SUPERVISORY STRESS TEST OF DERIVATIVES CLEARING ORGANIZATIONS: REVERSE STRESS TEST

Assumptions and Methodology

Report by Staff of the U.S. Commodity Futures Trading Commission

June 2024

SUPERVISORY STRESS TEST OF

DERIVATIVES CLEARING ORGANIZATIONS:

REVERSE STRESS TEST

Assumptions and Methodology

A REPORT BY STAFF

OF THE U.S. COMMODITY FUTURES TRADING COMMISSION

JUNE 2024

DISCLAIMER

Tables of Contents

List of Tables

List of Figures

List of Abbreviations

BMS	Base Market Scenario
CCP	Central Counterparty, or Clearinghouse
CDS	Credit Default Swaps
CFTC	United States Commodity Futures Trading Commission
CME	Chicago Mercantile Exchange Inc., United States
DCO	Derivatives Clearing Organization
DF	Default Fund(s) or Guaranty Fund
EOD	End of Day
ESS	Expanded Stress Scenario
Eurex	Eurex Clearing AG, Germany
F&O	Futures & Options (i.e., Futures Contracts & Options on Futures Contracts)
FX	Foreign Currency Swaps
ICE	Intercontinental Exchange Inc., United States
ICC	ICE Clear Credit LLC, United States
ICEU	ICE Clear Europe Limited, United Kingdom
ICUS	ICE Clear US Inc., United States
IRS	Interest Rate Swaps
LCH Ltd	LCH Limited, United Kingdom
LCH SA	LCH SA, France
LEI	Legal Entity Identifier, ISO 17442
LSOC	Legally Segregated Operationally Comingled
MGE	Minneapolis Grain Exchange LLC, United States
MPOR	Margin Period of Risk
Nodal	Nodal Clear LLC, United States
PnL	Profit and Loss
SIDCO	Systemically Important DCO
USD	United States Dollar
VM	Variation Margin

1. Introduction

The Risk Surveillance Branch (RSB) of the Division of Clearing and Risk of the United States Commodity Futures Trading Commission (CFTC) completed its fourth Supervisory Stress Test (SST) of registered Derivatives Clearing Organizations (DCOs)—i.e., central counterparties (CCPs) under the CFTC's jurisdiction.[1] In this *Assumptions and Methodology* document (CFTC 2024b) and the associated *Analysis and Results* report (CFTC 2024a), we abbreviate this exercise as the 2024-SST. The 2024-SST analysis focuses on a reverse stress test, a theoretical exercise which identifies the combination of market shocks and clearing member defaults that would result in the exhaustion of financial resources available to a DCO. Although a previous SST (CFTC 2019) included a reverse stress test component, the 2024-SST significantly broadens that earlier work. This reverse stress test includes more DCOs (nine, with 11 Clearing Service Lines), more stress scenarios (11), and a few methodological improvements, such as collateral valuation consistent with the underlying stress scenario. The 2024-SST includes both Single-DCO and Cross-DCO analysis, and the results of these analyses are included in a separate document (CFTC 2024a).

This document (CFTC 2024b), which is a supplement to the analytical report (CFTC 2024a), describes the assumptions and methodology used in developing the 2024-SST.

This *Assumptions and Methodology* document comprises a detailed overview of the scope of the 2024-SST, its reverse stress test methodology, including the division of work between the CFTC and the in-scope DCOs, and the set of assumptions used in the analytical framework. The following sections detail each of these subjects.[2]

2. Scope

This section describes the scope for key elements of the 2024-SST, with a focus on the included risk factors, DCOs, products, and financial resources.

[1] Section 5b of the Commodity Exchange Act (CEA), 7 USC § 7a-1, and Part 39 of the CFTC Regulations (17 CFR Part 39) describe the criteria, procedures, and requirements for registration as a DCO. Reference section includes citations for these regulations and other studies referenced in this document.

[2] This document includes four appendices: Appendix A contains all the tables (Tables 1-7); Appendix B includes all the figures (Figures 1-2); Appendix C summarizes the list of data elements provided by the DCOs; and Appendix D describes this study's background, containing an overview of SST and a summary of the CFTC's prior SST studies.

2.1 Risk Factors

The 2024-SST explicitly examines *counterparty credit risk* resulting from a combination of large market price changes and concurrent clearing member defaults.[3] The 2024-SST does not assess other risks faced by the DCOs, such as liquidity and operational risks.

Focusing on counterparty credit risk, stress scenarios include both "risk-on" and "risk-off" market conditions.[4] Some scenarios represent systemic market shocks that affected a large set of product classes while others focus on market shocks that only significantly affected a narrower subset of products.[5] The 2024-SST uses this broad set of historical base scenarios to ensure that for each DCO we could evaluate the impacts of price shocks that represent extreme market movements for its primary product set. In the exercise, each of the historical stress scenarios is amplified using shock multipliers ("multipliers") in order to generate large and implausible price shocks that will consume the DCO's financial resources, including, in many cases, assessments.

2.2 DCOs and Products

The 2024-SST includes most of the DCOs and clearing services (i.e., nine DCOs and 11 Clearing Service Lines) that are required to report to the CFTC under its regulations. Combined, the Clearing Service Lines included in this exercise represent a broad category of derivative contracts—i.e., futures and options on futures (F&O), interest rate swaps (IRS), credit default swaps (CDS), and foreign currency products (FX)—and various risk management processes (including default waterfall management). Some DCOs are excluded from this SST, either due to their structure (e.g., fully collateralized DCOs are not included, due to their nature) or size.[6] The nine DCOs included in this SST are CME, ICEU, ICC, ICUS, MGE, LCH Ltd, LCH SA, Eurex,

[3] This exercise implicitly includes risks associated with liquidation costs in the following way. We assume that a given market scenario represents the market movements that would occur as a result of independent market movements *as well as* any additional market shifts that result from the actual liquidation of a defaulted portfolio or portfolios, or costs associated with the bid/ask spread. This exercise includes collateral collected to cover these additional risks like liquidation and concentration margin add-ons: Thus, market scenarios referenced in the report must represent a combination of underlying factors. There is one exception: Of the two DCOs that clear CDS, while one DCO excluded the collateral posted for covering Jump-To-Default risk, the other DCO included that portion of collateral, in its resource calculations in respective stress tests. Jump-to-Default risk refers to the potential losses in excess of mark-to-market losses that a holder of a debt security could incur due to a sudden default of the issuer of that instrument.

