SUPERVISORY STRESS TEST OF

DERIVATIVES CLEARING ORGANIZATIONS: REVERSE STRESS TEST

Analysis and Results

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

June 2024

COMMODITY FUTURES TRADING COMMISSION

Division of Clearing and Risk

1155 21st St NW

Washington, DC 20581

SUPERVISORY STRESS TEST OF DERIVATIVES CLEARING ORGANIZATIONS: REVERSE STRESS TEST Analysis and Results

June 2024

Table of Contents

Table of Figures

Executive Summary

Staff of the Risk Surveillance Branch of the Division of Clearing and Risk of the United States Commodity Futures Trading Commission (CFTC) completed its fourth[1] Supervisory Stress Test (SST) of derivatives clearing organizations (DCOs) registered with the CFTC — *i.e.,* central counterparties subject to CFTC jurisdiction.

The analysis covers nine individual DCOs, comprising 11 clearing services. Eleven volatile historic dates were used as base market scenarios. Additional sets of corresponding expanded scenarios were created by applying incremental multipliers to each of the base scenario's "market shocks" (*i.e.,* shocks to prices, and implied volatilities, where applicable) for all products cleared by the included DCOs, such as equities, credit, interest rates, energy, and other commodities.

This latest exercise is a reverse stress test.[2] It focused, first, on identifying hypothetical combinations of (a) extreme and increasingly implausible market shocks along with (b) increasing numbers of parent-level clearing member (or "member") defaults, that would be necessary to exhaust: 1) prefunded DCO default resources and 2) total DCO default resources.[3] Given the number of DCOs involved, the number of base market scenarios included, the number of stress multipliers applied, and the number of members, more than 236,000 hypothetical default conditions were assessed.

The exercise also analyzes cross-DCO effects, assessing hypothetical cumulative losses summed across DCOs, potential cumulative resource demands at individual, non-defaulted members due to a DCO's use of their default fund (DF) and assessment powers, and interconnectedness related to entities that are members of multiple DCOs.

The analysis, which is performed at the parent level, is split into two main sections: Single-DCO Analysis and Cross-DCO Analysis.

---

[1] The 2016 exercise was a credit stress test using 11 extreme but plausible market stress scenarios at eight clearing services, including futures and options (F&O), cleared interest rate swaps (IRS), and cleared credit default swaps (CDS). It included only prefunded resources (see footnote 3). The 2017 exercise was an evaluation of DCO liquidity at four clearing services including F&O and IRS. The CFTC provided the participating DCOs with stress results and asked how they would convert non-cash collateral into cash in the event of a default. The 2019 exercise included a reverse stress test component and addressed liquidation costs. Links to the three prior stress tests are available in the companion report, *Supervisory Stress Test of Derivatives Clearing Organizations: Reverse Stress Test Assumptions and Methodology*.

[2] It is called a reverse stress test because it begins with a predetermined end point, for example, the point at which prefunded resources are consumed, and works backward to find stresses that could reach that point.

[3] Prefunded resources include margin collateral (initial margin, any add-ons, and any excess) posted by the defaulter(s), the DCO's own funds (*i.e.*, DCO's capital or "skin-in-the-game"), and mutualized default (or guaranty) funds. Unfunded resources are primarily powers of assessment that the DCO can call on its non-defaulted members if losses exceed prefunded resource levels. "Total resources" represent any resources contractually available to a DCO under a given default event, whether prefunded or unfunded.

Single-DCO Findings:

Staff identified the base market scenario most stressful for each DCO, increased those market shocks, and defaulted members with the largest deficits.[4]

The results indicate that, at the five DCOs clearing futures and options (F&O), it would require amplified base market shocks at least -

- as large as the base shocks (1.0X) to begin to consume ***any*** non-defaulter resources regardless of the number of defaults (range across five DCOs was 1.0X to 2.7X, with a mean of 1.6X). At the DCO where market shocks of 1.0X created a deficit at one potential defaulting member, only 0.4% of non-defaulters' DF contributions would have been used.

- as large as 1.9X base shocks with two defaults to completely exhaust the DF, or prefunded resources (range 1.9X to 4.1X, average 2.6X). Of the ten defaulters[5] (two at each of five DCOs), nine were affiliates of Global Systemically Important Banks (G-SIBs), which have conservative capital and supervisory requirements.

- as large as 3.6X with three defaults to completely exhaust assessments, or total resources (range 3.6X to 9.2X, average 5.3X). With three defaulters at five DCOs, there could have been 15 unique defaulters, but there were only 12 because three members had one of the three largest deficits at two DCOs. Ten of those 12 members were affiliates of G-SIBs.

At the six DCOs clearing either CDS, FX products, or IRS, it would require amplified base market shocks at least -

- as large as 2.1X to begin to consume ***any*** non-defaulter resources regardless of the number of defaults (range 2.1X to 3.2X, average 2.6X).

- as large as 3.7X with two defaults to completely exhaust the DF, or prefunded resources (range 3.7X to 16.7X, average 7.9X). Of the seven unique defaulters (out of a possible 12), all were affiliates of G-SIBs.

- as large as 4.1X with three defaults to completely exhaust assessments, or total resources (range 4.1X to 18.0X, average 10.5X). Of the eight unique defaulters (out of a possible 18), all were affiliates of G-SIBs.

---

[4] Deficit is defined as stress loss that exceeds the value of collateral posted by a given member, including the member's initial margin and DF contribution. Margin collateral for defaulters' client positions is included to the extent permitted by the relevant regulations. Members are defaulted in descending order, with the member generating the largest deficit defaulted first. All deficits were converted to USD to determine relative size.

[5] Members with losses exceeding collateral (*i.e.*, deficits) rarely default. However, for simplicity in this paper, a term such as "top (n) defaulter" will refer to a member with one of the (n) largest deficits at a DCO in a stress scenario.

Applying the Concept of a Reverse Stress Test to Cross-DCO Analysis:

For each of the 11 base market scenarios, it would take market shocks of at least 3.9X, concurrent with the synchronized defaults of the three members leading to the largest aggregate deficit, before all resources are exhausted at any single DCO (range 3.9X to 15X, average 6.9X).

