ask prices. Since $S_1 = 14.11$, we will consider options at strike prices 14.00 and 14.20, and for S_2 these will be 13.50 and 14.00. Using Matlab's `blsimpv` function, we can compute the following implied volatilities:

$$\begin{aligned} \sigma_1^- &= 28.13\% \\ \sigma_1^+ &= 29.80\% \\ \sigma_2^- &= 30.99\% \\ \sigma_2^+ &= 29.74\% \end{aligned} \quad ,$$

where the superscripts $^\pm$ refer to over the forward asset price and below, respectively.

Finally, to get the volatility at the forward, we need to compute x in the following equation

$$S_i = x_i K_i^+ + (1 - x_i) K_i^- \longrightarrow x_i = \frac{S_i - K_i^-}{K_i^+ - K_i^-} \quad ,$$

and apply it to the volatilities

$$\sigma_i^f = \sqrt{(\sigma_i^+)^2 x_i + (1 - x_i)(\sigma_i^-)^2} \quad .$$

Following this procedure we find

$$\begin{aligned} \sigma_1^f &= 28.89\% \\ \sigma_2^f &= 30.61\% \end{aligned} \quad ,$$

which then we can use to compute the jump volatility.

Exercise 5

We proceed now to compute the jump volatility using the following equation

$$\sigma_{\text{jump}} = \sqrt{\sigma_{\text{after}}^2 T - \sigma_{\text{diff}}^2 (T - 1)} \quad ,$$

where we will assume $\sigma_{\text{diff}} = \sigma_1^f$, for simplification. From here, using $T = 21$, we obtain a value of

$$\sigma_{\text{jump}} = 54.64\% \longrightarrow \text{daily move} = 3.4\% \quad .$$

Exercise 6

Finally we can determine what to do in this situation. Since the analyst estimates a lower daily move (2%), we can assume that the actual movement will be less than our value, let's take 2.7% as a more conservative value. Using these two volatilities we find that the expected asset value is going to change between 38 and 54 cents.

Since it is already too late to buy options expiring tomorrow (ask prices are higher than usual because of the Q1 results), we can buy options expiring in May, and then following a simple Γ hedging strategy we can estimate P&L by

$$\text{P\&L} = \Delta \delta S + \frac{1}{2}\Gamma(\delta S)^2 \quad ,$$

so considering the Δ and Γ values computed from the BS model shown in the last table attached, we can see that for K between 14.00 and 15.00 we have $\Delta \sim 0.7$ and $\Gamma \sim 0.2$, so we can expect a P&L between 28 and 36 cents per option.

Now, considering a volatility of 0%, even though it's highly unlikely, our hedging strategy wouldn't work and therefore P&L = 0. However, a change of a 10%, again highly unlikely, would mean $\Delta \sim 0.46$ and $\Gamma \sim 0.25$, giving a P&L of 90 cents per option, which is of course higher than our realistic estimate.

References

[1] P. Wilmott et al, *The Mathematics of Financial Derivatives*, 1995.

ING GROEP NV

Delayed Prices | Specification | Settlement Prices | Notices | Publication

Display: Expiry: SELECT DATES Number of Strikes: 5 Submit

CODES AND CLASSIFICATION

Code	ING	**Market**	Euronext Amsterdam	**Vol.**	2,098	20 Apr 2017
Exercise Type	American	**Currency**	€	**O.I.**	1,277,773	19 Apr 2017

UNDERLYING

Name	ING GROEP N.V.	**ISIN**	NL0011821202		**Market**	Euronext Amsterdam	
Currency	€	**Best Bid**	14.11	20 Apr 2017 09:53	**Best Ask**	14.12	20 Apr 2017 09:53
Time	CET	**Last**	**14.115**	20 Apr 2017 09:53	**Last Change %**	-0.39	
Volume	2,588,701	**High**	14.21		**Low**	14.025	

APRIL 2017 PRICES - 20/04/17

SUMMARY VIEW

Calls

Strike	Bid	Ask	Last	Vol	Time (CET)	Day Vol	O.I.	Settl.
13.80	0.32	0.34	-	-	10:09	-	99	0.39
14.00	0.15	0.17	**0.18**	10	09:45	33	14,671	0.21
14.20	0.05	0.07	-	-	10:09	-	401	0.10
14.40	-	0.02	-	-	10:09	-	3	0.03
14.50	-	0.02	**0.02**	1	09:32	100	8,131	0.02

