

## Margin methodology

*To enable a trustworthy clearing operation, reasonably conservative margins are required to avoid the risk of the clearing organization incurring a loss in a default. The margin requirements should not be too high, as this could discourage trading and clearing at NASDAQ OMX Derivatives Markets. This section describes the NASDAQ OMX Derivatives Markets' margining methodology and system.*

The margin requirement should theoretically be the negative market value of the account. However, under normal conditions an account cannot be closed at the instant a participant defaults at the prevailing market prices. It typically takes time to neutralize the account and the value of the account can change during this period, which must be catered for in the margining methodology.

The purpose of a margin requirement system is to calculate accurate risk-based margin requirements for each counterparty account. NASDAQ OMX Derivatives Markets uses a margining system called GENIUM Risk. It is based on the following margining methodologies, OMS II (equity and index) and CFM (fixed income). (See section 1.2 of this document for details on GENIUM Risk.)

### **1.1 Calculation of risk parameters for underlying instruments**

Since neutralizing an account in a default situation can take time, there is a lead-time from the moment default occurs to the time at which NASDAQ OMX Derivatives Markets is able to close the participant's positions and when necessary, liquidate the collateral that has been pledged. It is conservatively assumed that it takes two days on average to close counterparty's positions and liquidate related collateral in the event of a default. For this reason, the margin parameters are calculated with a two-day lead-time factored into the methodology.

An investigation of the underlying instruments for cleared products shows that historical movements are not normally distributed. This could cause concern as knowledge of the distribution could enable an estimation of accurate confidence intervals for the parameters in the margin calculations. Thus, in order to avoid discussions concerning the normal distribution, NASDAQ OMX Derivatives Markets instead uses a numerical statistical method to calculate its risk parameters. This method uses data over a one-year historical period to establish a numerical cumulative distribution. This distribution is then used to estimate a parameter with a 99.2 percent confidence interval that is equivalent to the second largest movement in the one year reference period.

### **1.2 GENIUM Risk – the margining subsystem**

GENIUM Risk is a subsystem integrated within the SECUR clearing system, which is used to generate the daily counterparty margin requirements and intraday counterparty margin calculations, (see section 8 "The clearing system –SECUR™" for details on the SECUR clearing system in OMX Derivatives Markets as a Counterparty). GENIUM Risk examines the portfolio as a whole to see how an adverse movement in the value of an underlying instrument would affect the value of the entire portfolio of a given counterparty. It uses a range of inputs in the margin calculation, some of which are specified below.

### Valuation interval

Different values for the account must be calculated since the market often moves after collateral is pledged and until NASDAQ OMX Derivatives Markets can close a position in the event of a default situation. To do this, GENIUM Risk varies the price for the underlying security for each series to calculate the neutralization cost. In this way, GENIUM Risk creates a “valuation interval” for each underlying security. The size of the valuation interval depends on the length of the lead-time and the size of the historic fluctuations in the price over this lead-time (see section 1.1, Calculation of risk parameters for underlying instruments).

### Valuation points

The upper and lower limits of the valuation points represent the worst expected movement (during the lead-time) for the margin calculation. However, the worst-case scenario for a portfolio with different options and forwards/futures based on the same underlying instrument can occur anywhere in the valuation interval. In order to reflect this, the valuation interval is divided into a number of valuation points with 31 being the most common figure used and 201 for most fixed income products.

GENIUM Risk calculates the neutralization cost for each series with the same underlying security in each valuation point; the actual margin requirement is then based on the valuation point that rendered the highest margins, i.e. the worst-case scenario. This means that a portfolio which contains a series for which margins normally would be calculated at different ends of the valuation interval is calculated in the same valuation point. This methodology is justified since the market can only go in one direction at the time (see section 1.3, Correlation between instruments).

### Volatility shifts

The risk for a change in volatility is taken into account by calculating the neutralization cost of an account by a higher and lower volatility than the current volatility. This ensures that the neutralization cost is calculated at each of the valuation points for three different volatility levels, low, current and high. A typical valuation interval therefore consists of 3x31 valuation points.

