Margining methodology

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1. Margins for EMIR regulated markets

1.1. Margin types

In accordance with the requirements, only those margin elements are defined that are used to cover the risks arising until the closing of the relevant positions. Calculation always takes place at the end of the day, therefore margin calculation is interpreted for positions not yet closed as at the end of the settlement day.

Intraday margin may be calculated for both spot markets with multinet settlement and derivative markets.

In the multinet market, the margin requirement consists of two parts:

1. **Collateralised price difference:** The result of the theoretical exchange rate loss on open positions calculated on the basis of trading prices and closing prices (negative price difference).
2. **Initial margin:** Value to cover risks expected until the position is closed.

There are two types of margin in the derivatives market:

1. **Price difference:** The result of theoretical exchange rate loss/gain on open positions calculated on the basis of trading prices and settlement prices, which is actually settled.
2. **Initial margin:** Value to cover the risks arising from changes in prices until the position is closed.
    a. For options, a premium margin calculation is applied, which is part of the initial margin.
    b. For option products, the initial margin includes the so-called "Net Liquidation Value" (NLV), which the option buyer is entitled to and reduces the amount of margin (the total margin value can only be reduced to 0).

1.2. Margin calculation frequency

The specified margin values should be reviewed regularly, where all requirements must be met. KELER CCP monitors the amount of margins and checks for compliance daily. Typically KELER CCP performs one margin calculation per day, but in the market with multinet settlement, margin may be calculated twice if certain conditions are met. In determining the amount of daily margins, the determination of the liquidation period is a stronger factor than the size of the period between the collections of margins.

1.3. Initial margin calculation parameters

SPAN calculation:

- Futures price scan range
- Volatility scan range
- Other parameters (to be explained under portfolio margining)

- Spread between maturities (for derivative capital and gas markets) and spread between settlement days (for multinet markets)
- Spread between products (for derivative capital and gas markets)

The parameters of the SPAN calculation are published by KELER CCP in its announcements.

VaR calculation:

- Lookback period: at least 1 year (250 days), which contains a period of stress (if not, the lookback period should be increased until a stress event is included)
- Confidence level: 99%
- Liquidation period: 2 days
- Procyclicality buffer: 25%
- Tolerance level: 1%
- Decay factor: 98.17% (in case of a lookback period of 250 days)

1.4. Determining the amount of initial margin

Notations used in the margin calculation methodology:

1. $KSzFmargin_t$: VaR value including expert buffer and (il)liquidity buffer
2. $PROmargin_t$: $KSzFmargin_t$ increased by 25% procyclicality buffer
3. $MINmargin_t$: current minimum value of the margin
4. $MAXmargin_t$: current maximum value of the margin
5. $margin_t$: actual margin valid for the day
6. $EWMA$: exponentially weighted moving average
7. σ_{EWMA}: exponentially weighted standard deviation
8. σ: equally weighted standard deviation
9. t: time
10. λ: decay factor
11. γ: tolerance level
12. K: length of the lookback period
13. α: confidence level
14. T: liquidation period
15. φ: (liquidity buffer parameter
16. θ: expert buffer parameter – fix level
17. π: procyclicality buffer
18. τ: margin band
19. DP: default buffer parameter
20. NV: nominal value
21. P: price
22. D: duration
23. D^*: modified duration
24. r_t: log return on day t
25. $\bar{r}$: expected value, average of daily log returns

1.4.1. Products of the multinet settlement markets

1.4.1.1. Shares

The following formulas determine the VaR value:

$$VaR_t^{return} = min(\sigma^{equally-weighted} \cdot N^{-1}(99\%); \sigma^{EWMA} \cdot N^{-1}(99\%))$$

$$VaR_t^{price} = -P_t + P_t \cdot e^{\sqrt{T} \cdot VaR_t^{return}}$$

If the trading currency of the product is not HUF, then the formula should be modified with the VaR value of the respective exchange rate and the VaR_t^{price} should be converted to HUF with the given day's MNB exchange rate (as KELER CCP determined the margin requirement in HUF, but the clearing happens in the trading currency)

$$VaR_t^{price} = -P_t + P_t \cdot e^{\sqrt{T} \cdot VaR_t^{return}} \cdot e^{VaR_{t,FX}^{return}} \cdot FX_t$$

In case of $VaR_{t,FX}^{return}$ only the equally-weighted standard deviation is needed for VaR calculation.

$$KSzFmargin_t = VaR_t^{price} \cdot (1 + \theta) \cdot (1 + \varphi)$$

$KSzFmargin_t$ is supplemented with expert and liquidity buffers determined based on sensitivity test.

$$PROmargin_t = VaR_t^{price} \cdot (1 + \theta) \cdot (1 + \pi) \cdot (1 + \varphi)$$

Where the procyclicality buffer is exhausted, the lower margin limit is "$KSzFmargin_t$", that is, the VaR value increased by the liquidity and expert buffer, while when the procyclicality buffer is not exhausted, then "$PROmargin_t$", that is, the value of "$KSzFmargin_t$" increased by the procyclicality buffer.

$$MINmargin_t = ha\begin{pmatrix} \left(\sigma_{EWMA} \cdot max\left(\frac{margin_{t-1}}{KSzFmargin_t}; 1\right) > \sigma\right); \\ min(max(margin_{t-1}; KSzFmargin_t); PROmargin_t); PROmargin_t \end{pmatrix}$$

KELER CCP aims to keep the margin as stable as possible, providing a band (τ), within which the value of the actual margin can move above the minimum required margin. The maximum margin value is determined based on the following formula:

$$MAXmargin_t = MINmargin_t \cdot (1 + \tau)$$

The narrower the band between the maximum and the minimum margin, the more often the margin is modified, since as soon as the actual margin would reach the maximum, the "$MAXmargin_t$" becomes the new margin, while if it reaches the minimum, the new margin value will be the "$MINmargin_t$". As long as it does not reach either limit, the margin's value is not modified:

$$margin_t = ha(margin_{t-1} > MAXmargin_t; MAXmargin_t)$$

$$margin_t = ha(margin_{t-1} < MINmargin_t; MINmargin_t)$$

$$margin_t = ha(MAXmargin_t > margin_{t-1} > MINmargin_t; margin_{t-1})$$

IPOs and illiquid shares

In the case of IPOs and illiquid shares, in the absence of historical data, KELER CCP chooses a proxy product based on an expert approach, and the volatility of the data series of this product provides the basis for the margin calculation.

