Risk Management Overview

Version 8.6 of February 2023

Cboe Clear

Contents

Cboe Clear

1. Introduction

Cboe Clear Europe N.V. (hereafter "Cboe Clear") operates a reliable, efficient and low risk clearing system. A robust risk management framework allows Cboe Clear and its clients to deal with various risk scenarios with confidence.

Clearing Houses are a core component supporting financial markets. One of the main functions of Cboe Clear is to provide continuity of the marketplaces it serves. As the default of a Clearing Participant (CP) can potentially threaten this continuity, Cboe Clear operates a risk model that mitigates this threat ensuring that adequate protection is available to mitigate systemic risk. Robust and effective rules, procedures and adequate financial resources are in place to handle default events. In chapter 2 Cboe Clear describe this model briefly, followed by a more detailed description of the parts in chapter 3 through 5.

Cboe Clears risk model is designed to mitigate the various repercussions of a default scenario as a CP may default for reasons beyond the CPs business at Cboe Clear (e.g., Lehman Brothers International). The order of liability in the case of a CP default is described in chapter 2.

Cboe Clear is authorised as a Central Counterparty under the European Market Infrastructures Regulation. Cboe Clear is regulated in the Netherlands by De Nederlandsche Bank (DNB, the Dutch Central Bank) and the Autoriteit Financiële Markten (AFM).

2. Risk Model / Default waterfall

Cboe Clear has reviewed the plausible sources of risk, both internal and external, and mitigates their impact through its Risk Model which uses appropriate systems, policies, procedures, and controls. Cboe Clears Risk Model consists of five layers:

1) Participation requirements: only authorized firms can join Cboe Clear as a Clearing Participant (hereafter "CP").

2) Collateral (including interoperability fund deposit and clearing fund contribution of the CP); Cboe Clear requires CPs to meet margin requirements on the portfolio by depositing collateral at Cboe Clear.

3) Skin in the game; Cboe Clear will use its dedicated own resources before using the Clearing fund contributions of non-defaulting CPs.

4) Clearing fund; in the unlikely event that a defaults and layers 2 and 3 are not sufficient to cover the liquidation of the portfolio of the CP, the clearing fund provides an additional buffer.

5) If the losses caused cannot be covered by the collateral provided by the defaulting participant, the skin in the game and the aggregate amount of the Contributions to the Clearing Fund of all Clearing Participants (layers 2, 3 and 4) the non-defaulting Clearing Participants shall on demand make an additional payment to Cboe Clear on a pro rate basis in proportion to the amount of their Contributions to cover any such remaining losses (limited to an amount equal to the amount of their Contribution).

Layer 1 provides assurance that all Clearing Participants are reputable and authorised to operate as a CP.
Layer 2 provides assurance that the portfolio of the CP can be liquidated in case of a default under normal or mildly extreme circumstances without additional costs to the non-defaulting CPs.
Layer 3 ensures that the CCP is incentivised to have conservative participation requirements and ensures a robust risk management framework.
Layer 4 provides assurance that in case the circumstances turn extreme, there will still be enough funds to cover a potential default.
Layer 5 provides additional assurance in addition to the financial resources. The financial resources (layers 2, 3 and 4) should together suffice to withstand the stress tests. Layer 5 is therefore more a recovery tool and not part of the financial resources.

3. Admission requirements

The first level of protection for Cboe Clear is to ensure only authorised firms are admitted as clearing participants. For this purpose, eligibility criteria have been defined which includes, in addition to regulatory authorization a number of financial resource requirements. These requirements must be met during admission and observed on an ongoing basis.

The financial requirements concerning the capital of the (applicant)-CP are:

- at least Euro 7.5 million (Direct CP) or Euro 25 million (General CP)
- at least 20% of the 30-day average Margin requirement
- at least 20% of the 250-day average Margin requirement

In addition, there are other requirements to be met to ensure that the CP is capable of fulfilling its role. Please refer to the Cboe Clear Clearing Rulebook sections 4 and 5 for more detailed information.