### Vector files

GENIUM Risk produces a vector file for each contract cleared. A vector file consists of a series data that is shared by all positions in the series. There are primarily two reasons to produce a vector file. The first is to achieve computational efficiency and the second is that the vector files can be distributed externally so that members can replicate the margin calculations in their own systems.

## **1.3 Correlation between instruments**

For different instruments that show a high correlation to each other, there is a need for a method that takes this into consideration with respect to margining calculations. The method used by NASDAQ OMX Derivatives Markets is called the “window method”. In this method, the scanning range limits the individual movement for each series, but there is a maximum allowed difference between the scanning points of the two series. This range can be represented as a window, hence the name. The size of this window is estimated roughly by the same method that is used to estimate scanning ranges. Daily differences between the movements of the series are calculated using one year of historical data. These values are then used to build a numerical cumulative distribution from which a 99.2 percent confidence interval is applied.

Based on a given covariance, the window can display a spread demonstrating the maximum allowable difference in price variation between two different underlying securities. In a narrow window, prices cannot vary as much as in a broad one. As a result, high covariance causes a narrow window, and vice versa.

## **1.4 Margin calculations**

The following information provides details about how margins are calculated for different instruments. (For more detailed numerical examples, see Appendix 2, in OMX Derivatives Markets as a Counterparty).

### **1.4.1 Stock and index options**

#### *Market price models for option contracts*

The market value of an option contract at each valuation point is calculated using industry standard valuation models. The market price models used by NASDAQ OMX Derivatives Markets to calculate margin requirements are based on the Black-Scholes or the binomial option valuation model for stock options, and Black-76 for index and interest rate options.

#### *Adjustments and assumptions used in the valuation of options*

When calculating implied volatility for exchange-traded options, there are two opposing forces to consider: flexibility and stability. Using the individual implied volatility for each series theoretically allows the clearing organization to cover “smile”<sup>1</sup> effects in volatility; however, the problem with obtaining accurate pricing for illiquid “out-of-the-money” and “in-the-money” series makes this method unstable.

To account for smile effects, NASDAQ OMX Derivatives Markets applies a volatility surfaces model for the ten most liquid instruments. For all other instruments an arithmetic average is calculated for the three closest “at-the-money” series for each expiration and underlying instrument. The mean value is then used as market volatility. This method does not consider smile effects, but is extremely stable. See Appendix 2 A in OMX Derivatives Markets as a Counterparty for an example on how to calculate margins for stock and index options.

### **1.4.2 Stock and index forwards/futures**

The margin calculated for a forward is made up of two core parts. The first is the accumulated profit and loss (variation margin), i.e. the difference between today’s forward price and the forward price agreed in the trade. The second part is the assessed potential risk of an adverse movement in the value of the underlying instruments during the lead-time (initial margin). Thus, the margin calculated for a forward is the minimum market value that can occur within the scanning range. See Appendix 2 B in OMX Derivatives Markets as a counterparty for an example on how to calculate margins for stock and index forwards.

A future is marked-to-market every day and therefore there is no accumulated profit, which means that a future only has initial margin.

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<sup>1</sup> According to the Black-Scholes framework, the volatility for options with the same time to expiration and underlying is equal. Experience shows that this is not correct and instead of a constant value, a “smile-like” function of the strike price can be deducted from implied volatility. This phenomenon is usually referred to as the “volatility smile”.

#### 1.4.3. Fixed income products

The margin calculation process for fixed income products is carried out in the same system as for stocks, GENIUM Risk. However, there are several differences. For example, the valuation interval is expressed in basis points instead of percent and the number of valuation points is 201 instead of 31.

Forward contracts based on Swedish fixed income instruments which are cleared by NASDAQ OMX Derivatives Markets are hybrid futures/forward contracts. The hybrid style arises from the fact that the contract is not settled daily; instead, monthly cash settlement is carried out. This means that margin calculations for fixed income forwards must consider the bought forward price or the previous fixing value depending on if the trade was carried out during the month or previous to the last monthly cash settlement. Furthermore, the margin calculation must consider the current market price of the forward and the potential movement of the underlying value.