Based on the issue price, the amount of margin will be a simple arithmetic mean of $MINmargin_t$ and $MAXmargin_t$ calculated according to the above methodology applied to the shares. However, due to the lack of data, there is a change in the determination of $MINmargin_t$ compared to the basic methodology, and thus the value of $MINmargin_t$ on the first day shall be the value of $PROmargin_t$.

$$MINmargin_1 = PROmargin_1$$

$$margin_1 = \frac{MINmargin_1 + MAXmargin_1}{2}$$

1.4.1.2. BÉTa Shares

On the BSE there is an opportunity to trade with foreign shares and ETFs. However, the trading happens in HUF.

In the case of BÉTa shares traded on the BSE for more than one year, there is appropriate time series to determine margin, with the use of the methodology covered with respect to equities. This can be done as in the case of these BÉTa equities there is appropriate HUF-denominated time series to determine the margin in HUF.

In case of IPO or illiquid products on the other hand, KELER CCP has only past time series related to the share concerned that is expressed in the domestic currency of the share and not in HUF. Thus, in order to take into account this extra risk, we determine VaR in HUF. This will be the practice until KELER CCP has sufficient information to determine margin based on HUF-based past time series.

1.4.1.3. Certificates, warrants

Certificates differ from the margin determination methodology applied in the case of shares in that in addition to the risk of changes in the prices of the underlying product, the currency risk must also be taken into account in the case of certificates with non-HUF-based underlying products. KELER CCP takes into account the correlation between the two risks by determining the value at risk from the return calculated on the basis of the price of the underlying product of the certificate expressed in HUF. Another difference in the case of certificates is in the determination of $KSzFmargin_t$, because there is a multiplier for each product, with which the VaR value increased by buffers has to be multiplied, regardless of whether the certificate has a HUF-based or FX-based underlying product.

$$KSzFmargin_t = VaR_t \cdot (1+\varphi) \cdot (1+\theta) \cdot multiplier$$

The determination of $MINmargin_t$ differs from the basic methodology in that the value of $MINmargin_t$ is the value of $PROmargin_t$.

$$MINmargin_t = PROmargin_t$$

In the case of a short certificate – if the underlying product is not HUF-based, but the settlement happens in HUF – in order to determine the margin a multiplier called "short/long correction" must also be applied due to the short position.

$$KSzFmargin_t = VaR_t \cdot (1+\varphi) \cdot (1+\theta) \cdot multiplier \cdot \left(1 + \frac{short}{long} correction\right)$$

If settlement is not in HUF but in the currency of the underlying, Value at Risk is also to be determined in the currency of the underlying, as the holder of the contract runs the risk of price change only with respect to the underlying and is not exposed to FX rate risk. However, as CCP determines margin in HUF, the risk from conversion to HUF is to be taken into account and margin has to be converted to HUF. Consequently, the formula is modified as follows:

$$KSzFmargin_t = VaR_t^{in\ trading\ currency} \cdot e^{VaR_{t,FX}^{return}} \cdot FX_t \cdot (1+\varphi) \cdot (1+\theta) \cdot multiplier$$

In case of $VaR_{t,FX}^{return}$ only the equally-weighted standard deviation is needed for VaR calculation.

The special feature of reverse convertible (RC) and Bonus certificates is that the maximum value of payment is limited. As soon as the price of the underlying reaches a set limit, payment is made based on the performance of the underlying. However, if the underlying price does not reach the limit set, then a "Bonus" determined in advance is paid. Therefore, the formula used for other certificate types is to be supplemented with the bonus value. For this reason, the determination of minimum margin is modified to check what the minimum margin would be if we decided to determine the margin as if there were no Bonus in the construction, and to check the Bonus value also. Margin computation will be based on the higher of the two values. Thus, the following formulae will be modified: VaR calculation, and $MINmargint$ determination (all other formulae remain unchanged).

$$VaR_t^{price\ (in\ case\ of\ RC/Bonus)} = VaR_t^{price} \cdot \frac{NV}{P_t}$$

$$MINmargin_t^{\frac{RC}{Bonus}} = MAX(MINmargin_t; NV \cdot Bonus)$$

1.4.1.4. Investment units

For investment units, margin is determined not at product level, but for investment units as a margin group, and is expressed as return. The product level margin is determined by projecting the margin return value for the nominal value or the market price of the given investment unit.