4. Margin Criteria

As set out in the European Market Infrastructure Regulation (EMIR) margin requirements should cover the losses in a portfolio in at least 99% of all cases. Furthermore, EMIR requires that CCPs take a number of factors into consideration when determining whether a percentage of 99% is sufficient or should be increased. In appendix A, the details of Cboe Clears' analysis and considerations in determining its confidence interval are provided. With the implementation of the new margin methodology Cboe Clear has changed the confidence level from 99.7% to 99.

The liquidation period that Cboe Clear uses for the margin calculations is set to three days.

Further information about the margin model of Cboe Clear can be found at:
https://Cboe Clear.com/document/Cboe Clear-coh-user-manual/

5. Clearing fund deposit criteria

The Clearing Fund is an important line of defence which can be used to protect CPs and CCPs in extreme stress scenarios such as a CP default. The Clearing Fund is a pool of funds made up of Clearing Participants contributions. All CPs are required to contribute to the Clearing Fund. The deposit of a clearing participant to the clearing fund is determined as follows.

5.1 Base Deposits

Pursuant to paragraph 8.2.2. (a) of the Clearing Rule Book, the applicable base deposits per Product Class are as follows:

- for a Direct Clearing Participant: € 1.000.000,00
- for a General Clearing Participant: € 3.000.000,00

5.2 Required Clearing Fund Size

The Required Clearing Fund Size is defined as 105% of the two largest uncovered potential losses over the last twelve (12) months.

The uncovered potential loss is the sum of the two (2) largest assumed liquidation losses calculated for both Products remaining after the deduction of Cboe Clear's dedicated own resources. The two (2) largest assumed liquidation losses per Product are determined by calculating and ranking all assumed liquidation losses of all Open Positions for each Clearing Participant.

5.3 Determination of the Contribution per Clearing Participant

Each Clearing Participants is required to deposit the base amount as stated in section 5.1

To determine the variable component of the Contribution for each Clearing Participant the average margin percentage is calculated as the average Margin based on the previous thirty (30) Clearing Days of the Clearing Participant's Open Positions per Product Class in Securities divided by the average Margin based on the previous thirty (30) Clearing Days of all Open Positions per Product Class in Securities of all Clearing Participants.

If the Required Clearing Fund Size is greater than the sum of the base amounts of all Clearing Participants, the remainder is allocated to each Clearing Participant pro rata per Product Class on the difference between the average margin percentage of the Clearing Participant and the base amount of the Clearing Participant divided by the Required Clearing Fund Size, provided the difference is greater than zero.

The calculation of the average margin percentage is performed on a monthly basis by Cboe Clear at the beginning of each calendar month taking the last Clearing Day of the previous calendar month as reference.

All CP Contributions to the Clearing Fund are rounded up to the next € 50,000.

Cboe Clear performs regular stress tests to validate the adequacy of the financial resources including the Clearing Fund on a daily basis.

6. Interoperability fund

Within the interoperability risk framework of the three CCPs each CCP runs the risk that a CCP with which it interoperates goes into default or fails otherwise on its obligations. This would leave the non-failing CCP exposed to the (net) position of the failing CCP in its books. To mitigate this risk, each CCP assesses the exposures that arise from its co-CCPs, in accordance with ESMA Guidelines, applying the same risk management methodology used for its clearing members.

Cboe Clear has established the Interoperability Fund to cover for margin obligations coming from the co-CCPs assessments. The Interoperability Fund is a pool of funds made up of Clearing Participants contributions. All CPs with transactions that can be settled through the Co-Operating Clearing Houses are required to contribute to the Interoperability Fund.

6.1 Base Amounts

Pursuant to paragraph 7.2.3 (a) of the Clearing Rule Book, the applicable base amounts are as follows:

- for a Direct Clearing Participant which enters into Trade(s) which can be settled through a Co-operating Clearing House: € 0
- for a General Clearing Participant which enters into Trade(s) which can be settled through a Co-operating Clearing House: € 0

6.2 Determination of the allocation percentage per Clearing Participant

The percentage which will be allocated to each Clearing Participant as referred to in paragraph 7.2.3 (b) of the Clearing Rule Book will be determined as follows:

The average Margin based on the previous thirty (30) Clearing Days of the Clearing Participant's Open Positions in Securities which can be settled through the Co-operating Clearing Houses divided by the average Margin based on the previous thirty (30) Clearing Days of all Open Positions in Securities which can be settled through the Co-operating Clearing Houses.

