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Reference	NASDAQ OMX Default Fund Policy Paper

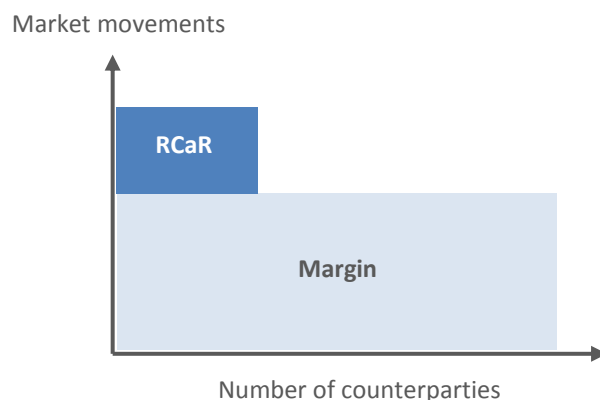
RCAR – RISK VALUATION CAPITAL AT RISK

NASDAQ OMX relies on a proprietary capital-at-risk calculation model and system, RCaR, as the main driver for establishing an adequate level of Clearing Capital. NASDAQ OMX will also apply this methodology when determining members' share of the default fund (see Policy Paper section "Calculating Clearing Member Contributions"). The methodology is approved by the Swedish Financial Services Authority (Finansinspektionen) and complies with applicable regulations (CPSS-IOSCO and draft of EMIR).

INTRODUCTION

A clearing house has counterparty risk in each position that it clears. To cover that risk the clearing house requires that all counterparties post collateral. The purpose of the RCaR measure is to estimate the risk that collateral may be insufficient to cover the costs of closing out the positions of a defaulting counterparty. The system generates implied loss given default calculations based on assumptions of extreme price movements and levels of simultaneously defaulting counterparties. The two main differences between the assumptions in RCaR and the ones applied in the margining methodology are the following:

- Market movements in margin calculations are described as "sufficient to cover a majority of normal trading days", while the movements applied in RCaR are designed to be "extreme but plausible", in order to comply with CPSS- IOSCO regulations on capital adequacy.
- Margins are applied to all accounts, but the RCaR value is calculated as the aggregated loss for a predefined number of simultaneously defaulting accounts in the worst extreme scenario applicable that day.



For each individual account and extreme scenario, a stressed market value is calculated and compared to the margin requirement applied to the corresponding account. The difference between the greatest stressed market value and the margin requirement is the RCaR value for that account. The RCaR value reflects the amount of NASDAQ OMX capital that is at risk for that scenario, if that counterparty were to default.

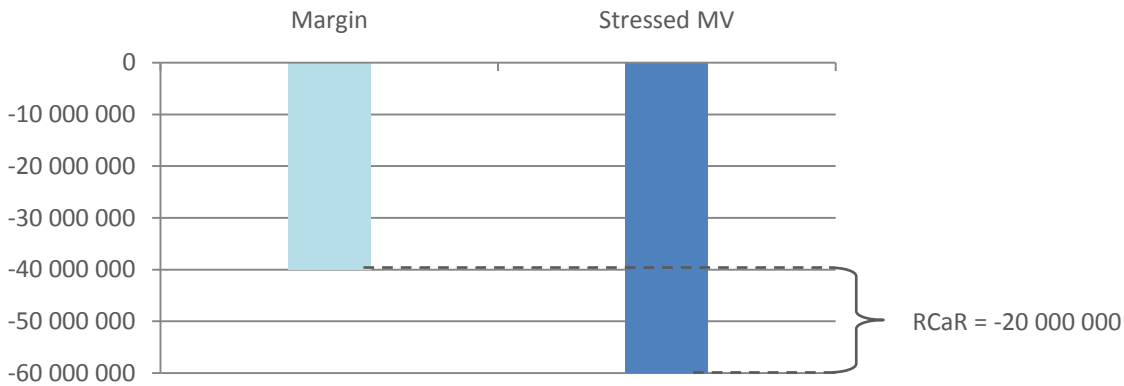


Figure 1. RCaR value for one individual account

The RCaR value used to determine the baseline Clearing Capital needs of the clearing house assumes a simultaneous default of two counterparties, a requirement that also meets regulatory standards. For each scenario that is generated in the RCaR calculations, the two largest RCaR exposures are added together. The scenario that generates the greatest sum equals the total RCaR for that specific day.

SCENARIOS AND MARKETS

In order to limit the number of scenarios without compromising accuracy, the RCaR methodology assumes that all underlying instruments in a specific market – such as Swedish equity or Swedish fixed income – move up or down with perfect correlation. As a result, only two scenarios are applied to each of NASDAQ OMX’s eight markets, thus leading to 256 possible combinations.