[4] In general, "risk-off" scenarios (characterized by low risk appetite) include those in which equity markets fall, US Treasury prices increase, credit spreads widen, commodity prices fall, etc. "Risk-on" scenarios (characterized by high risk appetite) are those where market movements are the reverse.

[5] The full set of scenarios, with descriptions, is shown in Table 5 (Appendix A: Reference Tables).

[6] Fully collateralized positions (i.e., the counterparty posts upfront the maximum amount that could hypothetically be lost on the position upon liquidation or expiration of the contract) eliminate the counterparty credit risk of a clearing member or its customer not meeting the margin call obligations and defaulting that DCOs face when they clear products that are traditionally margined.

and Nodal.[7] While seven of these DCOs represent a single Clearing Service Line, two DCOs represent two different Clearing Service Lines each in the study. Each Clearing Service Line is treated as a separate DCO for purposes of this SST and hence, in this report, clearing services are generally referred to as "DCOs." For this reason, the report discusses 11 DCOs, despite there being nine legal entities that are registered as DCOs.

All house and customer accounts are included when evaluating the impact of stress scenarios. Similarly, all CFTC regulated derivative contracts cleared by each DCO—i.e., F&O, CDS, IRS, and FX—are included when applying price shocks and volatility shocks, as appropriate. Table 1 illustrates the distribution of DCOs included in the 2024-SST, by asset class, while

[7] The full names and locations of each of these DCOs are included in the List of Abbreviations.

Table 2 shows a sample of benchmark products covered under each of these four asset classes (see Appendix A: Reference Tables). In certain cases, where products under CFTC jurisdiction were margined together with products not under CFTC jurisdiction, the DCO stressed all commonly-margined products, along with the associated collateral.

2.3 Financial Resources

The DCOs reported all available financial resources as referenced in their default management procedures. These resources include all prefunded resources and assessment powers (which are unfunded resources). Prefunded resources include margin collateral (initial margin, any add-ons, and any excess), mutualized default (or guaranty) funds, and the DCO's own funds committed to meeting member defaults (referred in this study as "DCO's capital" or "skin-in-the-game"). Assessment powers allow a DCO to call on its non-defaulting clearing members to contribute additional resources if losses exceed prefunded resource levels. Assessment powers vary by DCO and, often, by the number of defaulting clearing members at a given DCO within the cooling off period. Prefunded resources are sized by DCOs to cover either one or two clearing member defaults that represent the largest margin shortfalls under extreme but plausible market shock scenarios.[8]

Figure *1* (Appendix B: Reference Figures) provides an example of a "traditional" DCO waterfall. Table 3 summarizes the range and magnitude of resources available to the DCOs included in this study.

DCOs also stressed pre-haircut collateral values, with the same stress scenarios used for positions.[9] Where stress scenarios changed collateral values (e.g., when funds are held in non-cash collateral or in non-USD currencies subject to stressed currency rates), the stressed values were reported. Depending on the composition of collateral, resource values could increase or decrease under different stress scenarios.

3. Methodology

This section provides a detailed overview of the reverse stress test methodology used in the 2024-SST. Considerations for the choice of a reference date for positions and prices, and the construction and selection of stress scenarios are included in this overview. RSB's approach to shortfall calculations as well as data verification and validation are also described.

[8] Systemically Important DCOs (SIDCOs) and Subpart C DCOs, which are systematically important in multiple jurisdictions or are involved in activities with a more complex risk profile, must calibrate prefunded resources to cover the default of the two clearing members that represent the largest combined hypothetical exposure under such market conditions ("Cover two), whereas other DCOs must cover the default of the one clearing member creating the largest exposure under those market conditions ("Cover one") (CFTC 2013).

[9] Pre-haircut is the market value of the collateral before any downward adjustment is made to factor in the asset's risk characteristics. For example, a substantial haircut may be applied if the asset being used has historically high volatility of returns.

3.1 Overview

For the 2024-SST analysis, each of the 11 DCOs was asked to calculate stress test results related to the scenarios applicable to their respective service lines. Each DCO provided data to RSB on the changes in values of positions and collateral corresponding to every scenario that DCO modeled. These data were used by RSB to calculate the use of each DCO's prefunded resources and assessments given different member default assumptions and stress scenarios.[10]

The DCOs performed the following tasks:

- generated SST scenario parameters using their existing internal stress testing tools, procedures, modeling assumptions, and historical information;
- calculated profit and loss (PnL) for each settlement account of clearing members, and individual swaps clients;
- calculated stressed collateral values for each settlement account and stressed prefunded resources provided by the clearing members and the DCO;
- illustrated how resources would be used under their existing default waterfall methodologies;
- completed and submitted all SST data using a standardized data template (see Appendix C);[11,12] and
- communicated any model and parameter constraints, including any constraints on the input specifications (e.g., implied negative prices beyond the scope of the DCO's existing stress testing tools).

RSB staff performed the following tasks:

- provided guidance to each of the 11 DCOs on the simulation of extreme and implausible price shocks (i.e., stress scenarios);
- performed data validation checks of the results provided by each DCO using RSB's internal data and surveillance tools;
- identified and sought reconciliation or correction of ambiguous elements or unexpected discrepancies in a DCO's SST results, and inconsistencies across DCOs;
- interpolated each DCO's SST results for every modeled scenario to smaller shock increments and compared these stress losses to the DCO's resources in that

[10] More detail on the data elements provided to the DCOs by RSB, as well as provided to RSB by the DCOs, can be found in Table 4 in Appendix A.

[11] DCOs calculated results in the primary currency of the respective DCOs. RSB then applied currency conversions to USD where needed for result comparison.

[12] Appendix C includes a list of data elements submitted by each DCO for its final SST model runs.

scenario; however, in the case of cross-DCO analysis, some extrapolations were necessary;

- identified the maximum price shocks that each DCO could sustain under various default scenarios which would result in the exhaustion of that DCO's resources; and
- communicated each DCO's reverse stress test results with that DCO as means of verifying and validating the results.

More details on the data and methodology used in this reverse stress test are included below. Table 4 provides a separate summary of the key data and methodology elements developed by DCOs and RSB staff.

3.2 Reference Date

RSB staff selected **September 1, 2023** ("Reference Date") as the position reference date in the initial scoping phase to represent a reasonably "normal" market date, while providing DCOs sufficient time to ensure that their internal systems were able to execute the SST scenarios based on the Reference Date. The Reference Date was used when calculating both the portfolio and the financial resource values:

- The DCOs applied the stress scenarios' shocks to the Reference Date's end of day (EOD) prices and positions, generating the corresponding changes to portfolio values under the stress scenarios.[13]
- The DCOs applied the stress scenarios' shocked prices to the Reference Date's EOD collateral, including margin collateral, default fund and the DCOs' capital.

