Examples of margin calculations

1 Margin calculations for stock and index options

Definitions used in appendix:

$RM_{W/H}$ = Required margin (W for written, H for held).
VOL_{AP} = Implied volatility used for written put options (calculated from ask prices).
VOL_{BP} = Implied volatility used for held put options (calculated from bid prices).
VOL_{AC} = Implied volatility used for written call options (calculated from ask prices).
VOL_{BC} = Implied volatility used for held call options (calculated from bid prices).
V_u = Valuation interval up as percentage of underlying instrument.
V_d = Valuation interval down as percentage of underlying instrument.
VO_u = Upward interval for volatility expressed in absolute numbers.
VO_d = Downward interval for volatility expressed in absolute numbers.
UP = Underlying price (the closing of the underlying instrument).
T = Time between evaluation day and the expiration day expressed in year (actual/360).
P = Number of contracts in the portfolio.
CM = Contract size (The most common is 100).
r = Interest rate. A fixed risk parameter.
LP = Strike price of the option.
SP = Last paid price for the underlying (spot price).

Stock options

It is assumed that the reader is familiar with the standard stock option valuation formulas (e.g.Black-Scholes and the binomial model). NASDAQ OMX Derivatives Markets uses the binomial methods for pricing American (standardized) stock options and Black-Scholes for European options.

$$RM_W = \begin{cases} -Bino\min alPut\left(UP - \frac{V_d \cdot UP}{100}, LP, r, T, \frac{VOL_{AP} + VO_u}{100}\right) \cdot P \cdot CM \\ -Bino\min alCall\left(UP + \frac{V_u \cdot UP}{100}, LP, r, T, \frac{VOL_{AC} + VO_u}{100}\right) \cdot P \cdot CM \end{cases} \quad \text{(A.1)}$$

$$RM_H = \begin{cases} Bino\min alPut\left(UP + \frac{V_u \cdot UP}{100}, LP, r, T, \frac{VOL_{BP} - VO_d}{100}\right) \cdot P \cdot CM \\ Bino\min alCall\left(UP - \frac{V_d \cdot UP}{100}, LP, r, T, \frac{VOL_{BC} - VO_d}{100}\right) \cdot P \cdot CM \end{cases} \quad \text{(A.2)}$$

Observations:

The valuation interval up and down in the formula is also referred to as the scanning range. The most common situation is that up and down parameters are identical (symmetric intervals).

Example 1:

Margin calculation of a held ABC call option. For the following position, 1 held ABC call option with the following instrument specifics and parameters:

LP = 200
UP = 220
T = 37 days/360
V_d = 15
VOL_{BC} = 23
VO_d = 10
r = 4
P = 1
CM = 100

The required margin for this held stock option is calculated as follows:

$$RM_H = Bino\min alCall\left(220 - \frac{15 \cdot 220}{100}, 200, \frac{4}{100}, \frac{37}{360}, \frac{23-10}{100}\right) \cdot 1 \cdot 100 = 23 \qquad \text{(A.3)}$$

A held option position can never give a negative margin requirement.

Example 2:

Margin calculation of a written ABC call option. For the following position, 1 written ABC call option with the following instrument specifics and parameters:

LP = 200
UP = 220
T = 37 days/360
V_u = 15
VOL_{AC} = 23
VO_u = 10
r = 4
P = 1
CM = 100

The required margin for this written stock option is calculated as follows:

$$RM_W = -Bino\min alCall\left(220 + \frac{15 \cdot 220}{100}, 200, \frac{4}{100}, \frac{37}{360}, \frac{23-10}{100}\right) \cdot 1 \cdot 100 = \text{-5 392} \qquad \text{(A.4)}$$

Index options

It is assumed that the reader is familiar with the standard index option valuation formula, Black-76, which is used by NASDAQ OMX Derivatives Markets.

$$RM_W = \begin{cases} -B76Put\left(UP - \frac{V_d \cdot UP}{100}, LP, r, T, \frac{VOL_{AP} + VO_u}{100}\right) \cdot P \cdot CM \\ -B76Call\left(UP + \frac{V_u \cdot UP}{100}, LP, r, T, \frac{VOL_{AC} + VO_u}{100}\right) \cdot P \cdot CM \end{cases} \quad \text{(A.5)}$$

$$RM_H = \begin{cases} B76Put\left(UP + \frac{V_u \cdot UP}{100}, LP, r, T, \frac{VOL_{BP} - VO_d}{100}\right) \cdot P \cdot CM \\ B76Call\left(UP - \frac{V_d \cdot UP}{100}, LP, r, T, \frac{VOL_{BC} - VO_d}{100}\right) \cdot P \cdot CM \end{cases} \quad \text{(A.6)}$$

Observations:

The valuation interval up and down in the formula is also referred to as the scanning range. It is worth noting is that the scanning range is defined on the spot price rather than individual forward prices. This is because all forwards and options use the same scanning range based on index.