Out of a possible 33 defaulters (11 scenarios multiplied by three defaulters), the set of defaulters across the 11 scenarios includes only 13 distinct members; 11 of those 13 are affiliates of G-SIBs. This reflects a moderate level of concentration, with a relatively small number of members disproportionally driving the results. However, it is important to note that these members are affiliates of banks that are well capitalized and subject to high supervisory standards for internal risk management,[6] risk governance, and internal controls.

The scenario resulting in the largest total deficit across DCOs was 8.4X the 2020Mar18[7] base market scenario. For perspective, this base market scenario date had the third largest flow of variation margin (VM) across DCOs in history, and the expanded scenario represented market shocks that were 8.4X this extreme date. This scenario is highly implausible.

Impacts on Non-defaulting Members:

For the 8.4X expanded scenario just mentioned, the scenario that leads to the largest total deficit across DCOs, staff calculated what each non-defaulting member would lose in DF contributions and assessments across DCOs. For the top 20 non-defaulting members, a set that paid 80% of the total mutualized resources used, staff compared these costs to Tier 1 capital[8] at each parent bank. The maximum Tier 1 capital used in this highly implausible scenario was 6.2% (range 0.8% to 6.2%, average 2.5%).

In an attempt to approximate stress losses from a very extreme but less implausible level of market shocks, staff chose to analyzing results related to a 3X expanded scenario for this exercise, although the market shocks to some material products would still be highly implausible.[9] Under this 3X scenario, in order to fund the three largest deficits of defaulters, the maximum Tier 1 capital used at the top 20 non-defaulting members was 0.29% (range 0.03% to 0.29%, average 0.07%). This suggests that under less implausible scenarios, the burden on the large banks that pay the bulk of the costs would not be problematic.

---

[6] It is important to note that while the estimated stress test loss does represent a hypothetical liquidity demand, for these members it would generally not represent a true loss, as the positions are primarily hedging offsetting exposures.

[7] The date of each scenario is referred to in the format YYYYMMMDD. Thus, 2020Mar18 corresponds to the scenario on March 18, 2020.

[8] Tier 1 capital represents the core loss absorbing capital of a bank, available to provide protection against unexpected losses. Tier 1 capital is primarily composed of shareholder equity and retained earnings.

[9] It is important to note that staff is not suggesting any or all 3X scenarios are a requirement for "extreme but plausible."

Interconnectedness:

While half of the members of DCOs included in this study only clear at one DCO, there are also many members that clear at multiple DCOs. In fact, 12 members, or 10% of the total, clear at eight or more DCOs.

This interconnectedness leads to the potential for simultaneous defaults across DCOs. However, there is also a great deal of diversity in terms of the composition of each clearing member's house and client portfolios at the different DCOs at which it is a member. In practice, that diversification mitigates this theoretical risk related to interconnectedness in clearing, especially under less implausible market scenarios. For example, with the 2020Mar18 base market scenario referenced above, at 8.4X, non-defaulters' resources are used at seven DCOs, but at 3X that drops to four DCOs; at a lower multiplier of 2X it drops to two DCOs, and at 1X no non-defaulting member's resources are used at any DCO, even with three defaulters.

* * * * *

The broad themes of the results of this Supervisory Stress Test exercise are as follows:

- **All individual DCOs are well capitalized to withstand multiple defaults, concurrent with extraordinarily large market shocks.**

- **Though many global financial institutions are members of many DCOs, even in a scenario equivalent to more than eight times historically large price shocks, deficits resulting from three defaults at nine DCOs consume a manageable portion of non-defaulters' Tier 1 capital.**

- **With "less implausible" shocks of three times historically large price shocks across nine DCOs, fewer DCOs need to use mutualized resources, and resource demands on non-defaulting members were a very small proportion of Tier 1 capital.**

1. Introduction

This report provides a summary of the analytical findings from a Reverse SST of nine DCOs, comprising 11 service lines.[10] A primary purpose of this SST was to identify combinations of clearing member (hereafter referred to as "members" in this report) defaults and market shocks[11] that would exhaust either the prefunded or total resources available to each DCO individually.[12] These market shocks were often far beyond the bounds of plausibility. This report provides market participants and the public a reasonably complete picture of the types and extent of market shocks and default conditions that DCOs can cover with their available resources, as well as the DCOs' risk sensitivity to these factors. This analysis is performed at the parent level.[13]

Another key goal for this SST was to assess:

- risks across DCOs, including cumulative risks to DCOs;

- risks to non-defaulted members as measured by the potential costs of lost DF contributions and demands from assessments; and

- the interconnections driven by an individual member's risk profile at multiple DCOs.

Stress losses under a given combination of market shifts and member defaults are compared to all resources available to the DCO. Where applicable, DCO resources are stressed using the same market scenarios as applied to member positions. Available mutualized resources at DCOs included in this SST as of the position date used in this exercise (September 1, 2023), are shown in **Figure 1**.[14]

---

[10] For the remainder of this paper, clearing services will be referred to as DCOs for simplicity.

[11] Throughout the exercise, coherent scenarios were used. That is, the deficit of one member under one market scenario was never combined with the deficit of another member under a different market scenario.

[12] See **Figure 2** in the companion report [*Supervisory Stress Test of Derivatives Clearing Organizations: Reverse Stress Test Assumptions and Methodology*] for an example demonstrating calculations for going through the waterfall.

[13] Throughout this document, the term "member" refers to a clearing firm, but at the ultimate parent level. Thus, affiliated clearing firms are considered the same member. For this exercise we assume that if a member is declared in default, affiliated entities will cease sending funds to the DCO. Given this assumption, all entities that are subsidiaries of the same ultimate parent institution are assumed to default. However, funds from one entity are not used to offset deficits at another entity owned by the same ultimate parent entity. Both the member's proprietary (house) accounts and client accounts are included.

[14] Assessment powers related to two or more defaults assume they occur within each DCO's cooling off period. A cooling off period refers to the time during which assessments are limited (*e.g.*, 3X the member's DF contribution during the 30 days starting with the first assessment).