3.3 Stress Scenario Construction and Selection

This section provides an overview of the historical scenario construction, as well as the construction of the more extreme expanded scenarios where multipliers are assigned to each of the base historical scenarios.

3.3.1 Base Market Scenario

RSB staff identified 11 base historical dates that constitute the set of Base Market Scenarios (BMS) for this SST (Table 5). These dates draw from the period of 2020-2023, reflecting particularly volatile, recent events.[14] As illustrated in Table 5, the 11 scenarios encompassed

[13] Section 3.3 describes and illustrates the application of stress scenarios' shocks to the Reference Date's EOD prices to calculate the corresponding stress scenarios' shocked EOD prices.

[14] Historical dates for this exercise fall inside a relatively short "look back" window for a few different reasons. First, market conditions over the last few years have been such that a wide set of product classes have experienced at least one historically large market move. Second, challenges often arise for stress scenarios based on dates far in the past, given that many current products may not have existed at that time. Finally, because this exercise is primarily a reverse stress test, the focus of the exercise is not on the base scenario itself, but on the scenario that is generated and results in the use of all available resources.

- the onset of COVID-19 and its sudden impact to markets in 2020 (i.e., three BMSs—2020MAR09, 2020MAR13, and 2020MAR18),[15]
- the effects on commodity and related markets due to the Russian invasion of Ukraine in February-May 2022 (i.e., five BMSs—2022FEB25, 2022MAR01, 2022MAR09, 2022APR18, and 2022MAY09),
- the inflation shocks and the associated macro effects in 2022 (i.e., two BMSs—2022JUN13 and 2022NOV10), and
- the banking crisis affecting U.S. regional banks and the associated shocks to the banking system in 2023 (i.e., one BMS—2023MAR13).

Each BMS reflects the one-day price shocks that the market experienced for all included products on the specified historical date.[16] All shocks modeled in this SST represent *one-day shocks*, regardless of the actual MPOR associated with the products.

To construct the one-day price shocks associated with a given BMS, each DCO determined the most appropriate translation of the one-day price moves. The shocks were either relative (i.e., percentage) shocks or absolute shocks, as appropriate for different products. For those products that existed on the Reference Date but did not exist at the time of the given historical date, the DCOs imputed shocks, based on internal methodologies. The DCOs also shocked implied volatilities, where applicable, according to existing internal stress testing procedures.[17]

3.3.2 Expanded Stress Scenarios

BMSs are expanded by applying a series of multipliers (5X, 10X, 15X, 20X, and 25X) to all the price shocks corresponding to that BMS to calculate Expanded Stress Scenarios (ESSs).[18] For example, if the BMS's price shock equaled a 10% reduction in price, the shift for the associated 5X expanded stress scenario would be a 50% reduction in price (10% multiplied by 5X).

[15] The date of each scenario is referred to in the format YYYYMMMDD. Thus, 2020Mar09 corresponds to the scenario on March 9, 2020.

[16] Because the BMSs represent one-day market shocks, the interpretation of results for futures-clearing DCOs and swaps-clearing DCOs is necessarily different. Because swaps-clearing DCOs size resources to cover 5 to 7-day market moves, their resources generally represent approximately 2.2X or 2.6X (the square root of 5 or the square root of 7) the amount of resources held by futures-clearing DCOs. Given this difference in resource sizing, scenario multipliers for swaps DCOs are expected to be, and are, noticeably higher than those for futures-clearing DCOs. Where possible, results will distinguish the two groups.

[17] DCOs were asked to shock (i.e., apply the corresponding stress scenarios' price shocks to) both futures prices and implied options volatilities similarly, consistent with the futures prices and implied volatilities on the corresponding BMS date.

[18] All participating DCOs were asked to run expanded stress scenarios for a set of multipliers that peaked at 25X. These highly extreme multipliers were included to enable RSB staff to determine the resource exhaustion threshold (a threshold that, in many cases, required a very high multiplier).

Table 6 illustrates the number of DCOs that modeled each of the 11 BMSs and the corresponding ESSs. Under certain extreme ESSs expanded scenarios, a DCO may have needed to impose floors and/or ceilings for the price shocks. Such floor or ceiling constraints were not to be imposed merely for the sake of plausibility; rather they were imposed so that prices remained consistent with the DCO's stress testing model (e.g., if the DCO's stress testing model assumes a positive price for a product, the price may be floored above zero). These constraints were documented by product type and communicated to RSB staff by the DCO when reporting its results.

3.4 Data Interpolation

Based on the stressed data received across the BMSs and five corresponding ESSs, RSB staff *interpolated* each element of the stressed data (i.e., account PnL and collateral, clearing member default fund, and DCO capital, where applicable) to a finer set of scenario multipliers with an increment of 0.1. In other words, for each of the 11 BMS, RSB staff expanded the original base plus five multipliers (1X, 5X, 10X, 15X, 20X, 25X) to the BMS plus 240 multipliers (from 1X to 25X, by 0.1, such as 1.1X, 1.2X, …, 24.8X, 24.9X) derived ESSs.

RSB staff calculated the interpolations using polynomial regression models, fitted separately to each data element. Figure *2* illustrates an example of polynomial curve fitting for one account's PnL and collateral across the full range of multipliers.

3.5 DCO Profit and Loss Calculations

RSB staff used DCO data and interpolated values to estimate the DCO's hypothetical losses and resource use under specific scenario and default conditions. The calculations include the following steps and assumptions:

(i) Compare stress losses (i.e., negative stress PnL) at the individual client account level (under LSOC) in the case of swaps, and at the customer segregated account level in the case of futures, to the corresponding account's stressed collateral, and calculate the account's stress loss exceeding margin, or "individual account-level shortfall."[19]

(ii) Aggregate individual account-level shortfall at the clearing member-level based on each DCO's default methodology and consistent with applicable regulations (e.g., LSOC). That portion of the clearing member's aggregate losses exceeding the member's available margin, is the "clearing member's shortfall" (or "member's shortfall").

(iii) Compare the clearing member's shortfall to the clearing member's DF contribution that the DCO holds. That portion of the shortfall that exceeds the member's DF contribution is the "member's deficit".

[19] Individual settlement account level shortfall = individual account level stress loss (-) individual account level collateral

(iv) Assume that clearing members default in the descending order of their relative deficit size (i.e., from the largest to the smallest) in that DCO. For example, in the case of a single default, the clearing member that has the largest deficit is the only member that is assumed not to pay and thus is defaulted by the DCO; and in the case of two (or three) defaults, the two (or three) members that have the largest combined deficit are the two (or three) members that are assumed not to pay and thus are defaulted by the DCO.