The general principle of margin calculation on bond forwards and T-bill forwards is to take the original trade price and compare it to the estimated worst-case movement based on that day's closing prices, similar to the way stock and index forwards are calculated. There are particular changes which must be made for this to work. The first is to convert the yield (on which the contract is traded) to a price. The second is to take the monthly cash settlement into consideration; the price of a position held over such settlement must be altered in the margin calculation to reflect the fact that profits and losses to the end of the previous month have been settled. See Appendix 2 C in OMX Derivatives Markets as a Counterparty for an example of how to calculate margins for fixed income products.

### 1.5 Margin Simulation

In the SECUR<sup>TM</sup> Back Office application and over the open SECUR<sup>TM</sup> API a Margin Simulation facility is provided. Members can use this facility to get an indicative margin requirement on existing or fictive positions.

The Margin Simulation calculations are based on the same methodology and parameters as the official evening margin calculations. It is however important to note that the Margin Simulation is based on current real time prices and simulating the same position several times may thus give different results as market prices change. The result of the simulation should be seen as an indication of the official margin requirement.

### 1.6 Margin Back Testing

Comprehensive, automated Margin Back Testing was developed and introduced as a margining system enhancement by NASDAQ OMX Derivatives Markets in July 2005. Back testing in general aims at verifying and validating that a model or method meets the requirements that were intended. The aim of NASDAQ OMX Derivatives Market's automated margining back testing functionality is to verify that the OMS II Margining Methodology which NASDAQ OMX Derivatives Markets relies upon is adequate, or in other words, that the margining results are in line with what the margining methodology is designed to achieve.

Margin requirements are calculated each day by NASDAQ OMX Derivatives Market's risk margining system GENIUM Risk. These calculations are based on a number of assumptions, and it is therefore of interest to investigate how well these assumptions hold up to real market events. From a risk management perspective it is crucial to verify that the margin requirements are not too low. Since the margin requirement for most instruments are calculated using a two-day lead time, the main focus of the

Margin Back Testing is to analyze the changes in market value of the portfolios on the two days following the margin date, using current market prices. The principle for NASDAQ OMX Derivatives Market's Margin Back Testing is therefore that for each account and margin date the market value of the account is calculated on the position from the margin date but using actual market prices on the two days following the margin date. These calculations are done automatically every day for a one year reference period for all counterparty accounts and all instruments.

If the back-tested market value of an account on day one or two following the margin date is less than the margin requirement, a margin breach is understood to have occurred. It should be noted that given the confidence level with which NASDAQ OMX Derivatives Markets applies in calculating risk interval parameters (99.2%, see section 1.1 of this reference document), margin breaches of counterparty portfolios are theoretically expected. But since risk interval parameters are calculated per underlying instrument, the diversity factor of a portfolio will determine if a margin breach occurs when a risk interval parameter is breached (a risk interval parameter breach occurs when an underlying price move is larger than what the approved risk interval parameter accounts for).

The Margin Back Testing data that is produced is currently analyzed on a quarterly and annual basis by NASDAQ OMX Derivatives Markets. The annual Margin Back Testing analysis is also shared with Finansinspektionen (the Swedish FSA).

Thus far (for the period since July 2005 through 3rd Qtr 2007) the analysis of the results of NASDAQ OMX Derivatives Market's automated margining back testing results have consistently supported the validity of NASDAQ OMX Derivatives Market's reliance on the OMS II margining methodology as it is designed and approved at present. While limited margin breaches have occurred, the breaches are viewed as within the range of "expected breaches" and alternative counterparty risk management measures have proven sufficient to address the risks associated with the breaches. Accordingly, no changes to the OMS II margining methodology thus far have been deemed necessary specifically due to margin back testing results that have been generated.