Figure 1: Mutualized Resources Available to Cover Stress Losses[15]
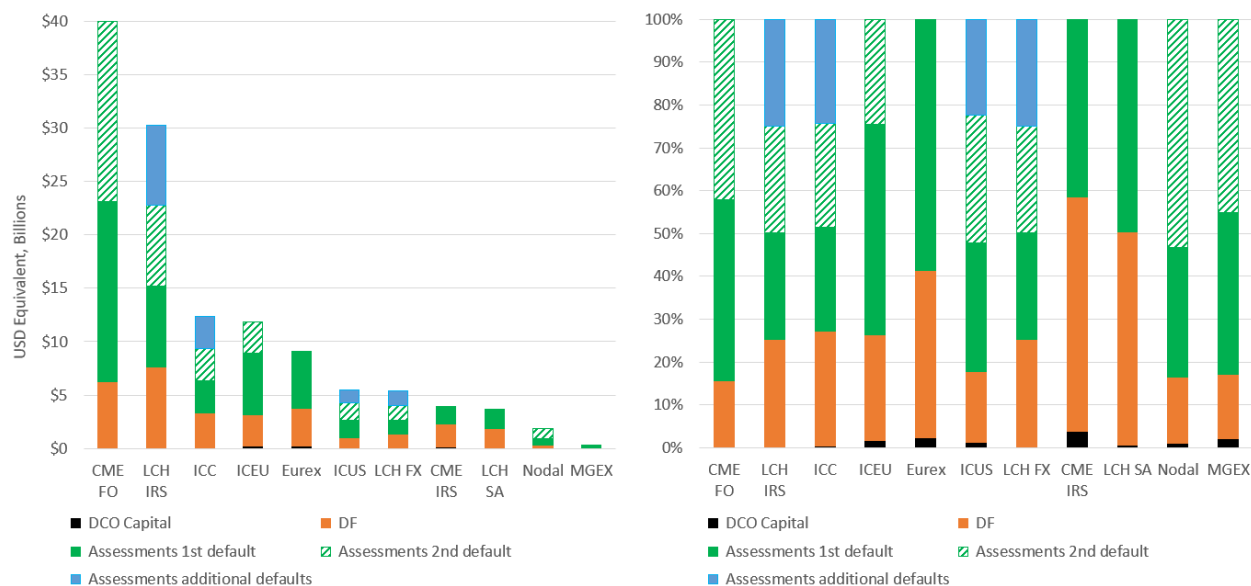
Note: DCO capital is included for each DCO, even if not visible in Figure 1.
Actual assessments would be less than shown in Figure 1 because the defaulted member or members would not pay.

These values are shown in absolute terms (left) and as a percentage of total resources at each DCO (right). Comparisons in this report between losses and resources at individual DCOs are benchmarked against these values.[16]

In order to generate extreme market scenarios for the Reverse SST, staff chose to start with historical scenarios. Staff selected a set of 11 highly volatile historical days as base market scenarios to be applied, as appropriate, across the DCOs. Since there have been multiple unusually volatile periods in recent years, staff was able to limit the selection of base market scenarios to the period of 2020 through 2023. Staff prioritized scenarios that would be stressful to members at as many DCOs as possible.

In fact, four of the dates selected (2020Mar09, 2020Mar18, 2022Mar01, and 2022Mar09) had the highest aggregate VM flows across the included DCOs since at least 2020, and likely ever in the history of the US cleared derivatives market.[17] The average of VM flows on those four dates was more than five standard deviations above the mean flow in the 2020-2023 period.

---

[15] Unless otherwise indicated, the sources of data in figures are stress test data submissions provided by DCOs, and CFTC staff calculations.

[16] The DF values in **Figure 1** include the haircuts assigned by the DCO. However, because collateral is valued relative to the market prices in a given scenario, DF values used in the analysis vary from scenario to scenario.

[17] This is not to say these were the four most volatile dates in history. There was less clearing of derivatives in 2008 and 1987, for example.

Staff also included a diverse set of market scenarios to ensure that the prices of the largest benchmark products (*e.g.,* equities, fixed income, energy) were stressed higher and lower. It was also necessary to include some dates targeting specific DCOs that clear products which may not be correlated with macro events. These dates had historically high VM flows at individual DCOs, but not necessarily across DCOs.

DCOs were only asked to generate stress test results for base market scenarios that staff considered relevant to specific DCOs. **Figure 2** shows each scenario that was calculated, ordered by date, and the DCOs that calculated them ("Y"), with individual DCOs calculating between two and ten scenarios each. Each specific scenario was used by three to nine DCOs.

Figure 2: Base Market Scenarios Included for Each DCO

	Futures & Options					IRS			CDS		FX	
	CME	ICEU	ICUS	MGEX	Nodal	CME	Eurex	LCH Ltd.	ICC	LCH SA	LCH Ltd.	count
2020Mar09 EQ↓, IR↓, EN↓	Y	Y	Y			Y	Y	Y	Y	Y		8
2020Mar13 EQ↑, IR↑	Y	Y	Y			Y	Y	Y	Y	Y		8
2020Mar18 EQ↓, IR↑, EN↓	Y	Y	Y			Y	Y	Y	Y	Y	Y	9
2022Feb25 EN/P/W↓	Y	Y		Y								3
2022Mar01 EN/P/W↑	Y	Y		Y		Y	Y	Y			Y	7
2022Mar09 EN/P/W↓	Y	Y	Y	Y								4
2022Apr18 EN/P/W↑		Y		Y	Y							3
2022May09 EN/P/W↓	Y	Y	Y		Y							4
2022Jun13 EQ↓, IR↑	Y					Y	Y	Y			Y	5
2022Nov10 EQ↑, IR↓	Y	Y	Y			Y	Y	Y	Y	Y	Y	9
2023Mar13 IR↓	Y					Y	Y	Y			Y	5
Count	10	9	6	4	2	7	7	7	4	4	5	65

Note: Below each base market scenario date is an abbreviated depiction of market direction.
EQ = equities, IR = interest rates, EN = energy (crude oil & byproducts, natural gas), EN/P/W = energy/power/wheat, moving in the same direction.