(v) Assume that when a DCO places a clearing member in default, all the affiliate members under the same parent entity as the defaulter will cease to meet further payment obligations (e.g., Assessments) to the DCO and thus be defaulted. However, any affiliate of the defaulting clearing member without deficits will still have their remaining DF contribution available to the DCO to cover the defaulter's deficit. The default of a clearing member with one or more affiliated clearing members may increase the contributions that unaffiliated, non-defaulting members need to make to fully cover the deficits of the defaulters (and, if applicable, their affiliated clearing members).

(vi) Calculate the total amount of financial resources that the DCO needs to cover member deficits, assuming members default at the corporate ultimate parent level, in sequential order, from the parent with the largest deficit to the parent with the smallest deficit. Thus, in this analysis, "Cover 1" represents the total amount of all resources that the DCO needs to cover the largest deficit from a single corporate parent, whereas "Cover 2" represents the total amount of resources that the DCO needs to cover the largest combined deficits from two unaffiliated corporate parents, etc.[20] These resources could include the DCO's capital, non-defaulting members' DF contributions, and Assessments from non-defaulting members (see Figure 1 for one common example). This order of resource use is most common across DCOs, but can differ depending on an individual DCO's rulebook.

Table *7* provides an illustration of how these assumptions translate to quantifying deficits and resource use in a specific combination of market scenario and member defaults for a DCO clearing swaps. Table *7* illustrates the calculations the RSB staff used to aggregate losses and deficits at the individual client and house account level to the respective clearing member level and then to the corresponding holding company level. Deviating from the terminology we have used in the rest of this report, in Table 7, we adopt the following terminology to illustrate the hierarchy of calculations: A holding company is referred to as "Parent" (i.e., Parent 1, Parent 2, and Parent 3 to refer to three holding companies); each affiliate clearing member of the holding company is referred to as "Member" (i.e., Member 1A, Member 1B, and Member 1C to refer to

[20] These "Cover" terms differ from Footnote 8's definitions of "Cover one" and "Cover two," which specify the threshold regulatory requirements for the DCO to size its prefunded default resources. For example (in this study), Cover 1 may include the DCO's callable, non-prefunded resources (i.e., assessments), in addition to the DCO's sized prefunded resources.

the three affiliate clearing members of Parent 1); each affiliate clearing member holds own positions in its "House" account and/or clients' positions in their respective "Client" account (i.e., House 1A, Client 1A_1, Client 1A-2 of Member 1A). To briefly outline the example:

The table, comprising four parts, provides an overview of the losses, and resources, associated with three holding companies at an abstract DCO, after an abstract stress event. Two of the holding companies have multiple subsidiaries that clear at the given DCO, and our methodology assumes that the default of any one subsidiary implies the default of the others. Each member subsidiary is then associated with the collateral posted (core margin + add-ons), other posted resources, like the default fund contribution, and the portfolio losses associated with the given stress event. These values are shown at the top chart of Table 7, broken down by each clearing member, and by member segregation. So, for instance, each member has a house account, with collateral posted to cover the risks of its own positions, as well as one or more customer accounts, with collateral covering the indirect risk of client default. DCO waterfalls allow for house collateral to be used to cover losses experienced in one or more client accounts. However, the reverse is not true; regulations do not allow for any customer resources to be used to cover any or all losses experienced by the member on its own (house) account.

Once these values have been assigned, both the member's and the parent company's deficits are calculated, as in the second chart of Table 7 (deficits are equivalent to losses that exceed the resources posted by the member or the parent).

Based on the above calculations, residual losses to the DCO can be compared to the remaining mutualized resources held by the DCO. The third and the fourth charts in Table 7 provide a summary of these resources, as well as how these resources might be used under a set of default assumptions (i.e. Cover 1 through Cover 3).

3.6 Default Waterfall Calculations and Frontiers of Coverage

Using the interpolated data points described above, RSB staff calculated resource depletion results ("waterfall") for each DCO/scenario combination to identify the threshold (i.e., multiplier) at which aggregate deficits would exhaust available resources. Staff calculated the waterfall for all default assumptions (e.g., Cover 1, Cover 2, to Cover All). Staff identified thresholds where different layers of DCO resources would be used to cover the deficits resulting from clearing member defaults. For example, under one scenario, a DCO may be able to cover the two largest deficits with prefunded resources for all multipliers up to X; using assessment powers, the top two deficits can be covered until multiplier X+Y.[21]

Based on the default waterfall calculations, RSB staff developed two "Frontiers of Coverage" (which are defined as the resource-exhausting combinations of shock multiplier and defaults) for each of the 11 DCOs. While one frontier of coverage is developed using only the DCO's

[21] At multipliers less than or equal to X, the deficits are small enough to be offset by prefunded resources, but shocks greater than those represented by X would require additional resources, which assessment powers can provide up to multiplier X+Y, to offset the deficits.

prefunded resources, the other frontier of coverage is developed using the DCO's *total resources* (including both prefunded resources and assessment powers).

Comparisons and implications of these multiplier thresholds across DCOs and scenarios, and frontiers of coverage, are discussed in the 2024-SST main report (CFTC 2024a).

3.7 Cross-DCO Deficit Calculations and Aggregate Resource Erosion

Extending the DCO-specific stress loss and deficit calculations described above, for each BMS, this SST analysis is expanded to include the stress losses and deficits incurred by members at all DCOs under an ESS. Additionally, it is assumed that, under each BMS, the three members creating the largest combined deficit across all the DCOs that modeled the scenario would be defaulted. The cross DCO analysis includes the following two types of expanded stress shock analysis for each of the 11 BMSs, both under the three member-default assumption:

(i) **5X Expanded Stress Shocks:** In this analysis, all the 11 BMSs are expanded by the multiplier of 5 and the stress losses and deficits for each clearing member in every DCO that modeled the scenario are aggregated across the DCOs.

(ii) **DCO-Resource Exhausting Stress Shocks:** In this analysis, each of the 11 BMSs are expanded to that multiplier at which one DCO exhausts all its resources. In this case, the stress multiplier associated with each BMS differs, depending on the extent of shocks underlying each BMS, the directions of shocks, and compositions of member portfolios.

Resource erosion caused by the defaulters in every stress scenario is calculated individually for every defaulter and also for all the three defaulters combined as a percentage of the modeled DCOs' total prefunded DF resources and assessments.