This calculation is performed on a monthly basis by Cboe Clear at the beginning of each month. Reporting of the percentage will be done within two (2) Clearing Days after the calculation, but always within the first five (5) Clearing Days of each month. The percentages will apply as from the first Monday following reporting.

Cboe Clear may change the percentages at any time during the month in special circumstances, for instance upon the entry of a new Clearing Participant or the departure of a Clearing Participant.

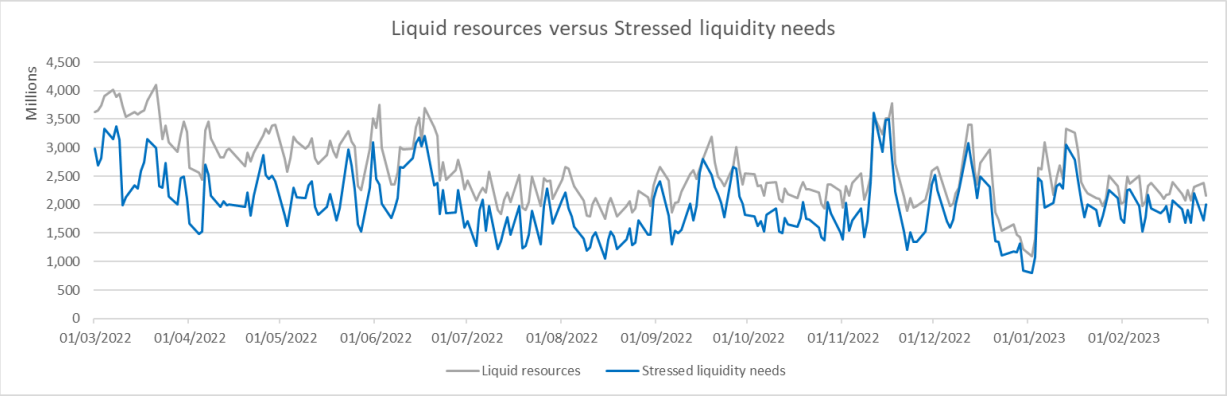
7. Liquidity Risk Management

Cboe Clear's liquidity framework is established in accordance with requirements as set in Article 44 of Regulation (EU) No 648/2012 (supplemented through RTS (EU)153/2013 article 32). The framework ensures with a high degree of confidence that Cboe Clear can continue to meet its payment obligations resulting from the settlement process it operates during stressed (hypothetical) market conditions, which includes the default of the two largest Clearing Participants (including linked family counterparty's) and CO-CCPs to which Cboe Clear has an interoperable link, on a day-by-day basis.

Cboe Clear's available liquid resources consists outs of a 1.5 billion loan, Margin Collateral (of the respective day) and Clearing Fund contributions. In addition to the above, and as referred to earlier, Cboe Clear has liquidity tools at its disposal to call for additional liquidity in the event of a (theoretical) shortfall.

As part of Cboe Clear's ongoing transparency requirements, the results from Cboe Clear's stress testing program are available for publication. Chart 1 shows the results of the worst hypothetical liquidity stress loss versus Cboe Clear's available resources of the last 12 months.

Chart 1 – Stressed liquidity results



8. Testing the robustness of the risk management framework

One of Cboe Clears primary objectives is to ensure continuity of the marketplaces it serves in both normal and extreme market conditions. As such Cboe Clear undertakes regular testing to identify, monitor, and manage risk to ensure its risk model remains robust and effective. These tests consider EMIR requirements and are derived from detailed analysis of historic data, hypothetical scenarios as well as discussions with Cboe Clears Risk Committee.

This section provides details of Cboe Clears systematic risk assessments and test results of the daily back and stress tests which are updated on a monthly basis.

8.1 Back testing

8.1.1 Cash Equities

Back testing is used to test whether the margin requirement of Cboe Clear covers at the minimum requirement of CPMI-IOSCO and EMIR that the margin requirement is at least sufficient in 99% of all cases. With the implementation of the new margin model on the 19th of April 2021, Cboe Clear internal requirements were changed form 99.7% to match the regulatory requirements of 99%.