The methodology is based on using risk factors applicable to all investment units that may affect the price of any of the investment units settled. KELER CCP selected the following risk factors for example to cover the underlying products: MSCI WORLD INDEX, MSCI EMERGING MARKETS INDEX, MSCI ACWI IMI REAL ESTATE INDEX, COMEX (NYMEX) gold price of closest expiry, Bonds: fictive zero coupon bonds for various maturities (O/N; 3 months; 6 months; 1 year; 3 years; 5 years; 10 years; 15 years).

$$PROmargin_t^{return} = VaR_t^{return} \cdot (1+\varphi) \cdot (1+\theta) \cdot (1+\pi)$$

$$MINmargin_t^{return} = if\left(\begin{matrix}\left(\sigma_t^{EWMA} \cdot max\left(\frac{margin_{t-1}^{return}}{KSZFmargin_t^{return}}; 1\right) > \sigma_t^{equally}\right); \\ min(max(margin_{t-1}^{return}; KSZFmargin_t^{return}); PROmargin_t^{return}); PROmargin_t^{return}\end{matrix}\right)$$

$$MAXmargin_t^{return} = MINmargin_t^{return} \cdot (1+\tau)$$

$$margin_t^{return} = if\left(\begin{matrix}margin_{t-1}^{return} > MAXmargin_t^{return}; MAXmargin_t^{return}; \\ if(margin_{t-1}^{return} < MINmargin_t^{return}; MINmargin_t^{return}; margin_{t-1}^{return})\end{matrix}\right)$$

Additionally, expert minimum margin can be set to determine the margin minimum value. It means that the final margin is determined based on the following formula:

$$margin_t^{return2} = \max(margin_t^{return}; expert\ minimum\ margin$$

The product level margin is determined by projecting the margin return value for the nominal value or the market price of the given investment unit with the following formulas:

$$margin_t^{inv.unit} = ha(NV \leq 1; 1; NV_t \cdot margin_t^{return})$$

$$margin_t^{inv.unit} = ha(P_t \leq 1; 1; P_t \cdot margin_t^{return})$$

If the nominal value or the market price is 1 HUF, then the margin will be 1 HUF.

When the $margin_t^{return2}$ is projected to market value and the market value is not HUF, then the VaR_t^{return} should be modified with the VaR value of the respective exchange rate.

$$VaR_t^{return} = min(\sigma^{equally-weighted} \cdot N^{-1}(99\%); \sigma^{EWMA} \cdot N^{-1}(99\%)) \cdot e^{VaR_{t,FX}^{return}}$$

In case of $VaR_{t,FX}^{return}$ only the equally-weighted standard deviation is needed for VaR calculation.

1.4.1.5. Debt securities

The margin requirement methodology for the government bonds, T-bills, corporate bonds and mortgage bonds are the same, only margin parameters may differ.

In the case of bonds, the risk is the change in the yield or yield curve of the bonds. The relationship between the bond yield (ΔP/P) and the change in the yield curve (Δr) can be indicated as follows, where D* denotes the modified duration:

$$D^* = \frac{\frac{\Delta P}{P}}{\Delta r}$$

In practice, when calculating the duration of bonds, KELER CCP determines D* on the basis of the yield on the notional zero-coupon bonds. Rearranging the formula, the standard deviation is:

$$\sigma_{bond} = \sigma\left(\frac{\Delta P}{P}\right) = D^* \cdot \sigma(\Delta r)$$

The formula can be interpreted as follows: the standard deviation of the yield on a bond is D* times the standard deviation of the change in yield level. Based on these, the VaR is as follows:

$$VaR_{bond}^{return} = N^{-1}(99\%) \cdot \sigma_{bond} = D^* \cdot N^{-1}(99\%) \cdot \sigma(\Delta r) = D^* \cdot VaR_{return}$$

$$VaR_{bond}^{price} = \left|P_t \cdot VaR_{bond}^{return}\right|$$

Determination of bond price: $P_t = \sum_{t=1}^{T} \frac{C_t}{(1+r_t)^t}$,, where Ct is the bond cash flow in period t, rt is the yield in period t, T is maturity date.

The VaR calculated from the formula is the basis of the margin. KELER CCP captures the probability of default by a buffer which is determined on margin group level. From this point on, the method of final determination of the margin is the same as that described for shares.

$$KSzFmargin_t = VaR_{bond}^{price} \cdot (1+\varphi) \cdot (1+\theta) \cdot (1+DP)$$

In case of non-HUF denominated debt securities, KELER CCP calculated the VaR from the yield curve of the respective currency. However, as CCP determines margin in HUF, the risk from conversion to HUF is to be taken into account and theVaR_{bond}^{price} has to be converted to HUF . Consequently, the formula is modified as follows:

$$VaR_{bond}^{price} = \left|P_t \cdot VaR_{bond}^{return}\right| \cdot e^{VaR_{t,FX}^{return}} \cdot FX_t$$

In case of $VaR_{t,FX}^{return}$ only the equally-weighted standard deviation is needed for VaR calculation.

The categories currently used are as follows (in brackets, the maturity point of the yield curve which is the basis for the margin calculation):

- Government securities
  - Discount treasury bill (1 year)
  - Government bonds with a maturity of less than 3 years (3 years)
  - Government bonds with maturity between 3 and 5 years (5 years)
  - Government bonds with maturity between 5 and 10 years (10 years)
  - Government bonds with maturity between 10 and 15 years (15 years)
  - Government bonds with a maturity of more than 15 years (15 years)
- HUF corporate bond (5 years)
- EUR corporate bond (5 years)
- USD corporate bond (5 years)
- HUF mortgage bond shorter than 3 years (3 years)
- EUR mortgage bond shorter than 3 years (3 years)
- HUF mortgage bond longer than 3 years (10 years)

1.4.2. BSE derivative market products

If KELER CCP also calculates margin for the underlying product of the particular futures product, KELER CCP uses the price data for the underlying product, and when determining margin, it takes into account the different contract size of the underlying product and the futures product. If KELER CCP does not calculate margin for the underlying product, the log returns calculated from the available closing prices of each maturity of the futures product are concatenated (always using the price of the next maturity on that past day) or KELER CCP uses a proxy product chosen based on expert approach. Apart from this, the methodology is the same as the methodology used for determining margin for shares. KELER CCP applies the level of the initial margin determined for each product type equally for each maturity, so the level of the initial margin does not differ from maturity to maturity within a product type.