Puts

Strike	Bid	Ask	Last	Vol	Time (CET)	Day Vol	O.I.	Settl.
13.80	0.01	0.03	-	-	10:09	-	995	0.02
14.00	0.04	0.06	**0.04**	2	09:43	73	8,508	0.05
14.20	0.13	0.16	-	-	10:09	-	55	0.12
14.40	0.29	0.31	**0.25**	1	09:34	6	22	0.26
14.50	0.37	0.41	-	-	10:09	-	3,738	0.36

More on Stock Options

Stock Options Overview
Contract List

Contract Info

SNAPSHOT

Name	ING GROEP NV	
Trading Code	ING	
Market	Euronext Amsterdam	
Product Type	Stock Option	
Currency	EUR	
Activity	20 Apr 2017 09:53 CET	
Volume	2,098	20 Apr 2017
Open Interest	1,277,773	19 Apr 2017

UNDERLYING

Name	ING GROEP N.V.
ISIN	NL0011821202
Market	Euronext Amsterdam
Currency	EUR

MAY 2017 PRICES - 20/04/17

Calls

Strike	Bid	Ask	Last	Vol	Time (CET)	Day Vol	O.I.	Settl.
13.00	1.24	1.28	-	-	10:09	-	1,019	1.31
13.50	0.84	0.86	-	-	10:09	-	6,661	0.92
14.00	0.51	0.54	0.54	1	09:43	1	7,115	0.57
14.50	0.27	0.30	0.29	10	09:48	72	4,455	0.31
15.00	0.13	0.15	-	-	10:09	-	5,603	0.16

Puts

Strike	Bid	Ask	Last	Vol	Time (CET)	Day Vol	O.I.	Settl.
13.00	0.28	0.30	-	-	10:09	-	7,363	0.29
13.50	0.45	0.47	-	-	10:09	-	27,505	0.44
14.00	0.67	0.70	0.68	2	09:43	53	2,528	0.68
14.50	0.99	1.02	-	-	10:09	-	187	0.98
15.00	1.38	1.41	-	-	10:09	-	715	1.35

Note: Settlement price is for the trading day CET

Vol - (Volume) is the number of contracts traded in the most recent transaction.

Day's Volume - Number of trades that have taken place so far in the trading day. This figure updates as the day progresses and more trades take place.

+/- Price of last trade compared to yesterday's settlement price.

Settl - The previous day's settlement price.

O.I. - (Open Interest) is the outstanding long and short positions of the previous trading day updated in the morning each day.

barchart

ING Group N.V. (ING)

15.29 +0.13 (+0.82%) 15:59 ET [NYSE]

15.24 x 500 15.31 x 500 REALTIME by (BATS)