For index options, the underlying is the individual forward contract. The underlying price is then the forward price (UP) given by the market. The spot price is the index itself and is the same price (SP) for all index products.

Example 3:

Margin calculation of a held OMXS30 call option. For the following position, 1 held OMXS30 call option with the following instrument specifics and parameters:

LP = 500
SP = 485
UP = 502
T = 37 days/360
$V_d = 9$
$VOL_{BC} = 28$
$VO_d = 10$
r = 4
P = 1
CM = 100

The required margin for this held Index option is calculated as follows:

$$RM_H = B76Call\left(502 - \frac{9 \cdot 485}{100}, 500, \frac{4}{100}, \frac{37}{360}, \frac{28-10}{100}\right) \cdot 1 \cdot 100 = 79 \quad \text{(A.7)}$$

A held option can never give a negative margin.

Example 4:

Margin calculation of a written OMXS30 call option for the following position, 1 written OMXS30 call option with the following instrument specifics and parameters:

LP = 500
SP = 485
UP = 502
T = 37 days/360
V_u = 9
VOL_{AC} = 28
VO_u = 10
r = 4
P = 1
CM = 100

The required margin for a written index option is calculated as follows:

$$RM_H = -B76Call\left(502 + \frac{9 \cdot 485}{100}, 500, \frac{4}{100}, \frac{37}{360}, \frac{28+10}{100}\right) \cdot 1 \cdot 100 = \text{-5 425} \qquad \text{(A.8)}$$

2 Margin calculations for stock and index forwards/futures

Definitions used in appendix:

$RM_{B/S}$ = Required margin (B for bought, S for sold).
FP = Margin settlement price for the forward contract.
CP = Contract price of the forward.
V_u = Valuation interval up as percentage of underlying instrument.
V_d = Valuation interval down as percentage of underlying instrument.
SP = Spot price (the closing of the underlying instrument).
P = Number of contracts in the portfolio.
$AF_{B/S}$ = Adjustment factor for positions (B for bought and S for sold).
CM = Contract size (The most common is 100).

Basic formula:

$$RM_B = \left[\left(FP \cdot \left(1 - \frac{AF_B}{100}\right) - \frac{V_d \cdot SP}{100}\right) - CP\right] \cdot P \cdot CM \quad \text{(A.9)}$$

$$RM_S = \left[CP - \left(FP \cdot \left(1 + \frac{AF_S}{100}\right) + \frac{V_d \cdot SP}{100}\right)\right] \cdot P \cdot CM \quad \text{(A.10)}$$

Observations:

The valuation interval up and down in the formula is also referred to as the scanning range. The most common situation is that up and down parameters are identical (symmetric intervals). The margin settlement price is typically the closing mid price. To capture the bid ask spread, an adjustment factor is used which typically is 2 percent (giving a total spread of 4 percent). If there are several positions in the same forward contract, an average contract price (volume-weighted average) for bought and sold positions. For the open position, the above formulas are applicable when using the average contract price. The accumulated profit and loss is added to the margin.

Example 1:

Margin calculation of bought ABC forwards. For the following position, 1 ABC forward bought at 102, the simulated parameters are:

FP = 103
CP = 102
SP = 100
V_d = 13
AF_B = 2
P = 1
CM = 100

The required margin for this bought index forward is calculated as follows:

$$RM_B = \left[\left(103 \cdot \left(1 - \frac{2}{100}\right) - \frac{13 \cdot 100}{100}\right) - 102\right] \cdot 1 \cdot 100 = \text{-1 406} \quad \text{(A.11)}$$

Example 2:
Margin calculation of sold OMXS30 futures. For the following position, 1 OMXS30 future sold at 497, the simulated parameters are:

FP = 485
CP = 497
SP = 502
Vu = 9
AFS = 2
P = 1
CM = 100

The required margin for this sold index forward is calculated as follows:

$$RM_S = \left[497 - \left(485 \cdot \left(1 + \frac{2}{100} \right) + \frac{9 \cdot 502}{100} \right) \right] \cdot 1 \cdot 100 = -4\,288 \qquad \text{(A.12)}$$

Note that OMXS30 futures are cash settled daily. The daily profit/loss is present as payment margin.