For each scenario, DCOs calculated stress test results for the assigned historic base market scenario (1X), as well as scenarios in which the base market shocks were magnified by linear multipliers[18] (in most cases 5X, 10X, 15X, 20X and 25X).[19] Staff then used interpolation to estimate scenario results for market shocks across a more granular set of increments (1.1X, 1.2X, etc.).

Staff compared the resulting profit and loss estimates to collateral values, which were also stressed. In most cases, all collateral from a member held by the DCO was considered available to offset stress losses if that member defaults.

The margin figures used for members include core margin as well as margin add-ons. Margin add-ons, such as concentration margin, are designed to cover the potential costs associated with closing out large positions that could move market prices because of their size.

The market shocks included in these magnified stress scenarios are implicitly assumed to encompass not only market movements, but also costs associated with liquidation and related activities. One exception relates to CDS portfolios, where both DCOs that clear CDS explicitly accounted for the impact of "jump-to-default" (JTD) risk, either by encompassing JTD risk in the stress test, or by removing collateral collected to cover JTD risk.

Additional details on the underlying assumptions and methodology of the Reverse SST are contained in the companion report *Supervisory Stress Test of Derivatives Clearing Organizations: Reverse Stress Test Assumptions and Methodology*.

---

[18] DCOs were similarly asked to magnify changes to implied option volatilities and collateral values.

[19] Staff performed data validation checks of the results provided by each DCO using internal data and surveillance tools.

2. Results

This results section includes two sub-sections. The first sub-section provides an overview of scenario results for anonymized, individual DCOs, highlighting combinations of market moves and member defaults that could exhaust prefunded and total resources at the given DCO. This type of supervisory analysis is similar to analysis performed by each DCO on a regular basis, as required by CFTC regulations as well as international standards for central counterparties,[20] but extends market scenarios beyond, at times far beyond, the extreme but plausible threshold.

The second sub-section provides an overview of scenario results for the DCOs as a group, analyzing the impacts of scenarios and member defaults synchronized across DCOs. This cross-DCO analysis seeks to identify conditions that could result in widespread deficits across the clearing system due to interconnectedness, which is not something that individual DCOs can do.

2.1 Single-DCO Analysis

This section includes a set of key themes related to the different combinations of scenario multipliers and member defaults that exhaust resources at individual DCOs, considering both prefunded and total resources at these DCOs.

2.1.a Futures and Options

At four of the five DCOs clearing F&O, it would require market shocks exceeding those in any of the base market scenarios in order to consume any non-defaulter resources, regardless of the number of defaulters. At the fifth DCO, the most stressful base market scenario included would have resulted in the use of only 0.4% of non-defaulter DF contributions with any number of defaults.

The remainder of this section focuses on the levels of expansion beyond the base market scenarios, and numbers of defaults, required to exhaust DCO resources.

---

[20] 17 C.F.R. §§ 39.11(a)(1), 39.33(a)(1), CPMI-IOSCO Principles for Financial Market Infrastructures, Principle 4, Key Consideration 4.

Figure 3 shows combinations of multipliers[21] and member defaults that exhaust prefunded resources and total resources at each DCO clearing F&O; all included DCOs are anonymized.[22]

Figure 3: Frontiers of Coverage – Futures and Options

	1	2	3	4	5	6	7	8
DCO 1	2.1	1.9						
DCO 2	4.3	3.2	3.1					
DCO 3	2.6	2.1	1.9	1.9	1.8	1.8	1.8	1.7
DCO 4	2.2	1.9	1.8	1.7				
DCO 5	4.3	4.1	3.9					

	1	2	3	4	5	6	7	8	9	10
DCO 1	4.4	4.6	4.2	3.8	3.7					
DCO 2	3.9	4.8	4.5	4.5	4.4	4.3	4.2			
DCO 3	8.6	6.3	5.0	4.7	4.6	4.4	4.4	4.3	4.2	
DCO 4	7.5	9.8	9.2							
DCO 5	4.3	4.0	3.6	3.0	2.6	2.4	2.3	2.2	2.2	2.1
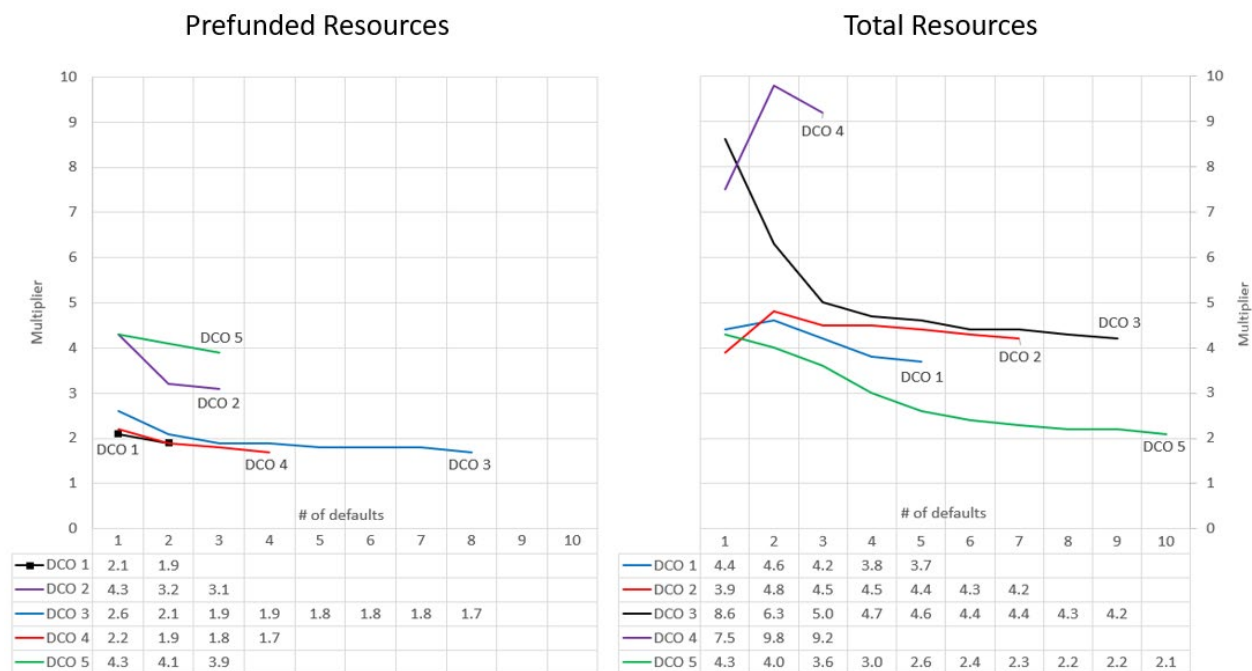
Using DCO 1 on the left as an example: the default of the member with the largest deficit, concurrent with market shocks equal to 2.1X those on the most stressful base market scenario date for DCO 1, would exhaust all of its prefunded resources. With two defaults, it would only require market shocks of 1.9X to exhaust these resources. With market shocks smaller than 1.9X the base market scenario date, prefunded resources at DCO 1 cannot be completely exhausted regardless of the number of defaults, so the line is not extended any further.