VOLATILITY & GREEKS for Thu, Apr 20th, 2017

Expiration: 2017-05-19 Near-the-Money

29 Days to expiration on **05/19/17**

Calls

Strike	Last	Theoretical	IV	Delta	Gamma	Rho	Theta	Vega	Volume	Open Interest	Type
6.00	N/A	9.26	195.40%	0.97706	0.00658	0.00427	-0.00814	0.00230	N/A	N/A	Call
7.00	N/A	8.26	165.97%	0.97298	0.00889	0.00498	-0.00795	0.00264	N/A	N/A	Call
8.00	N/A	7.26	0.00%	1.00000	0.00000	0.00613	-0.00017	0.00000	N/A	N/A	Call
9.00	N/A	6.27	0.00%	1.00000	0.00000	0.00690	-0.00019	0.00000	N/A	N/A	Call
10.00	N/A	5.27	118.01%	0.92762	0.02762	0.00668	-0.01245	0.00582	N/A	N/A	Call
11.00	N/A	4.27	0.00%	1.00000	0.00000	0.00843	-0.00023	0.00000	N/A	N/A	Call
12.00	N/A	3.27	0.00%	1.00000	0.00000	0.00920	-0.00025	0.00000	N/A	N/A	Call
13.00	2.35	2.27	41.15%	0.92901	0.07804	0.00909	-0.00447	0.00574	358	700	Call
14.00	1.45	1.28	28.78%	0.87041	0.17352	0.00915	-0.00484	0.00892	226	2,525	Call
15.00	0.70	0.43	34.76%	0.59203	0.26430	0.00637	-0.01036	0.01641	326	4,673	Call
16.00	0.26	0.06	32.86%	0.31976	0.25744	0.00353	-0.00896	0.01511	41	625	Call
17.00	0.20	0.00	34.43%	0.14045	0.15327	0.00157	-0.00584	0.00943	N/A	15	Call
18.00	N/A	0.00	42.96%	0.09288	0.09154	0.00103	-0.00542	0.00703	N/A	N/A	Call
19.00	N/A	0.00	60.09%	0.10928	0.07369	0.00118	-0.00852	0.00791	N/A	N/A	Call
20.00	N/A	0.00	62.13%	0.06910	0.05063	0.00075	-0.00625	0.00562	N/A	N/A	Call
21.00	N/A	0.00	65.14%	0.04686	0.03556	0.00051	-0.00483	0.00414	N/A	N/A	Call
22.00	N/A	0.00	82.99%	0.07026	0.03839	0.00075	-0.00846	0.00569	N/A	N/A	Call
23.00	N/A	0.00	90.50%	0.06565	0.03340	0.00069	-0.00875	0.00540	N/A	N/A	Call
24.00	N/A	0.00	97.54%	0.06191	0.02961	0.00065	-0.00901	0.00516	N/A	N/A	Call
25.00	N/A	0.00	104.16%	0.05882	0.02664	0.00061	-0.00924	0.00496	N/A	N/A	Call

Puts

Strike	Last	Theoretical	IV	Delta	Gamma	Rho	Theta	Vega	Volume	Open Interest	Type
6.00	N/A	0.00	190.22%	-0.02086	0.00624	-0.00030	-0.00720	0.00212	N/A	N/A	Put
7.00	N/A	0.00	161.69%	-0.02468	0.00846	-0.00035	-0.00705	0.00244	N/A	N/A	Put
8.00	0.03	0.00	137.00%	-0.02917	0.01148	-0.00040	-0.00686	0.00281	N/A	1	Put
9.00	N/A	0.00	122.27%	-0.04179	0.01728	-0.00057	-0.00822	0.00377	N/A	N/A	Put
10.00	N/A	0.00	95.39%	-0.04145	0.02200	-0.00054	-0.00637	0.00375	N/A	N/A	Put
11.00	N/A	0.00	77.24%	-0.05052	0.03185	-0.00065	-0.00604	0.00440	N/A	N/A	Put
12.00	0.15	0.00	64.69%	-0.07575	0.05217	-0.00096	-0.00694	0.00603	N/A	4	Put
13.00	0.25	0.00	56.65%	-0.13484	0.09061	-0.00171	-0.00923	0.00917	N/A	727	Put
14.00	0.40	0.01	53.62%	-0.25512	0.14171	-0.00327	-0.01291	0.01358	N/A	3,888	Put
15.00	1.10	0.16	52.57%	-0.42274	0.17616	-0.00552	-0.01538	0.01654	N/A	1,211	Put
16.00	1.40	0.79	56.02%	-0.58854	0.16432	-0.00794	-0.01623	0.01645	N/A	236	Put
17.00	N/A	1.73	66.97%	-0.68659	0.12523	-0.00976	-0.01765	0.01498	N/A	N/A	Put
18.00	N/A	2.73	141.91%	-0.58789	0.06489	-0.01009	-0.04141	0.01645	N/A	N/A	Put
19.00	N/A	3.73	108.72%	-0.71749	0.07357	-0.01179	-0.02742	0.01429	N/A	N/A	Put
20.00	N/A	4.73	119.59%	-0.74192	0.06393	-0.01283	-0.02881	0.01366	N/A	N/A	Put
21.00	N/A	5.73	131.06%	-0.75694	0.05651	-0.01377	-0.03058	0.01323	N/A	N/A	Put
22.00	N/A	6.73	141.59%	-0.76888	0.05088	-0.01468	-0.03214	0.01287	N/A	N/A	Put
23.00	N/A	7.73	143.18%	-0.79807	0.04653	-0.01571	-0.03000	0.01190	N/A	N/A	Put
24.00	N/A	8.73	143.18%	-0.82693	0.04230	-0.01674	-0.02720	0.01082	N/A	N/A	Put
25.00	N/A	9.73	160.43%	-0.81258	0.03969	-0.01741	-0.03210	0.01137	N/A	N/A	Put