3.8 Impacts on Non-Defaulters

The cross-DCO analysis also includes an evaluation of the potential costs to the non-defaulting members, in terms of DF contributions used, and assessments paid, to cover their respective DCOs' defaulters' deficits. These costs represent loss to the member, but they are different from the stress losses. These costs are calculated separately for every member, for a set of multipliers associated with the 2020Mar18 BMS, which generated the largest total deficit in the Cross-DCO analysis that evaluates DCO-Resource Exhausting Stress Shocks described above. As a proxy for the burden placed on these firms, these costs are compared to the reported Tier 1 capital associated with the member parent company.[22]

[22] The twenty non-defaulting members with the largest associated losses were all affiliates of banking institutions, so Tier 1 capital can be found in regular public reports.

3.9 Evaluation of Interconnectedness

Finally, the cross-default analysis includes an overview of the level of interconnectedness amongst both DCOs and members. In this context, interconnectedness is equated more generally with cases where an individual institution is a member of multiple DCOs (or an institution, as well as affiliates), and more specifically with cases where an individual institution may have losses or deficits across multiple DCOs. This section of the analysis provides both 'single dimension' analysis of the level of interconnectedness, quantifying the extent of common memberships across DCOs, and 'multiple dimension' analysis, which summarizes interconnectedness through network diagrams representing both DCO membership, as well as cases where individual members can lead to deficits at one or more DCOs.

References

CEA "Commodity Exchange Act," Chapter 1, Title 7 (Agriculture), U.S. Code (7 USC § 7a-1). https://www.law.cornell.edu/uscode/text/7/chapter-1

CFTC Regulations "Part 39—Derivative Clearing Organizations" https://www.ecfr.gov/current/title-17/chapter-I/part-39#se17.1.39_1

CFTC 2013. "Derivatives Clearing Organizations an International Standards," Final Rule. 78 FR 72476, CFTC, December 2. https://www.federalregister.gov/documents/2013/12/02/2013-27849/derivatives-clearing-organizations-and-international-standards

CFTC 2016. "Supervisory Stress Test of Clearinghouses," Staff Report, CFTC, November 2016. https://www.cftc.gov/sites/default/files/idc/groups/public/@newsroom/documents/file/cftcstresstest111516.pdf

CFTC 2017. "Evaluation of Clearinghouse Liquidity," Staff Report, CFTC, October 2017. https://www.cftc.gov/sites/default/files/idc/groups/public/@newsroom/documents/file/dcr_ecl1017.pdf

CFTC 2019. "CCP Supervisory Stress Tests: Reverse Stress Test and Liquidation Stress Test," Staff Report, CFTC, April 2019. https://www.cftc.gov/system/files?file=2019/05/02/cftcstresstest042019.pdf

CFTC 2021. "Cleared Derivative Markets: March – April 2020," Interim Staff Report, CFTC, 2021. https://www.cftc.gov/node/237456

CFTC 2024a. "Supervisory Stress Test of Derivative Clearing Organizations: Reverse Stress Test - Analysis and Results, Staff Report, CFTC, March 2024.

CFTC 2024b. "Supervisory Stress Test of Derivative Clearing Organizations: Reverse Stress Test - Assumptions and Methodology," Staff Report, CFTC, March 2024.

Appendix A: Reference Tables

Table 1. Number of DCOs Included, by Asset Class

	Asset Class				Total
	IRS	CDS	FX	F&O	
Number of DCOs	3	2	1	5	11

Note: See Section 2.2 DCOs and Products for an explanation of in-scope DCO legal entity and Clearing Service Line counts.

Table 2. Sample Products Included, by Asset Class

Product's Short Name	Product's Descriptive Name	Product Category	Asset Class			
			IRS	CDS	FX	F&O
USD 5-yr	USD 5-year Fixed for Float interest rate swap	Interest Rate	x			
EUR 30-yr	EUR 30-yr Fixed for Float interest rate swap		x			
GBP 10-yr	GBP 10-yr Fixed for Float interest rate swap		x			
JPY OIS 6-mo	6-month Overnight Indexed Swaps (OIS)		x			
USD OIS	USD Overnight Index Swaps (OIS)		x			
€STR 3-mo	3-Month Euro Short-Term Rate (€STR) Swaps		x			
2-yr T-Note	2-yr U.S. Treasury Note Futures					x
U.S. Treasury Bond	U.S. Treasury Bond Futures					x
S&P 500	S&P 500 Futures	Equity				x
Gold	Gold Futures	Metal				x
HRS Wheat	Hard Red Spring Wheat Futures	Grains				x
Brent Crude Oil	Brent Crude Oil Futures	Crude Oil				x
Dutch TTF Nat Gas	European Natural Gas - Dutch Title Transfer Facility, Netherlands	Natural Gas				x
CDX.NA.IG	Markit North American Investment Grade CDX Index	Credit		x		
ITraxx Senior Financials	Markit iTraxx Europe Senior Financial Index			x		
CDX.NA.HY	Markit North American High Yield CDX Index			x		
USDTWD	United States Dollar to New Taiwan Dollar (USD/TWD)	Foreign Exchange			x	
USDINR	U.S. Dollar to Indian Rupee (USD/INR)				x	

Note: All IRS positions were stressed, and the DCOs used their internal prices for the stress scenarios. All CDS and FX positions, and all futures and options on futures positions were stressed.

Table 3. Default Waterfall Resources Across Included DCOs, by Asset Class

Waterfall Layer Resources*	Asset Class			
	IRS	CDS	FX	F&O
Member DF[1]	2 Billion USD - 6 Billion USD	2.2 Billion USD - 3 Billion USD	1.3 Billion USD	54 Million USD - 6 Billion USD
DCO Capital[2,3]	45 Million USD - 260 Million USD	20 Million USD - 50 Million USD	10 Million USD - 20 Million USD	7.5 Million USD - 200 Million USD
Assessment Power for 1 Default[4]	1x DF	1x DF	1x DF	2x DF - 2.75x DF
Assessment Power for 2 Defaults[4]	2x DF	1x DF - 3x DF	2x DF	4x DF - 5.5x DF
Maximum Assessment Power for Defaults[4]	2x DF - 3x DF	1x DF - 2x DF	2x DF	5.5x DF

Notes: * These resources vary by DCOs and, for some DCOs, some layers' resources remain constant across stress scenarios, but in others, they vary by stress scenarios, depending on the type of products they are held in.

[1] Default Fund

[2] This represents the DCO's "skin-in-the-game". For some DCOs the values represented stressed values--i.e., they vary with the price shocks associated with the stress scenarios.