When performing the bask test, Cboe Clear compares the margin requirement with the actual result of the CPs' portfolios over the liquidation horizon. Since Cboe Clear set the liquidation horizon at 3 days, the price of the positions held on at the close of business day 1 will be compared with the price of the same position at the close of business day 4. The result of the portfolio is calculated by multiplication of the price differences between day 1 and 4 with the actual positions at the close of business day 1 (a so-called clean back test).

For each house and client account of a Clearing Participant, Cboe Clear defines both observations and violations. An observation is counted when a margin requirement calculated for an account. A violation is counted in case the margin requirement for the account is smaller than the 3-day negative change in value of the portfolio on the account. Hereby the portfolio is kept constant over this 3-day period.

Overall, the number of violations is less than the risk tolerance of Cboe Clear states as limit: 99.99% is well above the regulatory requirements of 99% (which is set for the previous 24 months).

The information for publication is limited to the last 12 months.

Period	Number of observations	Number of violations	Percentage
Mar 2022	1,334	1	99.93%
Apr 2022	1,086	0	100.00%
May 2022	1,238	0	100.00%
Jun 2022	1,243	0	100.00%
Jul 2022	1,168	0	100.00%
Aug 2022	1,307	0	100.00%
Sep 2022	1,259	0	100.00%
Oct 2022	1,201	0	100.00%
Nov 2022	1,276	1	99.92%
Dec 2022	1,190	0	100.00%
Jan 2023	1,241	0	100.00%
Feb 2023	1,170	0	100.00%
Total	**14,713**	2	**99.99%**

8.1.2 Equity Derivatives

This chapter provides the results for Cboe Clear product group Equity derivatives. To prevent duplication in metrics or information provided in respect to the explanation of the respective metric, if a metric is no different for Cash equities and Equity derivatives than no supplementary information regarding the respective metric is provided – a reference is made to the relevant chapter. In the event a metric is specific to Equity derivatives, supplementary information regarding the metric is provided.

Cboe Clear's internal confidence for Equity Derivatives is 99% (Margin Period Of Risk of three (3) business days) over the last 24 months. However Cboe Clear extended its clearing activities for Equity Derivates on the 6th of September 2021, therefore 24 last months are not yet available.

The information for publication is limited to the last 12 months.

Period	Number of observations	Number of violations	Percentage
Mar 2022	81	0	100.00%
Apr 2022	57	0	100.00%
May 2022	64	0	100.00%
Jun 2022	64	0	100.00%
Jul 2022	63	0	100.00%
Aug 2022	69	0	100.00%
Sep 2022	66	0	100.00%
Oct 2022	62	0	100.00%
Nov 2022	67	0	100.00%
Dec 2022	71	0	100.00%
Jan 2023	66	1	98.48%
Feb 2023	60	0	100.00%
Total	**790**	**1**	**99.87%**