This fact highlights one result that is generally true – DCOs are not very sensitive to the number of defaulted members after a certain point. This may be because, for a given stress level, after the first few (largest) defaults, deficits for the remaining members are relatively small. It can also be that, as the market stress level is decreased, members transition from having a deficit to having no deficit.

---

[21] The multipliers shown represent the minimum multiplier needed to exhaust resources for the given set of member defaults, under the most stressful base market scenario for the specific DCO. The most stressful base market scenario date is defined as the one which exhausts prefunded resources at the lowest multiplier, assuming the default of the two members with the largest deficits.

[22] In all cases in this report, the DCOs are fully anonymized within and across charts. For example, DCO 1 on the left side of **Figure 3** is not necessarily the same as DCO 1 on the right side.

Expanding from this example, there are a few additional observations related to the frontiers of coverage across DCOs for the two resource pools:
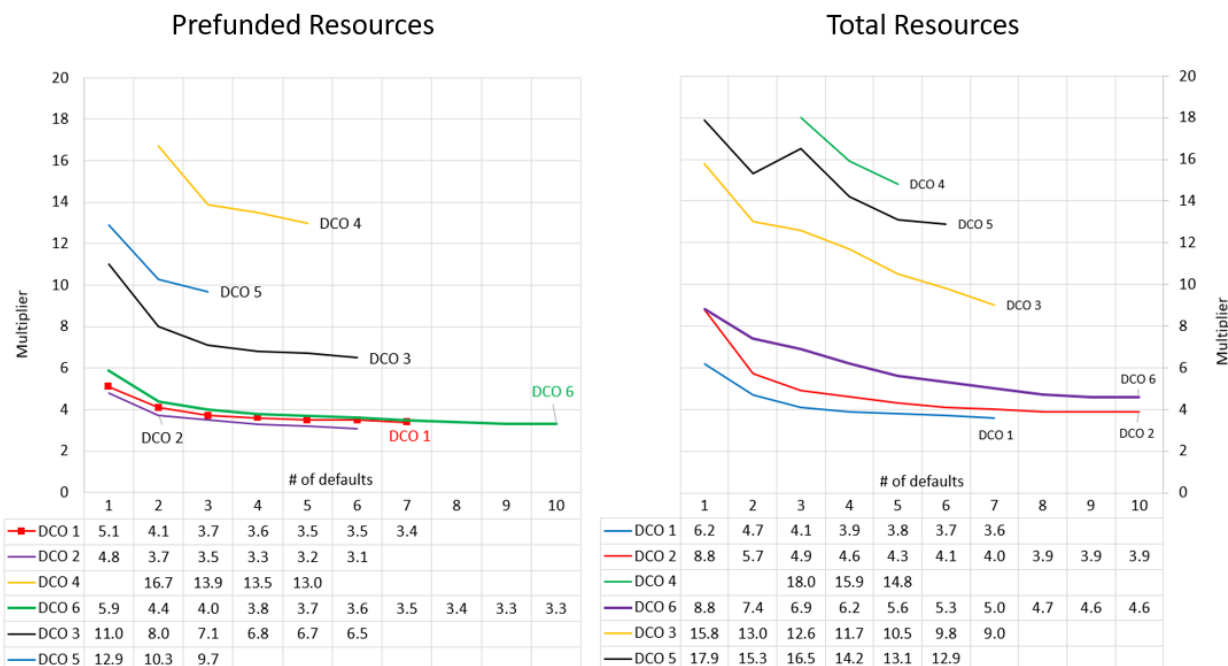
- **Prefunded resources**:

  - CFTC regulations require DCOs to hold, at a minimum, prefunded resources adequate to cover losses from either one or two defaults under extreme but plausible market events. In all cases above, DCO prefunded resources cover at least 2.1X historically extreme market movements concurrent with one default, and 1.9X concurrent with two defaults. For DCO 2 and DCO 5, the default of the largest member would require a multiple of at least 4X an extreme date to exhaust prefunded resources.

  - Even after increasing the number of defaults, scenario multipliers needed to exhaust resources were not significantly different. In no case, even out to eight defaults, would DCOs exhaust prefunded resources with multipliers lower than 1.7X. For DCO 2 and DCO 5, prefunded resources could not be exhausted with multipliers less than 3X.

- **Total resources**:

  - In general, sensitivity to the number of defaults was higher when comparing losses against total resources than against prefunded resources. The level of sensitivity is, in part, driven by two conflicting factors. Some DCO rulebooks allow for a higher level of assessments when more than one member defaults. As an example, DCO 4 in the right panel of **Figure 3** exhausts resources at a 7.5X multiplier with one default, but a second default requires market shocks of 9.8X to exhaust all resources, given the higher level of assessments. On the other hand, since assessments are unfunded, they are not paid by defaulted members. So, as more members are defaulted, the available level of assessments decreases.