Equity	Fixed Income	Commodities
Denmark	Denmark	Commodities
Finland	Norway	
Norway	Sweden	
Sweden		

Table 1. NASDAQ OMX’s RCaR markets

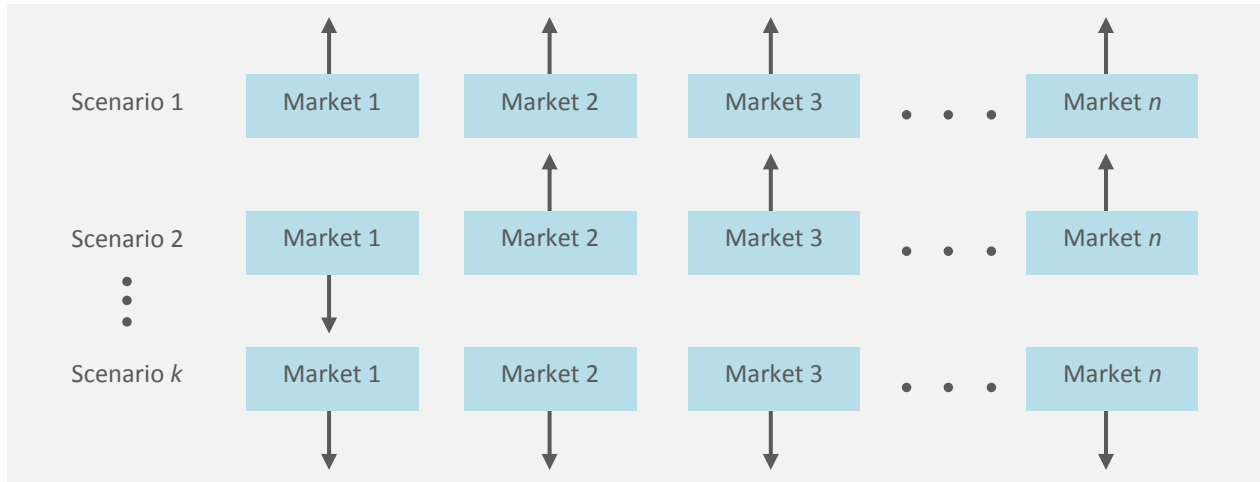


Figure 1. Stress test scenarios

CALCULATING RCAR

The margin requirement M , for counterparty k , calculated with market prices p , positions PO and margin parameters MP , is expressed as:

$$\text{Margin} = M(p, PO(k), MP)$$

The size of the stressed market value is determined by underlying or market specific stress parameters. The stress parameters within a market are simultaneously stressed either up or down, resulting in two market-specific scenarios, MSS , per market.

A stress test scenario, STS , is composed of one market-specific scenario per market. The number of stress test scenarios is given by:

$$\prod_{\text{Market}} MSS_{\text{Market}}$$

The stressed market value MV , of counterparty k , calculated with market prices p , positions PO and stress parameters in stress test scenario i , is expressed as:

$$\text{Stressed market value} = MV(p, PO(k), STS(i))$$

If stress test scenario i were to occur and counterparty k defaults, the stress test loss, STL , would be the difference between the stressed market value and the margin requirement, as seen here:

$$STL(k, STS(i)) = MV(p, PO(k), STS(i)) - M(p, PO(k), MP)$$

Losses are aggregated differently, depending on the type of counterparty. For members' own accounts the losses are aggregated according to the following equation:

$$STL(k, STS(i)) = \sum_{k \in \text{Member own}} MV(p, PO(k), STS(i)) - \min \left[0, \sum_{k \in \text{Member own}} M(p, PO(k), MP) \right]$$

In many cases, stress test losses and RCaR values are calculated on a "Super Member" level. A Super Member denotes a group of members that belong to the same organization. If one member defaults, it is assumed that all other members belonging to the Super Member level also default. A margin surplus from one member cannot be used to offset a loss from another member, hence the following equation:

$$STL(\text{Super Member own}, STS(i)) = \sum \min[0, STL(\text{Member own}, STS(i))]$$

The following equation is applied on NCMs, omnibus accounts, direct pledge accounts and indirect pledge accounts:

$$STL(k, STS(i)) = \min \left[0, MV(p, PO(k), STS(i)) - \min [0, M(p, PO(k), MP)] \right]$$

A counterparty's individual RCaR value is the stress test loss corresponding to the scenario that generates the greatest loss.

$$RCaR(k) = \min [STL(k, STS(i))]$$

CALCULATING RCAR PARAMETERS

RCaR parameters set the stressed market values, MV, on each product set, which drive Clearing Capital requirements in the RCaR system. NASDAQ OMX follows a systematic and homogeneous procedure to calculate RCaR parameters for each product line and asset class. The purpose of following an objective methodology is to calculate capital contributions fairly, such that stress levels neither penalize nor favor any particular market or product. The extreme but plausible scenarios generated by these RCaR parameters are based on the long-term historical tail risk of each product and asset class. The stressed market values for each product set are completely independent (i.e. fully decoupled) from the level of margin requirements.

To appropriately measure tail risk, NASDAQ OMX splits the stress levels into two parts:

- **An extreme market percentile (EMP)**, representing rare but realized historical market returns (thereby creating "extreme but plausible market events"), plus
- **An additional buffer (AB)** based on how well the EMP has been measured. This is an additional line of defense, measuring a buffer for scenarios in excess of the EMP and thereby creating an even more robust financial structure of the CCP. The AB is particularly relevant for products a) that do not have sufficient data to determine the EMP with desired statistical confidence, or b) for which the EMP itself may be uncertain, due to the tail risk from either the underlying asset or the derivative contract itself.