The initial margin parameter of option products is the same as the initial margin parameter for the underlying product in the case of currency options, index options and grain options. The initial margin parameters of stock option products are equal to the announced margin parameter of the futures product with the same underlying product.

1.4.3. HUDEX derivative gas market products

The margin calculation is based on reference data series that have been concatenated for each product type from the log returns calculated from the available closing prices of the products with the nearest maturity. From this point on, the calculations are identical to the methodology presented for the shares, with the exception that in the $KSzFmargin_t$ formula, VaR_t^{price} is determined by the instrument with the highest contract-level price (*price*contract*), and by P_t we mean contract-level price. KELER CCP applies the level of the initial margin determined for each product type equally for each maturity, so the level of the initial margin does not differ from maturity to maturity within a product type.

1.5. Portfolio margining - spread discounts

The regulation allows KELER CCP to use spread parameters in its margin calculation methodology that result in a reduction of the initial margin calculated at the segregation level for net open positions as part of the portfolio level margin calculation. The extent of these is stated by KELER CCP in its announcements.

There are three types of spread discounts: 1) Spread discount between products (on the derivative capital and gas market), 2) Spread discount between maturities (on the derivative capital and gas market), 3) Spread discount between settlement days (on the spot market). The determination of discounts is based on a correlation calculation and certain lower and upper limits must be taken into account.

1. Based on an analysis performed for this purpose, KELER CCP shall only grant spread discounts for products for which the minimum correlation for log returns of 250 days, revised and recalculated at least monthly, reaches or exceeds 0.7.
2. In accordance with Article 27(4) of Regulation (EU) No 153/2013, the spread discount shall not exceed a ceiling of 80%.

The ratio used in the spread discount is based on the size of the margin for each relevant product and not on the price level of each product, that is, in calculating the portfolio margin KELER CCP does not apply the discount rate to the price value but to the margin value.

1.6. Protection against procyclical effects, application of APC measures

For protection against procyclicality, Delegated Regulation 153/2013/EU RTS allows for 3 methods, of which method "a" was chosen by KELER CCP. In this case, the value of the margin is determined with 99% requirement during the daily review, which is increased by a multiplier of at least 1.25 in normal periods[1]. The determination of the procyclicality buffer happens on product level according to the following formula:

$$\text{procyclicality buffper} = min\left(max\left(0; ha\left(MINmargin_t > effecitve\ margin_t; \frac{effective\ margin_t}{KSZFmargin_t} - 1; \frac{MIN\ margin_t}{KSZFmargin_t} - 1\right)\right); 25\%\right)$$

1.6.1. APC measures

The purpose of the next two subsections is to comply with the MNB Recommendation prepared on the basis of the ESMA Directive published on 28 May 2018 (ESMA, 2018) (in Hungarian it was published on 15 April 2019). This Directive encourages all EMIR-authorised

[1] See: Chapter 1.41.1, Formula $MINmargin_t$discussed for shares.

central counterparties to develop a methodology for taking into account, measuring and managing the potential procyclical effects of an increase in initial margin. MNB expects the KELER CCP to apply the recommendation from 31 January 2021. Until the relevant function of the new risk management system goes live, KELER CCP will apply the APC methodology in the following categories: index, shares and foreign currencies, as well as bonds, HUDEX/Gas products and investment units. Products outside these categories represent only a minimal part of the turnover.

In applying the recommendation[2], KELER CCP interprets the concept of procyclicality in the case of central counterparties as meaning that, in the event of a stress period of increased volatility, a margin increase will result in a further fall in traded market instrument yields and a further increase in volatility. As a result, due to the increased risk, it would be necessary to further increase the margin, thus causing a spiral and deepening the stress period even further, increasing the risk.

The main focus in defining APC ***indicators*** is to measure margin stability and the conservative treatment of procyclicality, as well as compliance with the indicators set out in the ESMA/MNB Directive. Based on these

1) to measure *short-term* stability, **the standard deviation of margin** is applied by KELER CCP: based on 12 months' data, the standard deviation of the log percentage change in the margin, applying equally-weighted standard deviation;
2) to measure *long-term* stability, KELER CCP uses **maximum/minimum ratio of the margin value**: the quotient of the largest and the smallest margins, taking a lookback period of 1 and 3 years, respectively.