    - Two DCOs reflect a notable sensitivity to the number of member defaults, with one of the two (DCO 5) requiring a multiplier of 4.3X for a single member default, but a lower 2.1X for ten defaults. The other (DCO 3) requires an 8.6X multiplier for a single member default, but only a 4.2X multiplier at nine defaults.

    - Two DCOs (DCO 1 and DCO 2) did not exhibit significant sensitivity to the number of defaults, with market shocks between 3.7X and 4.8X of the base market scenario needed to exhaust all possible resources, regardless of the number of member defaults.

2.1.b CDS, FX, and IRS

At all DCOs clearing CDS, FX or IRS, it would require market shocks at least 2.1X those in any of the base market scenarios in order to consume any non-defaulter resources, regardless of the number of defaulters.

Figure 4 shows combinations of multipliers and member defaults that exhaust prefunded and total resources at each DCO clearing CDS, FX or IRS. As swaps, these products have a minimum five-day margin period of risk (MPOR).[23] All multipliers are still applied to one-day historical market shocks from the base market scenario dates. As expected, larger multipliers are required to exhaust resources related to these products than for F&O, due to the difference in stressed period of risk (SPOR).[24] As with F&O, all results are based on the most stressful base market scenario, assuming two simultaneous member defaults.

Figure 4: Frontiers of Coverage – IRS, CDS, and FX

Prefunded Resources

	1	2	3	4	5	6	7	8	9	10
DCO 1	5.1	4.1	3.7	3.6	3.5	3.5	3.4			
DCO 2	4.8	3.7	3.5	3.3	3.2	3.1				
DCO 4		16.7	13.9	13.5	13.0					
DCO 6	5.9	4.4	4.0	3.8	3.7	3.6	3.5	3.4	3.3	3.3
DCO 3	11.0	8.0	7.1	6.8	6.7	6.5				
DCO 5	12.9	10.3	9.7							

Total Resources

	1	2	3	4	5	6	7	8	9	10
DCO 1	6.2	4.7	4.1	3.9	3.8	3.7	3.6			
DCO 2	8.8	5.7	4.9	4.6	4.3	4.1	4.0	3.9	3.9	3.9
DCO 4			18.0	15.9	14.8					
DCO 6	8.8	7.4	6.9	6.2	5.6	5.3	5.0	4.7	4.6	4.6
DCO 3	15.8	13.0	12.6	11.7	10.5	9.8	9.0			
DCO 5	17.9	15.3	16.5	14.2	13.1	12.9				

- **Prefunded resources**: For the three DCOs clearing IRS, market shocks between 4.8X and 5.9X of the base market scenario were required to exhaust resources with a single member default, decreasing to 3.1X to 3.4X with multiple member defaults. At the other three DCOs (clearing CDS and FX), much larger multipliers were required to exhaust prefunded resources. No multiplier is defined for DCO 4 at a single default because even at a multiplier of 25X (the maximum multiplier tested) prefunded resources still

---

[23] MPOR is the time period from the last exchange of collateral covering a set of transactions with a defaulted counterparty until that counterparty is closed out and the resulting market risk is re-hedged and auctioned. CFTC regulations prescribe minimum MPORs, but DCOs are free to use a longer MPOR for products as they deem appropriate based on market structure.

[24] SPOR used to size the DF should be at least as long as the MPOR.

remained. In all cases, market moves significantly higher than the base market scenario of historical one-day shifts were needed to exhaust prefunded resources.

- **Total resources**: There is a wide range of outcomes among these DCOs in terms of the market shocks required to exhaust all resources. DCO 1 ranges from 6.2X for one default to 3.6X for seven defaults. DCO 4 does not exhaust total resources even at 25X with either one or two defaults, and can cover the defaults of all members with losses with market shocks less than 14.8X. Generally, the gap between the multipliers necessary to exhaust prefunded versus total resources are smaller for DCOs clearing swaps relative to DCOs clearing F&O, with the ratio of assessments to DF in most cases lower for swaps DCOs (range 0.7 to 3.0) than F&O DCOs (range 2.9 to 5.4).

2.1.c Price Shocks – Putting Multipliers in Perspective

Since the price shocks for a particular product vary across base market scenarios, the multipliers needed to consume a given level of resources are not necessarily comparable across scenarios. For a particular product, 3X applied to a less volatile base market scenario could represent a smaller price shock than 2X applied to a more volatile base market scenario, for example. Therefore, it is useful to highlight the size of some of these derived price shocks, applied below to the default of the two members with the largest combined deficit.

For scenarios reflecting more global macro market shocks, generating large potential default losses across multiple DCOs from product groups with large exposures and open interest:

- For DCOs that clear equity products, equity futures need to move, in one day, up by at least 17% or down by at least 30% to exhaust prefunded resources, compared to a historical range of +10% to -10% maximum one-day shifts since January 2010.

- For those DCOs that clear interest rate products, 10-year US dollar IRS rates and 30-year Euro IRS rates need to move in one day twice the largest five-day moves since January 2010.

For DCOs where commodities are relatively more important, even larger market movements were often required. Because positions in these product classes are generally smaller, similar resource depletion required larger underlying shifts. For example:

- Crude oil futures needed to move up at least 39% (compared to largest historical one-day move in the high open interest month of +25%) or lose all their value (100% down – compared to largest historical of -43%) for prefunded resource exhaustion in some scenarios.

- Natural gas futures need to shift up by 73% or lose all value (compared to largest historical one-day move of up 18% or down 18%).

Note that the above price shocks are not stand-alone but concurrent with price shocks in all other products cleared by the DCO. In a large proportion of scenarios, the price shocks that are necessary to exhaust available prefunded resources, assuming the default of the two members with the largest deficits, exceed the largest one-day price moves within the last decade for many of the most material products cleared at those DCOs.

To assess compliance with regulatory requirements at DCOs clearing swaps, five-day price shocks would be appropriate. Here, staff started with one-day base market scenario price shocks for consistency across products. Given the frequency of VM payments,[25] and the speed at which a DCO will hedge defaulted portfolios, one-day price shocks are meaningful for DCO risk assessment.