3 Margin calculations for fixed income products

On August 16, the margin requirement for the following position in the September 5 Year Swedish Government Bond Forward was calculated as follows:

R5UU:

Bought	100 @ 5.15%	(Traded in July)
Bought	20 @ 5.50%	(Traded in August)
Sold	100 @ 5.40%	(Traded in August)
July Fixing R5UU		5.328%
Closing mid yield		5.940%

The purchase of 100 at 5.15 percent in July has already been subject to an interim settlement at the end of July, at the monthly fixing yield of 5.328 percent. Since the difference between the traded price and the monthly fixing yield has already been settled, the margin calculation program uses the fixing yield and not the trade price in the calculations.

Thus, the positions to be margined become:

Bought	100 @ 5.328%
Bought	20 @ 5.500%
Sold	100 @ 5.400%

According to the methodology of the calculations for Swedish stock forwards, the locked profit or loss on the netted position is added to the margin requirement for the open net position, using the average trade price.

The interest is converted to a dirty price used in the margin calculation according to equation A.13 below:

$$P = \frac{\left(\frac{C}{Y}\right)\cdot\left(\left(1+Y\right)^{n}-1\right)+N}{\left(1+Y^{\left(n-1\right)+\left(\frac{1}{360}\right)}\right)} \qquad \text{(A.13)}$$

Where:
P = Price
C = Coupon (e.g. 6%)
Y = Yield to maturity (e.g. 0.05328)
n = Remaining number of coupons (e.g. 5)
N = Redemption price (e.g. 100)
t = Number of days until next coupon (every month is 30 days (30E))

Equation A.13 gives new dirty prices, stated below (coupon = 6%)

Forward Price	@5.328%	= 102.88322 (A.13)
Forward Price	@5.500%	= 102.13514 (A.13)
Forward Price	@5.400%	= 102.56921 (A.13)
ACP (Bought)		= 102.75854
ACP (Sold)		= 102.56921

Where ACP means average contract price.

The above calculations render a locked position in profit or loss for 100 contracts as follows:

(102,56921 - 102,75854) · 10000 · 100 = -189 330 SEK

The price is calculated as a percentage of nominal value. Since the nominal value is SEK 1 million, the price is multiplied by SEK 1 million/100 = 10 000 to get the actual contract value.

The required margin for the open position is calculated by first calculating the yield at which the open contracts should be valued.

Closing mid yield	= 5.94%
Interval range for 5 year Government Bond	= +25/-25 basis points
Upper limit	= 5.94 + 0.25 = 6.19%
Forward price FP(u) @ 6.19%	= 99.20377 (A.13)
Lower limit	= 5.94 – 0.25 = 5.69%
Forward price FP(l) @ 5.69%	= 101.31692 (A.13)

The second step when calculating the required margins for the open position is to adjust for a synthetic spread (with 0.999 and 1.001) since the upper and lower limits are derived from the closing mid yield. This adjustment should be expressed in SEK and is calculated using equation A.13.

Bid side adjustment factor	= 0.999
Adjustment yield 5.94 · 0.999	= 5.93406
Forward price @ 5.94%	= 100.25315
Forward price @ 5.93406%	= 100.27826
Adjustment factor, AF(b), in % of nominal amount	= (100.27826 – 100.25315) = 0.02511
Offer side adjustment factor	= 1.001
Adjustment yield 5.94 · 1.001	= 5.94594
Forward price @ 5.94%	= 100.25315
Forward price @ 5.94594%	= 100.22806
Adjustment factor, AF(b), in % of nominal amount = 0.02509	= (100.25315 - 100.22806)

The required margin for an open bought position is calculated according to equation A.14, below.

$$RM(b) = [\ FP(u) - ACP(b) - AF(b)\ ] \cdot 1000 \cdot P \qquad (A.14)$$

$$RM(s) = [\ ACP(s) - FP(l) - AF(s)\ ] \cdot 1000 \cdot P \qquad (A.15)$$

Where:
RM(b) = Required margin for bought contracts.
RM(s) = Required margin for sold contracts.
ACP(b) = Average contract price for bought contracts.
ACP(s) = Average contract price for sold contracts.
AF(b) = Adjustment factor for bought contracts.
AF(s) = Adjustment factor for sold contracts.
P = Number of sold contracts.

Required margin for the open position in this example.

RM(b) = [99,20377 - 102,75854 - 0,02511] * 1000 * 20 = -715 976

The total required margin for the open position is the sum of the locked figure in the P/L and the required margin for the open position i.e.:

Total Required Margin = -189,330 + (-715,976) = -905,306

Thus, the total required margin for the displayed portfolio would be SEK 905,306, given the stated assumptions.