8.2 Stress testing

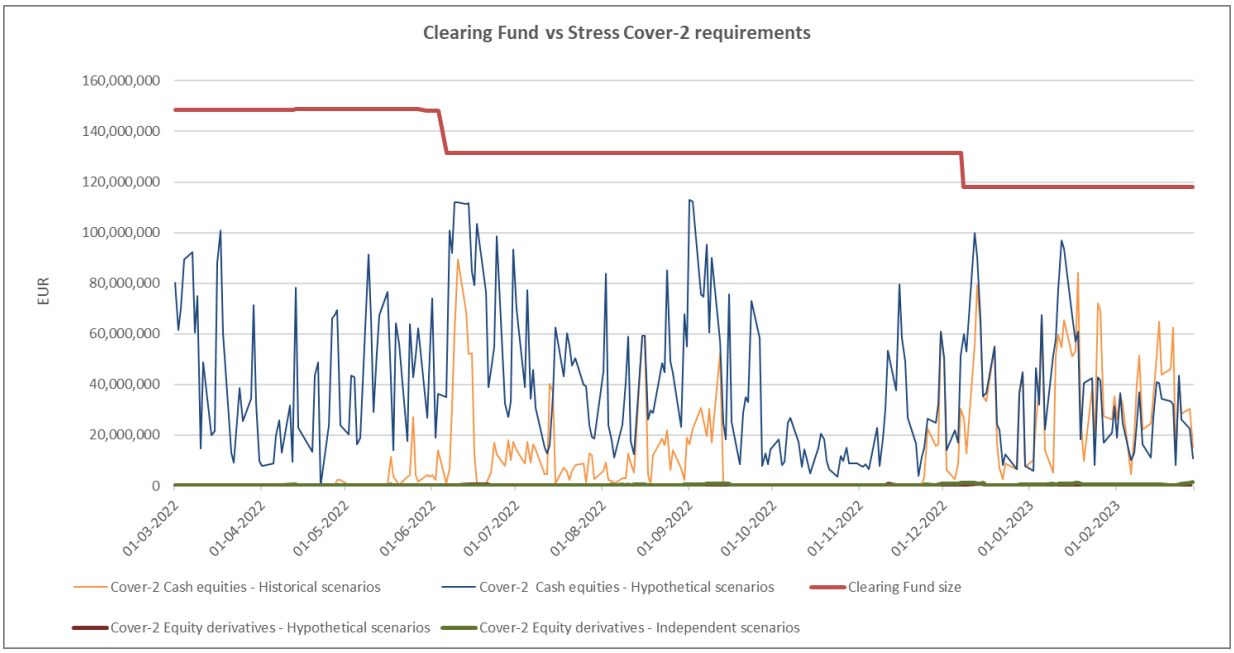
Stress testing is an important tool for Cboe Clear to assess the potential losses from the default of Clearing Participants (CPs) beyond their margin requirements. In Cboe Clears stress testing both historical and potential future stress scenarios are applied.

For both the historical and the potential future scenarios the two clearing participants to which Cboe Clear has the greatest exposure is identified. The stress levels for these portfolios will be added to identify a total exposure amount. The adequacy of the financial resources is assessed by checking if the available resources as set out in Cboe Clears risk Model are larger than the calculated total exposure amount.

Cboe Clears financial resources consist of Cboe Clears skin in the game and the Clearing Fund contributions of the CPs (incl. the defaulting CP). As stipulated in the Clearing Rule Book, the Clearing Fund may be called upon in the event that a default occurs and that losses exceed the amount of (1) collateral, (2) skin in the game and (3) Interoperability Fund deposit and clearing fund contribution posted by the defaulting participant(s).

The below figures show on a daily basis the largest stress value (Largest P&L) and the second largest stress values (Total P&L) compared to Cboe Clears Clearing Fund Size. Stress values are defined as the stress outcome after deduction of the collateral value of the CP. The data period is from the 1st of March 2022 until 28th February 2023.

Clearing Fund vs Stress Cover - 2 requirements



Additional Cboe Clears publicly available resources

Further information about Cboe Clears Admission criteria and Rules can be found at:
https://Cboe Clear.com/download/Cboe Clear-clearing-rule-book/

Further information about Cboe Clears eligible collateral requirements can be found at:
https://Cboe Clear.com/document/Cboe Clear-acceptable-collateral/

Further information about Cboe Clears dedicated own resources can be found at:
https://Cboe Clear.com/download/regulation-dedicated-own-resources/

Further information about Cboe Clears clearing fund requirements can be found at:
https://Cboe Clear.com/document/regulation-clearing-fund-2/

Appendix A: Considerations on the determination of the confidence interval

Under EMIR, Cboe Clear adheres to the minimum confidence interval as specified in Regulation (EU) No 153/2013 article 24. The article specifies that margin requirements should cover potential losses in a portfolio with a minimum confidence interval of 99%.

The same article also requires a CCP to consider a number of factors to determine whether it should raise the percentage above the minimum and to inform its regulator and clearing members of the results.

Cboe Clear undertakes regular testing to ensure its procedures are robust and effective and publishes details of its confidence interval determination on a quarterly basis. The confidence interval is primarily set to regulate the frequency with which margin shortfalls are expected to occur. However, Cboe Clear thinks that it is even more important to (attempt to) set the margin in such a way that any margin shortfall is within the risk tolerance of the CCP. Cboe Clear recognizes that the margin shortfall may be difficult to predict in advance and that the frequency of margin shortfalls can be seen as a crude indicator of the size of the shortfall. A more refined indicator might be something to strive for as a focus on the level of the confidence interval might create a false sense of security if the frequency of margin shortfalls is not correlated in a linear way with the size of the shortfalls of the margin.