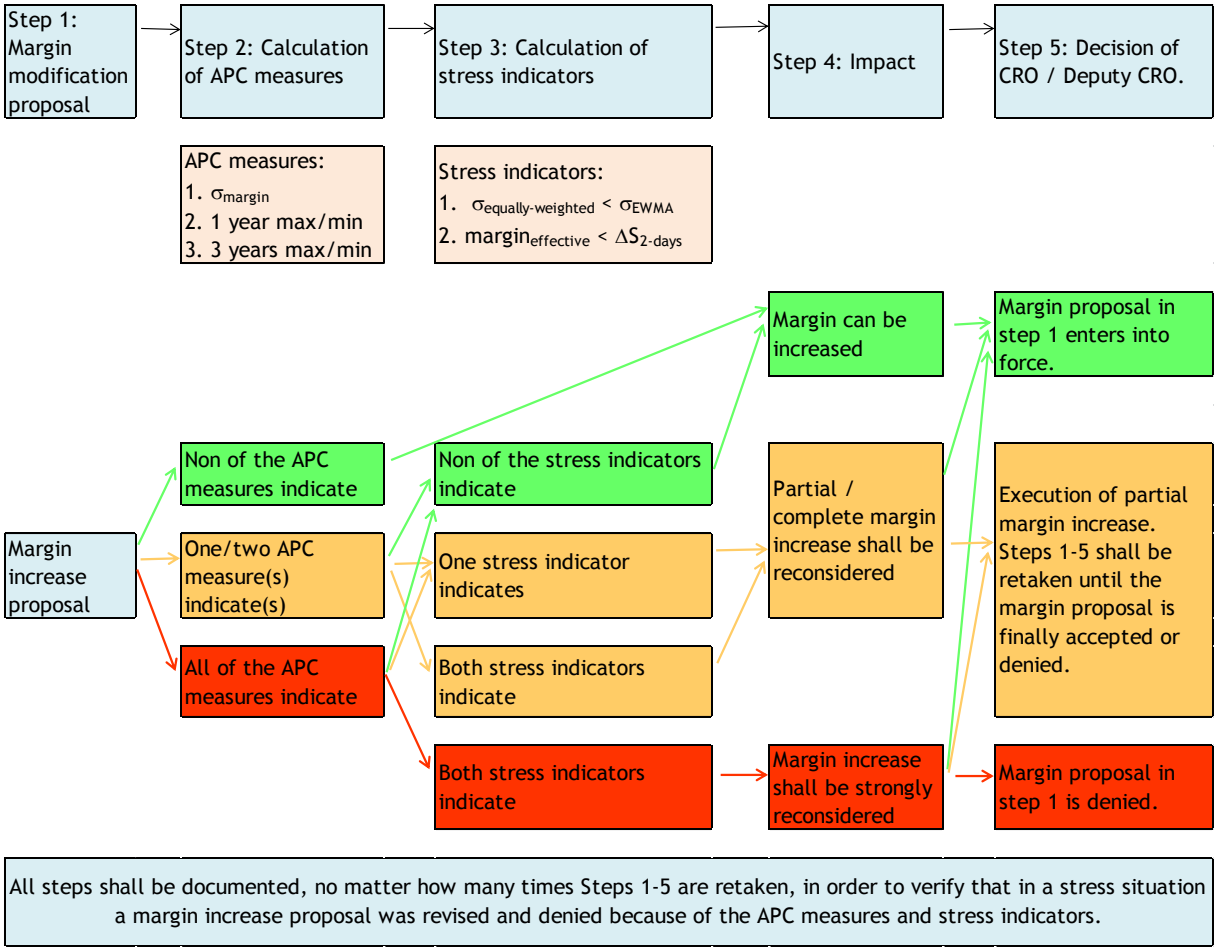
As APC measure these indicators should be used as follows: if an **increase** should occur in the standard deviation AND/OR value of max/min ratio as a result of the **margin increase**, it may indicate that the margin can have a procyclical effect.

In the case of both indicators, it may happen that their value increases in the case of a margin increase in a "calm" (normal) economic environment, thus showing a procyclical effect. However, the purpose of increasing margin in a calm environment is precisely that when a period of stress comes, a buffer should be built into the margin level that can be exhausted and no sudden large margin increases are required. Therefore**, KELER CCP does not take into account indications of APC measures in cases where there is a calm environment** (no period of stress). Stress is determined at the product level (with a few exceptions, detailed later), taking into account two stress ***indicators***:

1) **Based on standard deviations**: if, taking into account a 1-year lookback period, the EWMA standard deviation of the log return of the product exceeds the equally-weighted standard deviation, it may be a more stressful period, so the indications of the APC measure(s) are taken into account, AND/OR
2) **Based on price change**: if the two-day price change of a given product exceeds the value of the applicable margin, the indication of the APC measure(s) is also taken into account in this case.

[2] Recommendation 6/2020 (V.04.) of the Hungarian National Bank (Magyar Nemzeti Bank) on measures for central counterparties regarding EMIR anti-procyclicality margin requirements

The following workflow diagram summarises the application of APC measures and the decision process for them:



Importantly, it is not the value of the APC measure that should be examined, but only the times when the **log change in the APC measure was positive.** This is because the point is that the value of the procyclicality indicator increases. If its value does not change as a result of the margin increase (and possibly even the relation of standard deviations and the price change indicates stress), then we assume that there is no indication from the APC measure.

1.6.2. Product specialties

Debt securities

For debt securities, the securities are classified into margin groups based on maturity categories, and the APC is calculated based on notional zero-coupon bonds corresponding to the maturity categories. Thus, debt securities are handled at margin group level, not at product level.

Investment units

For investment units, APC measures are managed at margin group level, as during the margin calculation. The basis of margin for the margin group is expressed as return, thus the APC measures are also computed from the margin expressed as return. For the stress

indicator the equally-weighted and EWMA standard deviation is computed from every factors used for margin calculation then we take the maximum from these values.

Options

In case of options an additional risk factor which may have effect on procyclicality and KELER CCP has opportunity to modify is the change in standard deviation ($\Delta\sigma$). The value of $\Delta\sigma$ should be the historical maximum standard deviation change calculated on daily basis.

APC measures and stress indications are examined by KELER CCP in respect of the underlying product. If there is no indication from any of these, the value of the change in standard deviation will be increased by 25% (*1.25), and if one of the APC measures indicates while one of the stress indicators also indicates, then the change in standard deviation will only be multiplied by 1, that is, in the case of stress, KELER CCP does not form an additional buffer in its value.