2.2 Cross-DCO Analysis

This section provides an overview of the potential impacts of member defaults across the DCOs included in this exercise, concurrent with extreme market shocks.

Given the focus of this cross-DCO analysis on exhausting total DCO resources (*i.e.*, prefunded default resources and assessments), the three members creating the largest exposures are defaulted, instead of just the one or two members creating the largest exposures.[26]

In this exercise:

- Staff first examined the resource use at DCOs that results from the default of the three members that represented the largest aggregate deficits across the DCOs modelling the scenario.

- Staff separately analyzed the potential financial resource demands on non-defaulted members (in the form of assessments and losses of DF contributions), and what these represent as a fraction of such members' Tier 1 capital.

- Staff analyzed the level of interconnectedness among DCOs and members.

2.2.a Impacts on DCOs

In the cross-DCO analysis, the impacts across DCOs of members defaulting during periods of extreme volatility were examined in two ways.

- First, staff assumed that all base market scenario shocks would be amplified by 5X, and then quantified losses and deficits related to these 5X portfolio stresses. Note that this multiplier was the median multiplier necessary to consume total resources, assuming three defaults in the scenario that results in the largest deficits for a given DCO.[27]

- Second, staff assumed that all base market scenario shocks would be amplified across DCOs to the level needed to exhaust total resources at a single DCO.

---

[25] VM settlement is required to take place at least once each business day, 17 C.F.R. § 39.14(b), and at some DCOs regularly takes place multiple times each business day.

[26] Because prefunded default resources are sized to cover the default of one or two members in extreme but plausible scenarios per CFTC regulations, when assessing the use of total resources, it is appropriate to focus on more than two such defaults.

[27] Put differently, at five DCOs, exhausting total resources assuming three defaults required a multiplier less than 5X and at five DCOs it required a multiplier greater than 5X (see Figures 3 and 4).

These two analytic scenarios are characterized as 5X Expanded Stress Scenarios and Resource Exhausting Stress Scenarios. The key impacts examined under each of these scenario sets is illustrated below and includes aggregate deficit, aggregate stress loss, and resource erosion at DCOs.

2.2.a.i 5X Expanded Stress Scenarios

The analyses presented in **Figures 5 through 8** show results related to base market scenarios scaled by a 5X multiplier (the 5X Expanded Stress Scenarios). Given the base market scenario dates were chosen for their extreme severity (for example, four of the 11 base market scenario dates average more than five standard deviations from the historic mean of daily VM), it is reasonable to assume that expanding all stress scenarios to 5X results in scenarios that are far beyond plausible.

In each scenario, staff assumed the default of the three members with the largest deficits when aggregated across all DCOs. Staff assumed the default of the three members that created the largest deficit in total *across DCOs*, not necessarily the three largest deficits at any single DCO. Consistent with earlier sections of this report, the deficit caused by a member's default is the portion of a member's stress loss that exceeds the collateral posted by that member. This portion of losses necessarily must be covered by the resources of other members, or of the DCO itself. The selection of defaulters was calculated independently for each scenario.

Though a maximum of 33 possible members could have been in the top three defaulters across the 11 scenarios, in actuality only 16 distinct members were one of the three largest defaulters in at least one scenario.

An overview of the absolute deficits and losses for these three defaulters is provided below, followed by a comparison of these deficits relative to the resources of the DCOs.

Figure 5 and **Figure 6** provide a summary of aggregate deficits and stress losses resulting from the three largest potential member defaults. **Figure 5** summarizes the total deficits for each of these three members for each scenario, while **Figure 6** summarizes the total stress losses; the collateral posted by the defaulters represents the difference between these stress losses and deficits.

Figure 5: Cross-DCO Deficits with Three Defaults and 5X Expanded Stress Scenarios
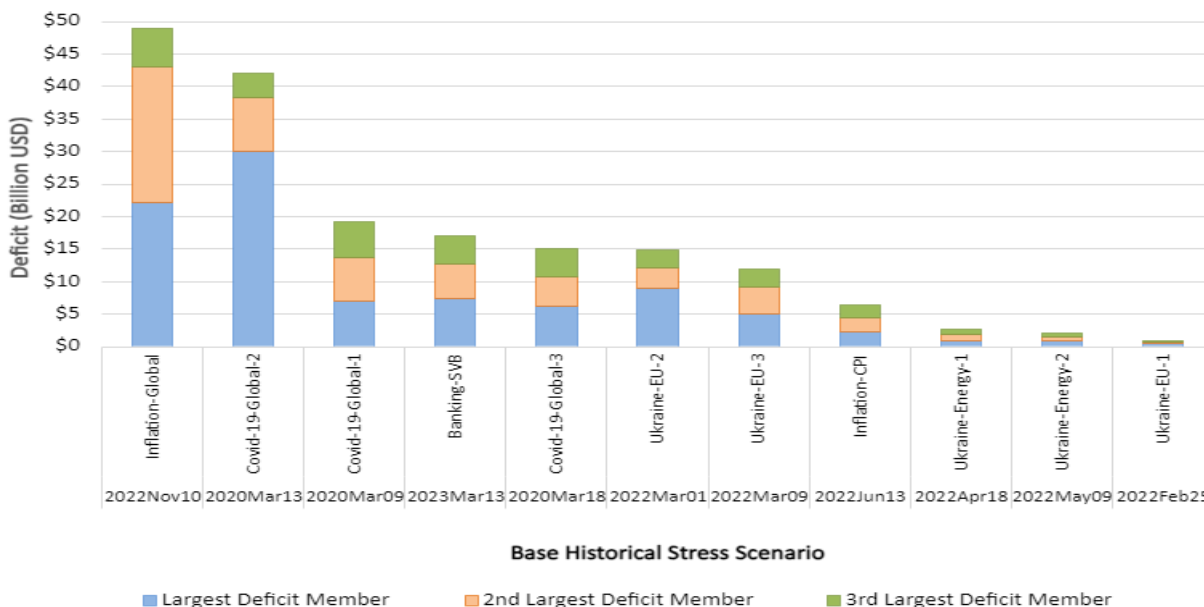
Note: The deficit shown for each defaulted member represents the sum of the deficits that the defaulted member incurred across the DCOs that modeled the scenario. In calculating aggregate deficits, surpluses (*i.e.*, cases where a member had a net stress gain or a net stress loss smaller than eligible collateral) were not deducted.