Cboe Clear has examined below the factors specifically listed in the regulation and included details of -factors which Cboe Clear deems to be important to the considerations.

Factors to consider as specified in the regulation:

(a) the complexities and level of pricing uncertainties of the class of financial instruments which may limit the validation of the calculation of initial and variation margin;

The cash equity products cleared by Cboe Clear are all listed on trading platforms. These platforms issue closing prices each day and during the day real-time information on bid/ask transaction prices are available. As such no complexities or significant pricing uncertainty will limit the validation of the calculation of the margin amounts. Cboe Clear uses closing prices provided by vendors – Refinitiv & Bloomberg.

(b) the risk characteristics of the class of financial instruments, which can include, but are not limited to, volatility, duration, liquidity, non-linear price characteristics, jump to

default risk and wrong way risk;

The cash equity products cleared by Cboe Clear are not considered complex products. More specifically the cash equity class of financial instruments is not particularly volatile, and it is quite liquid. Wrong way risk is not relevant as the collateral that Cboe Clear accepts is not exposed to the same risk factors as equities, while the other characteristics listed above are not applicable to cash equities.

(c) the degree to which other risk controls do not adequately limit credit exposures;

Cboe Clear has installed participation requirements designed to give reasonable assurance that clearing participants are reputable and fully authorized as fit to participate in a clearing system. However, participation requirements by themselves do not prevent defaults of clearing participants. In itself the participation requirements therefore do not impact the required confidence interval. The other financial resources together with the margin requirement ensure that the credit exposures are adequately limited; this process is however independent of the chosen percentage for the confidence interval and only sets the balance between the two types of resources.

(d) the inherent leverage of the class of financial instruments, including whether the class of financial instrument is significantly volatile, is highly concentrated among a few market players or may be difficult to close out.

Cboe Clear only clears cash-equities that remain in the books of Cboe Clear until settlement at T+2 only (and in some markets T+3). Cash equities do not have inherent leverage. However, during COVID-19 times, it has been observed cash equities had high volatility. However, this hight volatility is not comparable to the past 30 years' history volatility. Given the number of venues on which cash-equities are traded and that Cboe Clear only has unsettled positions to guarantee, closing out positions is not perceived as an issue. Note further that additional margin is required in case positions in an ISIN are large in comparison to the overall trading volume in that ISIN.

Additional factor(s) to consider:

(e) Balance between margin requirement and other financial resources.

The margin requirement together with the other financial resources should cover the potential losses in case of a defaulting clearing participant. This means that a relatively low margin requirement would need to be offset by a relatively high amount of other financial resources for a given potential loss. The reverse also holds relatively high margin requirements can be offset by relatively low amount of other financial

resources. Although the balance between margin requirement and other financial resources was not specifically taken into account when the confidence level was set, it must be taken into account when a change to the confidence level is considered.

(f) Expected size of the margin shortfall.

Cboe Clear monitors not only the frequency of margin shortfalls but also concerned about the size of a margin shortfall. Cboe Clear would rather observe 10 shortfalls of €1 than have to record 1 shortfall of €1 million. To this end both the maximum and average shortfall are being monitored. Over the reporting period (see chapter 7.1) the maximum shortfall equal to € 28.312,00 while the average shortfall is € 9931,80. These outcomes have not led to insurmountable losses to Cboe Clear or its default fund.

(g) Risk tolerance of the CCP and its shareholders.

The current shareholders have not considered changes to the policy in place at one of the predecessors of Cboe Clear NV to set the confidence level at 99%. If the shareholders would consider reviewing their risk tolerance in this respect, it may lead (up) to a change.

Conclusion

Based on the factors listed in article 24 of the Regulation (EU) No 153/2013 and Cboe Clears risk management framework in its entirety, there is no need for a confidence interval above 99%.

At the moment there is no compelling reason for Cboe Clear to revise the current percentage it has set for the confidence interval.