[3] A few DCOs have additional DCO capital layers, including default insurance.

[4] Indicates the maximum assessment powers available to the DCO in the case of the specified number of clearing members' default. 1x DF indicates one time the size of the non-defaulting members' Default Fund contribution, 2x DF indicates two times the size of the non-defaulting members' Default Fund contribution, and so on.

Source: Data compiled from the DCO provided data on their default waterfall layers and RSB staff calculations.

Table 4. Key Data and Methodology Elements, by Source

Reverse Stress Test Model Data and Methodology Elements	Generated by RSB Staff	Generated by DCOs
Base Market Scenarios (BMSs) identification	x	
Expanded Stress Scenarios (ESSs) development methodology	x	
Reference Date Identification	x	
BMSs and ESSs modeling and calculation of stress losses		x
DCO-specific SST model, methodology and assumptions (development, application, and communication to CFTC)		x
DCO-specific SST Model results of a range of stress scenario impacts (i.e., stressed PnL, collateral, DF, DCO Capital) - Test Run & Final Runs		x
DCO-specific Waterfall calculation in the Test Run		x
Default Scenarios Determination	x	
Interpolation of DCO's SST results (of stress losses and resources)	x	
Default Waterfall Calculation for each BMS and ESS scenarios and DCO in the Final Run	x	
DCO-specific and Cross-DCO reverse stress test analysis	x	
Identification and development of Shock-absorption boundary under alternative default scenarios and extreme price shocks	x	

Table 5. Base Market Scenarios

Base Market Scenario Dates	Base Market Scenario Narrative		Description
2020Mar09	Covid-19	Global Macro	Second largest VM day for all DCOs combined, and largest CDS VM day; Equities lower
2020Mar13	Covid-19	Global Macro	Tenth largest VM day for all DCOs combined, and second largest CDS VM day; Equities higher
2020Mar18	Covid-19	Global Macro	Third largest VM day for all DCOs combined; Equities lower
2022Feb25	Ukraine	EU Focus	Natural Gas and Wheat prices lower
2022Mar01	Ukraine	EU Focus	Largest VM day for all DCOs combined; Energy and Wheat prices higher
2022Mar09	Ukraine	EU Focus	Fifth largest VM day for all DCOs combined, and largest day for F&O VM; Wheat prices lower
2022Apr18	Ukraine	Energy	Energy prices increased
2022May09	Ukraine	Energy	Energy prices decreased
2022Jun13	Inflation	CPI Surprise	Fifth largest IRS VM day; Equities lower
2022Nov10	Inflation	Global Macro	Seventh largest VM day for all DCOs combined; Equities higher
2023Mar13	Banking Crisis	Silicon Valley Bank	Large spike in 2-year US Treasury futures price

Note: All VM values are in net USD equivalents.

Table 6. DCOs' Base Market Scenarios (BMSs) and Expanded Stress Scenarios (ESSs), by Asset Class

BMS Dates	BMS Name	Number of DCOs Modeling the BMS					Total Number of BMSs and ESSs Modeled by DCOs*
		IRS	CDS	FX	F&O	All Asset Classes	
2020Mar09	Covid-19-Global-1	3	2		3	8	48
2020Mar13	Covid-19-Global-2	3	2		3	8	48
2020Mar18	Covid-19-Global-3	3	2	1	3	9	54
2022Feb25	Ukraine-EU-1				3	3	18
2022Mar01	Ukraine-EU-2	3		1	3	7	42
2022Mar09	Ukraine-EU-3				4	4	24
2022Apr18	Ukraine-Energy-1				3	3	18
2022May09	Ukraine-Energy-2				4	4	24
2022Jun13	Inflation-CPI	3		1	1	5	30
2022Nov10	Inflation-Global	3	2	1	3	9	54
2023Mar13	Banking-SVB	3		1	1	5	30
Total							**390**

Note: *Calculated by multiplying the total number of DCOs (in "All Asset Classes" column) and the total number of stress scenarios each DCO models and evaluates for SST (=6, comprising one BMS and five ESSs. Eight DCOs used multipliers 5X, 10X, 15X, 20X, and 25X, while three DCOs used multipliers 3X, 5X, 7X, 8.5X, and 10X).

Table 7. Illustration of Member Deficit and DCO Waterfall Calculation

Clearing Members for Parent 1

	Member 1A			Member 1B			Member 1C	
	House 1A	Client 1A_1[1]	Client 1A_2	House 1B	Client 1B_1	Client 1B_2	House 1C	Client 1C_1
Required Core Margin	*140*	*80*	*470*	*260*	*65*	*60*	*750*	*100*
Margin Add-ons	*10*	*0*	*10*	*40*	*0*	*0*	*15*	*0*
Excess Margin	*0*	*10*	*10*	*0*	*10*	*0*	*15*	*0*
Total Collateral	150	90	490	300	75	60	780	100
Stressed PnL	100	-200	-790	-350	-135	200	-760	-110
Account Shortfall	250[2]	-110	-300	-50	-60	0[3]	20	-10
Member Shortfall	**-160**			**-110**			**0**[4]	

1. This example is for a DCO clearing swaps, under LSOC (legally segregated, operationally commingled). However, for DCOs clearing futures, segregation rules were applied which allow PnL for all clients in the same seg account to be netted, and margins for all those clients to be combined.
2. House gain and/or excess collateral are used to offset client shortfall.
3. Client gain is not used to offset house or other client shortfall.
4. Excess collateral from one member is not used to offset shortfall from other members, even under the same parent.

Top 3 Defaulting Parents

	Parent 1			Parent 2			Parent 3
	Member 1A	Member 1B	Member 1C	Member 2A	Member 2B	Member 2C	Member 3A
Default Fund Contribution	60	50	50*	50	50*	50*	100
Member Shortfall	-160	-110	0	-200	-20	0	-220
Member Deficit	-100	-60	0	-150	0	0	-120
Parent Deficit	**-160**			**-150**			**-120**

* Default fund contributions from members with no deficit remain available to DCO to cover defaulters' deficit.