2. Margins for non-EMIR regulated markets

2.1. Balancing Clearing (Information Platform – IP)

Balancing Clearing Turnover Margin Calculation for system users not acting as TSOs on the Hungarian gas market

Turnover margin basis

Balancing Clearing turnover margin is based on three core components, and the maximum of these will be the turnover margin basis. The first component is calculated with the application of the coherent risk metric, Expected Shortfall. This will likely to be the turnover margin basis, when there were significant imbalances of the Clearing Member in the lookback period. The second component is a floor based on the internal risk assessment of the Clearing Member, and the size of Member's average EXIT portfolios (offtakes). The last component is a minimum component, the fixed floor. The following formula explains the turnover margin basis, or $KSZFmargin$.

$$KSZFmargin_i = max(ES_i, RF_i, FF), \text{ where}$$

- $KSZFmargin_i$: Turnover margin basis for settlement day i
- ES_i: Expected Shortfall component for settlement day i
- RF_i: Ratio Floor component for settlement day i
- FF: Fixed Floor component, which has a constant value

Expected Shortfall component (ES)

Expected Shortfall is a risk metric that takes the average of losses higher than the VaR for the same period.

$$ES(x, \alpha) = E[x|x > VaR(x,\alpha)], \text{ where}$$

- x: Variable for which the calculation is prepared, usually losses
- α: Confidence level, 99%
- $VaR(x,\alpha)$: The loss assigned the αth percentile of the loss distribution. If L_p is the loss assigned to the p-th percentile then $VaR(x, 99\%) = L_{99}$
- $E[x|x > VaR(x,\alpha)]$: Expected value of the values of x knowing they are higher than $VaR(x,\alpha)$

In our calculation the underlying variable is not loss but a ratio of aggregated exposure and average aggregated EXIT.

$$aggregated\ exposure_i = \sum_{t=1}^{n} daily\ imbalance\ position\ (EUR)_t, \text{ where}$$

- $aggregated\ exposure_i$: From KELER CCP's perspective, this is the potential, total exposure upon default of the Clearing Member calculated on settlement day i cumulated backwards
- i: The settlement day of calculation
- t: It denotes gas day, $t = 1$ is the gas day before the calculation day
- n: Counting backwards, the number of gas days until and including the second settlement day from the calculation day
- *Time period between* $t = 1$ *and* n: Usually it is either a 2-day or a 4-day period. For example, if the calculation is run on Wednesday, the timeframe consists of Monday and Tuesday. If the calculation is run on Monday, the timeframe consists of Thursday, Friday, Saturday and Sunday. In case of holidays, the timeframe used for exposure calculation might be ever longer.
- $daily\ imbalance\ position\ (EUR)_t$: The difference between the ENTRY (MWh) and EXIT (MWh) amounts determined by the TSO for each gas day. The difference is converted to EUR with either the marginal purchase price or marginal sell price depending on the direction. In case the EXIT is higher than the ENTRY for a gas day, then the marginal purchase price is applied. This is considered positive difference (EXIT-ENTRY). The resulting imbalance positions are also increased by the VAT if the Clearing Member is required to pay VAT in Hungary. Due to the aggregation process daily positive and negative imbalance positions can offset each other.

To exclude potential distortion of the proportional exposure compared to EXIT, we apply aggregated EXIT as well. This way significantly volatile EXIT portfolios will not necessarily result in higher turnover margin requirement.

$$aggregated\ EXIT_i = \sum_{t=1}^{n} daily\ EXIT\ portfolio\ (EUR)_t, \text{ where}$$

- $aggregated\ EXIT_i$: Daily EXIT portfolios determined by the TSO are summed for the

Time period between $t = 1$ *and* n.

- i: The settlement day of calculation
- t: It denotes gas day, $t = 1$ is the gas day before the calculation day
- n: Counting backwards, the number of gas days until and including the second settlement day from the calculation day
- *Time period between* $t = 1$ *and* n: Usually it is either 2-day or a 4-day period. For example, if the calculation is run on Wednesday, the timeframe consists of Monday and Tuesday. If the calculation is run on Monday, the timeframe consists of Thursday, Friday, Saturday and Sunday. In holiday periods, the timeframe used for exposure calculation might be ever longer.
- $daily\ EXIT\ portfolio\ (EUR)_t$: TSO determines the total EXIT for each gas day in MWh and it is converted to EUR with the marginal purchase price.

To further adjust the denominator for its volatility, KELER CCP added an average calculation for smoothing effect. From the long average (250 settlement day) and the short average (10 settlement day), the higher is taken as the final average, which then fed into the Expected Shortfall calculation.

$$average\ aggregated\ EXIT_i = max\left(\frac{1}{n}\sum_{i=1}^{250} aggregated\ EXIT_i ; \frac{1}{m}\sum_{i=1}^{10} aggregated\ EXIT_i\right),$$

where

- n: The number of settlement days in the 250 settlement day lookback period when the EXIT was higher than zero
- m: The number of settlement days in the 10 settlement day lookback period when the EXIT was higher than zero
- i: It denotes settlement days, $i = 1$ denotes the current settlement day (calculation day).