To generate the EMP and AB stress values following a reproducible procedure, the clearing house maintains clean historical time series for each product set using the following rules:

- The most extensive available historical data is used to reflect a long-term view.
- Daily closing prices and corresponding daily returns are used.
- The data is screened for typos and other extraneous effects (stock splits, bond rolls, futures and forwards rolls, etc.)
- Price gaps are filled by linearly interpolated prices, if necessary.
- If using forwards or futures data, the most liquid contract is used at each point in time to generate a single stitched time series of relative returns, representing each product category.
- For power contracts, separate time series are generated to represent predetermined ranges of time-to-delivery, measured in days, which are directly linked to the risk of the contract at a given point in time.

After clean time series of prices and/or returns have been generated, a statistical analysis of market returns is performed for each product set, in the following way:

- Two sets of observed extreme returns are selected, corresponding to positive and negative returns, using a points-over-threshold approach, which is applied consistently across all markets.
- The tail shapes of the two sets of extreme return data are fitted using **Extreme Value Theory (EVT)**. This theory contains a library of tail shapes that include normal and extreme tail distributions. A best fit to the observed tail risk is obtained.
- The most conservative value from the positive or negative tails is selected, and then multiplied by the liquidation period factor (see following section). The EMP and AB are thereby obtained.
- The EVT RCaR parameter results are verified by the Risk Management Group using empirical formulas for the EMP and AB.
- The data sets and the results of the EVT RCaR analysis are registered in the RCaR system and archived by the Clearing House.

Ultimately, Clearing Capital requirements and aggregate default fund sizes are based on the RCaR exposures calculated from stress levels given by the EMP. The more conservative AB levels will be used as a benchmark for the sizes of the Assessment Power requirements, which are not pre-funded capital.

The RCaR exposures are designed to be calculated in such a way that they produce parameters that are as stable as possible, stemming from the long-term market data utilized. Due to the stability of the stress parameters, the re-calibration of RCaR parameters will be done on a bi-annual basis, unless a specific market experiences unprecedented volatility that the risk committee deems to justify a re-evaluation of RCaR parameters.

LIQUIDATION PERIOD

Different products may be assigned different liquidation periods (measured in days), which depend on the Risk Committee's evaluation of normal market liquidity. All of the calculations leading to RCaR parameters consider one-day market risk, which is then scaled up by a factor determined by the liquidation period. This scaling procedure has the advantage of producing more stable and predictable risk parameters for margins and capital levels than considering n-day returns, because sometimes two-day return series have hardly any more market risk than one-day return series, especially over a limited time horizon. With a scaling factor, a two-day risk parameter will always be $\sqrt{2}$ times larger than a one-day risk parameter, and so on, always scaling as \sqrt{n} , for a liquidation period of n days.

The liquidation period evaluation is based on the open interest, concentration, and daily volumes observed in each family of products, as well as on the efficiency of default management mechanisms available on each market. The Clearing House intends for liquidation period measures to be stable insofar as the liquidity profile of a particular market has not dramatically changed over a sustained period of time.

As a result of this approach, cleared products that enjoy good liquidity will generally have smaller margin and capital requirement levels than products with limited liquidity. In determining the liquidation period, it should be noted that the Clearing House also takes into account the availability of alternative (e.g. cash) markets that would allow the clearing house to hedge the derivatives portfolio of a defaulting member, before an actual liquidation (or transfer of positions to another member) takes place.

ADVANTAGES OF RCAR AS A CLEARING CAPITAL METHODOLOGY

RCaR provides the market and the clearing house with a stress scenario framework for calculating individual member exposures and aggregate Clearing Capital requirements, offering the following advantages:

- **Ease of compliance** with regulatory requirements, as compliance is built into its design.
- **Realistic but extreme macro-level market conditions**, divided by broad asset class and geography.
- **Transparent scenario combinations** (up or down, per asset class, all combinations allowed).
- **Coverage of systemic risk**, because simultaneous extreme moves across equity, fixed income, and commodities markets are covered by RCaR, as well as the two largest defaults.
- **Coverage of idiosyncratic default risk**, because the individual member exposures are based on the worst-case scenario tailored to each member's aggregate portfolio, and these scenarios vary from one member to another.
- Systematic, equitable, and disciplined **determination of stress levels (recently judged to be best in class by Standard & Poor's)** that are completely independent of margin levels.
- **Counter-cyclicality of capital requirement compensates for any pro-cyclicality in margins** – that is, if margins are pro-cyclical, capital is anti-cyclical, thus relieving the pressure of stressed markets on the financial system. This setup allows capital to decrease when margins increase, and vice versa.
- **Stable stress levels for capital determination**, and therefore stable financial resources (margin resources plus minimum aggregate capital) over each economic cycle.