DCO Resources

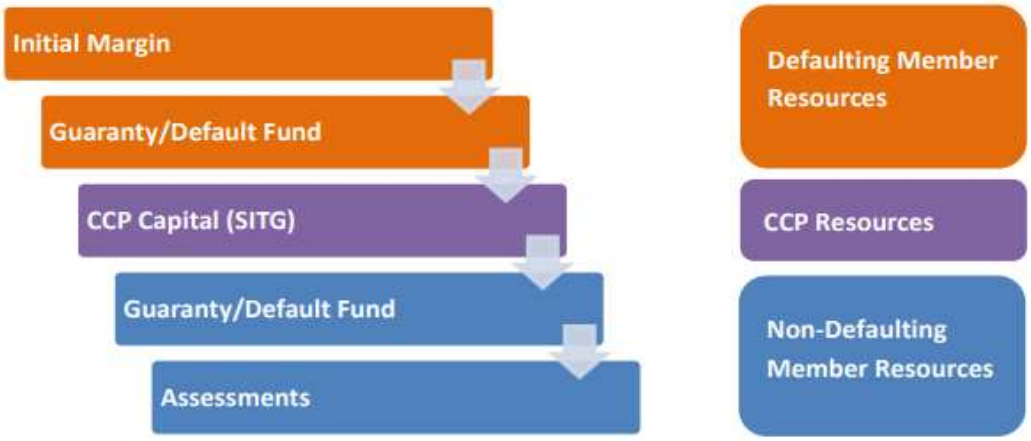
DCO Capital	25	Power of Assessment for one default	500
Total Default Fund	500	Power of Assessment for two or more defaults	1000

Resources use through waterfall

Cover	Total Deficit	DCO Capital	Available Default Fund	Assessment Needed	Assessment Callable
One Default	-160	25	400	0	500 - [commitment from Members 1A-1C]
Two Defaults	-310	25	350	0	1000 - [commitment from Members 1A-1C & 2A-2C]
Three Defaults	-430	25	250	155	1000 - [commitment from Members 1A-1C, 2A-2C, & 3A]

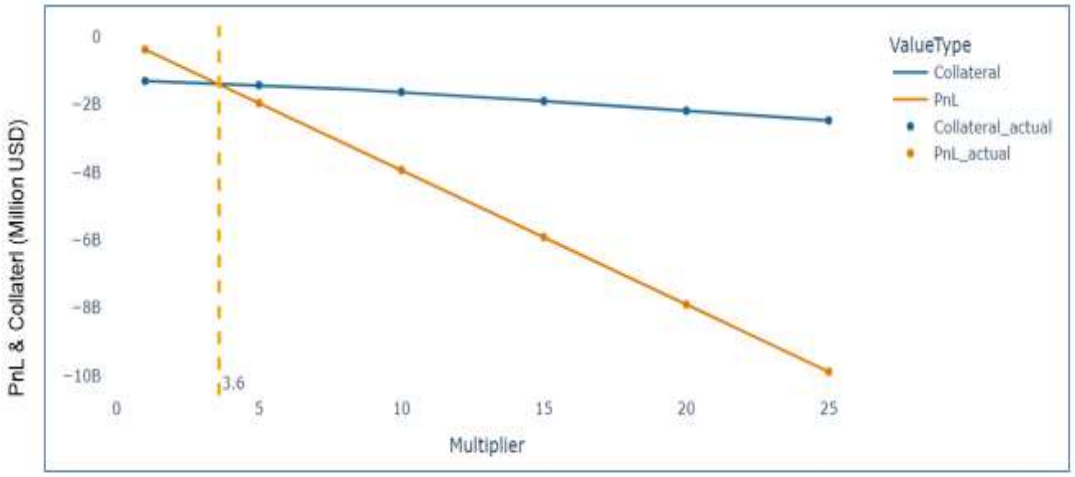
Appendix B: Reference Figures

Figure 1. CCP's Generalized Default Waterfall Resources



Source: CFTC 2021

Figure 2. Example of a Polynomial Fitted Multiplier Line for a Clearing Member



Appendix C: DCO Submitted SST Data Elements

Field Name	Description
Clearing Fund Segregation Type	Account segregation type, including all segregation types the DCO uses. Examples include Customer Segregated funds (CSEG), Customer Non-Segregated funds (CNSEG), Non-Segregated funds (NSEG; for house or proprietary), and Customer Cleared Swap funds (COTC).
Clearing Member LEI	Legal entity identifier (LEI) or, if no LEI, ID for clearing member.
Clearing Member Name	Name of clearing member.
Clearing Member Parent LEI or ID	LEI or ID for clearing member's ultimate corporate parent entity.
Clearing Member Parent Name	Name of clearing member's ultimate corporate parent entity.
Collateral Type	Optional if able, collateral values by asset type, such as cash, government bond, and so on.
Collateral Value	Value of collateral after stress shocks are applied to pre-haircut collateral values. Analogous to shocking derivatives positions, base shocks should come from the scenario date, with multipliers applied.
Collateral Value, post-haircut	Value of collateral, post-haircut. All collateral, as posted, including excess and add-ons.
Collateral Value, pre-haircut	Value of collateral, pre-haircut. All collateral, as posted, including excess and add-ons.
Currency	DCO currency of choice, i.e., the currency used for internal risk reporting/aggregation. DCOs reported all results in this one currency throughout the templates, including collateral.
Customer Margin ID	Account for which PnL or margin is calculated, including individual clients under legally segregated, operationally commingled (LSOC) collateral models.
Customer Margin ID (Swaps Stressed Collateral)	Assuming collateral cannot be stressed for individual accounts, stress gains and losses from the member account will need to be applied proportionally to individual accounts.
Default Fund Amount, post-haircut	Total default fund amount, post-haircut.
Default Fund Amount, pre-haircut	Total default fund amount, pre-haircut.
Default Fund Contribution, post-haircut	Total default fund amount, post-haircut.

Field Name	Description
Default Fund Contribution, pre-haircut	Total default fund amount, pre-haircut.
Description of other Prefunded DF Level Resources	Description of additional prefunded default fund or clearing service level resources if applicable.
First Layer of Skin in the Game, post-haircut	First of DCO's prefunded own resources to be used in waterfall, post-haircut.
First Layer of Skin in the Game, pre-haircut	First of DCO's prefunded own resources to be used in waterfall, pre-haircut.
Market Segment	Default fund name or asset class, e.g., IRS/CDS/FX/F&O, if applicable.
Other Prefunded Resources Amount, post-haircut	Additional prefunded default fund level resources that can be used after non-defaulting members contributions, post-haircut.
Other Prefunded Resources Amount, pre-haircut	Additional prefunded default fund level resources that can be used after non-defaulting members contributions, pre-haircut.
Profit and Loss (PnL)	Stress profit or loss in DCO currency of choice. The spot FX conversion rate on the position date should be shocked according to the stress scenario.
Position Date	Stress shocks should be applied to EOD positions on this future date, to be provided by RSB. As of June 2023, the selected date is September 1, 2023.
Powers of Assessment after the default of 1 member	Powers of assessment after the default of one member, reported for each clearing member separately.
Powers of Assessment after the default of 2 members	Additional powers of assessment due to the default of a second member.
Powers of Assessment after the default of additional members, as outlined in rules	For example, if DCO’s rulebook specifies powers of assessment for the 1st, 2nd, 3rd and 4th defaults, please report for each separately.
Reported Margin Value	Reported margin value for each client with a swaps account.
Scenario ID	Base market scenario date.
Scenario Multiplier	Multiplier on base market scenario to create expanded stress scenario.
Second Layer of Skin in the Game, post-haircut	If applicable, second layer of DCO's prefunded own resources to be used in waterfall, post-haircut.