The underlying variable (x_i) to the Expected Shortfall can now be calculated for each day in the 250 settlement day lookback period.

$$x_i = \frac{aggregated\ exposure_i}{average\ aggregated\ EXIT_i}$$

Then the Expected Shortfall is calculated as follows:

$$ES(\%)_i = \frac{1}{k}\sum_{i=1}^{250} max[x_i; VaR(x_i; \alpha)], \text{ where}$$

- k: The number of settlement days in the lookback period when $x_i > VaR(x_i; \alpha)$
- α: Confidence level, 99%

$$ES_i = ES(\%)_i * average\ aggregated\ EXIT_i$$

In case of a new Clearing Member, right after receiving the Clearing right, the value of Expected Shortfall cannot be computed. For the first 3 settlement days after receiving the Clearing right, there is a simpler calculation for this component.

$$ES_i = ES(\%)_i * simple\ average\ daily\ EXIT_i, \text{ where}$$

- ES_i: In case of new Clearing Members, it is a simplified component and not based on the risk metric Expected Shortfall
- $ES(\%)_i$: The maximum of $\frac{daily\ imbalance\ position\ (EUR)_t}{daily\ EXIT\ portfolio\ (EUR)_t}$ for all the gas days since receiving the Clearing right
- $simple\ average\ daily\ EXIT_i$: Simple average of $daily\ EXIT\ portfolio\ (EUR)_t$ for all the gas days since receiving the Clearing right (not identical what is used in case of Ratio Floor)

Ratio Floor (RS)

The Ratio Floor was designed to capture the risk of potential imbalance exposures caused by Clearing Members who have not had any imbalances in the past. These potential future exposures cannot be incorporated in the Expected Shortfall component. The Ratio Floor is based on the average size of the EXIT portfolio, the creditworthiness of the Clearing Member and the size of Clearing Member compared to its average EXIT. To calculate this component two variables are necessary, the ratio (R) and the $average\ daily\ EXIT_i$.

The ratio (R) is a percentage parameter that is unique for each Clearing Member. It is recaulcated quarterly and sent to the Clearing Members via e-mal. The ratio (R), among other information, utilizes the result of the internal risk assessment of the Clearing Member. Its minimum is 5% and the maximum is either 45% or 60%. The maximum depends on whether the Clearing Member is considered an existing or a new Member. After receiving the Clearing Right, the Clearing Member is considered new[3] until the second, orderly review of the ratio (R) (minimum 3 months, maximum 6 months).

The $average\ daily\ EXIT_i$ is similar to the $average\ aggregated\ EXIT_i$, however both the average calculation and the underlying values differ. In this case we do not apply aggregation, but use only the simple, daily EXITs.

$$average\ daily\ EXIT_i =$$
$$max\left(\frac{1}{j}\sum_{t=1}^{15} daily\ EXIT\ portfolio\ (EUR)_t ; \sum_{t=1}^{365} \omega_t * daily\ EXIT\ portfolio\ (EUR)_t\right), \text{where}$$

- j: The number of gas days in the 15 gas day lookback period when the EXIT was higher than zero
- t: It denotes gas day, $t = 1$ is the gas day before the calculation day

[3] This is different from the New Clearing Membership in case of Expected Shortfall

- ω_t: The weight calculated[4] for gas day t and $\sum_{t=1}^{365} \omega_t = 1$

Fixed Floor (FF)

The Fixed Floor is currently set to 50.000 EUR.

Applied buffers

KELER CCP applies two buffers on top of $KSZFmargin$. The first buffer is the expert buffer and the second is the procyclicality buffer.

$$MINmargin_i = KSZFmargin_i * (1 + \theta_i), \text{ where}$$

- θ_i: The expert buffer (%) which is effective from settlement (calculation) day i. It is based on iterative backtesting and reviewed on a daily basis. It is published on KELER CCP's website.

$$PROmargin_i = max[MINmargin_i * (1 + \pi_i); PROmargin_{i-1} * (1 - \tau)], \text{ where}$$

- $PROmargin_i$: This is the buffered turnover margin basis on settlement day i except if it would result in a higher than acceptable decrease in margin requirement
- $PROmargin_{i-1}$: $PROmargin$'s value for the previous settlement day
- π_i: The procyclicality buffer which is effective from settlement (calculation) day i. It is published on KELER CCP's website.
- τ: The maximum decrease of turnover margin. Its current value is **20%** meaning the value of $PROmargin_i$ cannot be lower than the 80% of the $PROmargin_{i-1}$

KELER CCP applies rounding rules to get the final turnover margin requirement.

$$margin_i = \begin{cases} PROmargin_i\,, & if\ only\ I.\ condition\ is\ met \\ \left\lceil \frac{PROmargin_i}{\gamma} \right\rceil * \gamma\,, & if\ II.\ or\ III.\ condition\ is\ met \\ \left\lceil \frac{PROmargin_i}{\gamma} \right\rceil * \gamma + \gamma\,, & if\ neither\ condition\ is\ met \end{cases}$$

- γ: The scale of rounding, its current value is 10.000 EUR
- [ ]:The value inside these brackets are rounded up to the nearest integer
- $I.condition$: The value of $PROmargin_i$ is below the *rounding minimum*, which has a value of 100.000 EUR.
- $II.condition$: After a decrease to a lower rounding category, $PROmargin_i$ has been lower than the nearest 10.000 EUR at least by the *rounding threshold*, which has a value of 3.000 EUR, for 5 consecutive settlement days
- $III.\ condition$: The margin increases

[4] $\omega_t = \frac{(1-\lambda)*\lambda^{t-1}}{1-\lambda^{365}}$, where $\lambda = 0{,}9875$ and $t = 1$ is the gas day before calculation day

Balancing Clearing Turnover Margin Calculation for system users acting as TSOs on the Hungarian gas market

Due to the special characteristics of the operation of a TSO, there is a different methodology for turnover margin calculation for such Clearing Members. Only TSOs acting as TSOs in Hungary will have this methodology applied. A TSO for a different area joining the Hungarian gas market will have the methodology explained above.

Turnover margin basis

Both components of the turnover margin basis are calculated with the application of the coherent risk metric, Expected Shortfall.

$$KSZFmargin_i = \left\lceil \frac{max(SES_i, LES_i)}{\gamma} \right\rceil * \gamma, \text{ where}$$

- $KSZFmargin_i$: Turnover margin basis for settlement day i
- [ ]:The value inside these brackets are rounded up to the nearest integer
- SES_i: Short Expected Shortfall component for settlement day i
- LES_i: Long Expected Shortfall component for settlement day i
- γ: The scale of rounding, its current value is 500.000 EUR

Short Expected Shortfall component (SES)

$$SES_i = \frac{1}{k}\sum_{t=1}^{n} max\left[daily\ imbalance\ position\ (EUR)_{t,pos}; VaR\left(daily\ imbalance\ position\ (EUR)_{t,pos}; \alpha\right)\right]$$

, where

- k: The number of gas days in the lookback period of n when $daily\ imbalance\ position\ (EUR)_{t,pos} > VaR\left(daily\ imbalance\ position\ (EUR)_{t,pos}; \alpha\right)$
- t: It denotes gas day, $t = 1$ is the gas day before the calculation day
- n: The number of gas days in the 365 gas day lookback period when $daily\ imbalance\ position\ (EUR)_t > 0$
- α: Confidence level, 99%
- $daily\ imbalance\ position\ (EUR)_t$: The difference between the ENTRY (MWh) and EXIT (MWh) amounts of other non-TSO system users, determined by the TSO, summed up for each gas day. Before summing the positions, the imbalances (MWh) are converted to EUR with either the marginal purchase price or marginal sell price depending on the direction. In case the EXIT is higher than the ENTRY for a gas day, then the marginal purchase price is applied. This is considered negative difference in case of a TSO (ENTRY-EXIT). The resulting imbalance position is also increased by the VAT if the TSO is required to pay VAT in Hungary.

- $daily\ imbalance\ position\ (EUR)_{t,pos}$: It equals to $daily\ imbalance\ position\ (EUR)_t$ when the TSO would have had a net financial obligation due to other system users' imbalances. Therefore this excludes all negative results.

Long Expected Shortfall component (LES)

$$LES_i = \frac{1}{k}\sum_{t=1}^{n} max\left[daily\ imbalance\ position\ (EUR)_{t,pos}; VaR\left(daily\ imbalance\ position\ (EUR)_{t,pos}; \alpha\right)\right],$$

- n: This is a continuously changing parameter. The number of gas days since 2010.07.01 when $daily\ imbalance\ position\ (EUR)_t > 0$
- The rest of the variables are the same for SES_i and LES_i

Applied buffers

KELER CCP only applies the expert buffer in case of the TSO. The final turnover margin requirement then calculated as follows:

$$margin_i = KSZFmargin_i * (1 + \theta_i), \text{ where}$$

- θ_i: The expert buffer which is effective from settlement (calculation) day i. It is based on iterative backtesting and reviewed on a daily basis. It is published on KELER CCP's website.

2.2. Trading Platform (TP)

Turnover Margin

- There is no algorithm based turnover margin requirement calculation by KELER CCP for Trading Platform market. Clearing Members can voluntarily define the amount of turnover margin necessary for their trading limits.
- Clearing Members can define the necessary amount of collaterals (EUR) as turnover margin based on their planned exposures and trading limits.
- If Clearing Members do not generate any financial obligations, the placement of turnover margin is not necessary, meaning the required minimum amount of turnover margin is 0 EUR for Trading Platform Clearing Members.

Position limit

The positon limit is the actual amount of blocked collaterals for KELER CCP as beneficiary, adjusted with financial positions.

$$Position\ limit = \frac{B}{1 + VAT} + T + \min(Tp; 0) + \min(Sp; 0)$$

where,

- ***B***: Value of collateral assets (placed for Trading Platform).
- ***VAT***: The current value of value-added tax. In this calculation, the value of VAT is 0% for foreign Clearing Members.
- ***T***: Cumulated financial position based on the transactions which are not yet cleared on Trading Platform in the current clearing cycle (value is positive in case of net seller, negative in case of net buyer).
- T_p: Cumulated financial position based on the transactions which are not yet cleared on Trading Platform in the previous clearing cycle (value is positive in case of net seller, negative in case of net buyer).
- S_p: Net financial position based on the transactions which have been already cleared but not yet settled on Trading Platform (value is positive in case of net seller, negative in case of net buyer).

2.3. CEEGEX spot gas market

Turnover Margin

- There is no algorithm based turnover margin requirement calculation by KELER CCP for CEEGEX spot market. Clearing Members can voluntarily define the amount of turnover margin necessary for their trading limits.
- Clearing Members can define the necessary amount of collaterals (EUR) as turnover margin based on their planned exposures and trading limits.
- If Clearing Members do not generate any financial obligations, the placement of turnover margin is not necessary, meaning the required minimum amount of turnover margin is 0 EUR for CEEGEX spot Clearing Members.

Position limit

The positon limit is the actual amount of blocked collaterals for KELER CCP as beneficiary, adjusted with financial positions.

$$Position\ limit = \frac{B}{1 + VAT} + T + \min(Tp; 0) + \min(Sp; 0)$$

where,

- ***B***: Value of collateral assets (placed for CEEGEX).
- ***VAT***: the current value of value-added tax. In this calculation, the value of VAT is 0% for foreign Clearing Members.
- ***T***: Cumulated financial position based on the transactions which are not yet cleared on CEEGEX in the current clearing cycle (value is positive in case of net seller, negative in case of net buyer).
- T_p: Cumulated financial position based on the transactions which are not yet cleared on CEEGEX in the previous clearing cycle (value is positive in case of net seller,

negative in case of net buyer).

- S_p: Net financial position based on the transactions which have been already cleared but not yet settled on CEEGEX. (value is positive in case of net seller, negative in case of net buyer).