Field Name	Description
Second Layer of Skin in the Game, pre-haircut	If applicable, second layer of DCO's prefunded own resources to be used in waterfall, pre-haircut.
Stressed Amount - First Layer of Skin in the Game	Stressed value of first of DCO's prefunded own resources to be used in waterfall.
Stressed Amount - Second Layer of Skin in the Game	If applicable, stressed value of second layer of DCO's prefunded own resources to be used in waterfall.
Stressed amount of Other Prefunded Resources	If applicable, stressed value of additional prefunded clearing service level resources.
Stressed Default Fund Amount	Value of default fund collateral after stress shocks are applied to pre-haircut collateral values. Analogous to shocking derivatives positions, base shocks should come from the scenario date, with multipliers applied.
Stressed Default Fund Contribution	Stressed default fund contribution.
Unique Margin ID	Akin to a settlement account, not individual client account. While collateral account may differ from account for variation margin, the two must be linked so that shortfalls can be calculated.

Appendix D: Background

D.1 Overview

CCPs or clearinghouses, including DCOs regulated by the CFTC, help protect the integrity of the financial system by systematically quantifying the magnitude of the impacts of large potential shock scenarios on their own clearing members, identifying vulnerabilities in their own respective DCO models and risk management practices, and by mitigating, through the collection of financial resources, the potential negative, systemic, effects, if one or more members or their clients fail to meet their contractual obligations (CFTC, 2013).

Stress testing is routinely conducted by CCPs to effectively manage risk, even in highly stressed conditions. Generally, stress testing is used to ensure a CCP's ability to withstand all resource demands resulting from extreme but plausible market movements, coupled with the unexpected default of one or more clearing members.

To aid this goal, regulatory agencies such as the CFTC conduct supervisory stress tests (SST) to, in part, identify risks that span multiple CCPs and to evaluate the CCPs' financial sufficiency and resiliency to sustain extreme market shocks and associated clearing member defaults across CCPs. Analysis performed by regulatory agencies that incorporates information from multiple CCPs, like the 2024-SST, is additive to detailed analysis that individual CCPs do on their own positions and risks.

In addition to this "traditional" stress testing, in which extreme but plausible market shocks result in losses that the CCP is able to effectively manage, another common analysis done by CCPs and regulators is reverse stress testing. In reverse stress tests, analysts seek to identify the combinations of market movement and default that would exhaust a CCP's financial resources (either prefunded or unfunded); given regulatory requirements, these market movements would represent extreme and implausible market conditions. Although they represent implausible market conditions (which can be seen in the associated report), reverse stress testing can provide information to CCPs and regulators regarding the sensitivity of losses to specific market shifts or to specific types of clearing member defaults.

Reverse stress tests compare theoretical losses with actual resources**.**

Figure *1* (in Appendix B: Reference Figures) illustrates the general waterfall of resources available to a DCO in the case of a clearing member's default (or multiple defaults). These prefunded resources include initial margin, a guaranty fund with contributions from all clearing members, and the DCO's capital ("skin-in-the-game"). The unfunded resources include charges that the DCO can, per its rulebook, impose on non-defaulted members ("assessment powers" or "assessments"). The specific size of the resources and the individual components of the waterfall layers may vary across DCOs. However, in the case of a member default which results in losses that exceed that member's collateral, each DCO will use resources available to them to offset the shortfall in the order of the waterfall (

Figure 1).

D.2 Prior Exercises

In the first SST (CFTC 2016), staff internally developed SST scenarios and assessed the ability five DCOs to meet the required levels of resiliency under Cover 2 assumptions, under 11 different, extreme but plausible, hypothetical scenarios representing stressed market conditions. The main focus of this first exercise was on DCO counterparty credit risk and on clearing firms that held memberships at two or more DCOs. For this analysis, the staff used data that DCOs regularly submit to the Commission, including detailed information on positions and margin held by that DCO. This study, in evaluating DCO risk management, included only prefunded resources (but not assessment powers).

In the second SST (CFTC 2017), the staff evaluated the impact of a hypothetical, extreme stress scenario on DCOs' funding liquidity, under the assumption of a simultaneous default of two large clearing members and their five largest IRS customers, at each of three DCOs. This study's extreme stress scenario created liquidity demand equivalent to three times that which would have resulted if the two largest members had defaulted following Brexit. The extreme stress scenario and the two asset classes (i.e., futures and options on futures, and IRS), were large in all three DCOs, and were proportionate to the relative sizes of the DCOs.

The third SST (CFTC 2019) included two separate analyses: a reverse stress test, and a stressed liquidation costs analysis. The reverse stress test focused on identifying the largest, extreme and implausible, hypothetical market price shocks, along with a range of clearing member defaults, that the DCOs' mutualized prefunded resources could sustain. Twelve stress scenarios, comprising four largest historical market moves and eight hypothetical, amplified market moves, were developed and applied to two DCOs' positions, comprising either F&O or IRS asset class products. This study excluded other resources that DCOs had access to in the case of member default, including assessment powers and defaulting clearing members' non-initial margin collateral, such as margin add-ons and liquidity add-ons.

The third SST's stressed liquidation cost analysis focused on assessing the sufficiency of the DCOs' prefunded resources to meet their respective defaulting clearing member's payment obligations, arising from the largest, extreme but plausible market shocks to their clearing members' IRS positions, combined with one of three stressed scenarios of higher than expected, defaulted members' portfolio liquidation (i.e., hedging and auctioning) costs. For 10 clearing members across two DCOs, this study calculated the share of DCOs' mutualized prefunded resources that would be required to offset each clearing member's largest market shock-triggered losses to, and the associate stressed liquidation costs of, their IRS positions.

In this fourth SST (2024-SST), the staff used Reverse Stress Test analysis to identify the combinations of extreme and implausible market price shocks (or stress scenarios) and clearing member default combinations (or default scenarios, such as Cover 1, Cover 2, and Cover N) that would exhaust the resources available to the DCOs.