Figure 6: Cross-DCO Stress Losses with Three Defaults and 5X Expanded Stress Scenarios
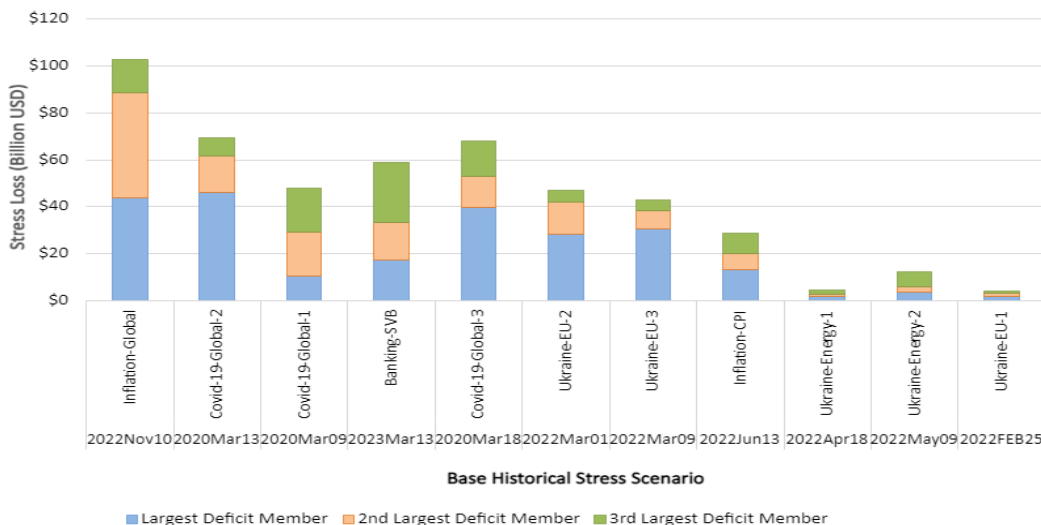
Note: Stress loss is the sum of stress losses incurred by the respective defaulted member in that scenario across all DCOs.

**Analysis/Findings related to Figures 5 and 6:**

- How varied are the losses/deficits across scenarios, and what can drive this variation?

    o Two of the 5X Expanded Stress Scenarios, based on the dates of 2022Nov10 and 2020Mar13, result in the highest deficits. For these, aggregate losses for an individual member peak at approximately $46 billion, with deficits peaking at $30 billion, as shown in the two stacked bars on the left side of both figures. These scenarios do share some characteristics, with both representing large moves in equity products. Perhaps because of this overlap in market shifts, both the largest and the 2nd largest deficit members are the same in both scenarios, (the 3rd largest deficit member differs). It is noteworthy that without multipliers (*i.e.*, at 1X) none of these members had deficits.

    o In the next five scenarios shown, the highest deficit for a member ranged between $5 billion and $9 billion. It is noteworthy that, at 1X in each of these scenarios, these same members had no deficits.

    o In the last four scenarios, representing historical dates that mainly impacted DCOs clearing a set of smaller products, losses and deficits were materially smaller; the highest deficit for any member was in the range between $0.5 billion and $2.2 billion.

- Do the members with the largest stress losses always also have the largest deficits?

    o Not always. In seven of the 11 scenarios, the member with the largest losses is also the member associated with the largest deficit. However, this is not the case for the remaining four scenarios. Given that the difference between deficits and losses is represented by collateral, this distinction can often be due to proportionally higher or lower collateral for one member as compared to others.

- Does the defaulter's collateral cover most of the stress loss?

    o Yes. In aggregate, 63% of losses were covered by collateral (so only 37% translated to deficits), for the three members with the largest deficits, across the 11 scenarios.

    o However, the proportion of stress losses covered by a member's collateral was highly varied, ranging from as high as 90% to as low as 18% across the individual defaulters in each scenario. This resulted in some notable differences between Figure 5 and Figure 6. For example, in Figure 6 the second bar (Covid-2) and the fifth bar (Covid-3) had similar aggregate losses for the top three defaulters (just under $70 billion), but in Figure 5 these two scenarios had noticeably different aggregate deficits (just over $42 billion for the second, vs $15 billion for the fifth).

- How concentrated are losses/deficits across the three defaulting members?

  o The distribution of losses and deficits among the top three defaulters varies across the 11 scenarios. In a few scenarios, losses and deficits are somewhat evenly divided across the three members, implying a somewhat flat distribution of exposures (*e.g.*, deficits in Covid-19-Global-1). In other scenarios, losses and deficits are highly skewed to the largest of the three members (*e.g.*, Covid-19-Global-2).

- How do losses/deficits at the implausible 5X level compare to those at smaller multipliers?

  o In general, losses for a given defaulter and scenario are linear with respect to the multiplier. This is not usually the case for deficits, especially at lower multipliers, because of the defaulter's collateral.

Cross-DCO effects can come in a number of forms. **Figures 5** and **6** speak to the aggregate size of potential exposures of DCOs under specific market scenarios. In addition to this 'depth' of exposures across markets is the potential 'breadth' of exposures – the sheer number of DCOs that can be affected by extreme market moves and defaults. **Figure 7** provides a view of this 'breadth' - how widespread deficits are across DCOs under each of the 5X Expanded Stress Scenarios.

For each scenario, four counts are provided; color-coding coincides with that of the prior two charts. Each bar represents the number of DCOs at which that defaulted member has deficits (blue: largest member; orange: second largest; green: third largest). The red dots represent the total number of DCOs that calculated stress results for a given scenario.

Figure 7: Number of DCOs Impacted by Three Synchronized Defaults and 5X Expanded Stress Scenarios
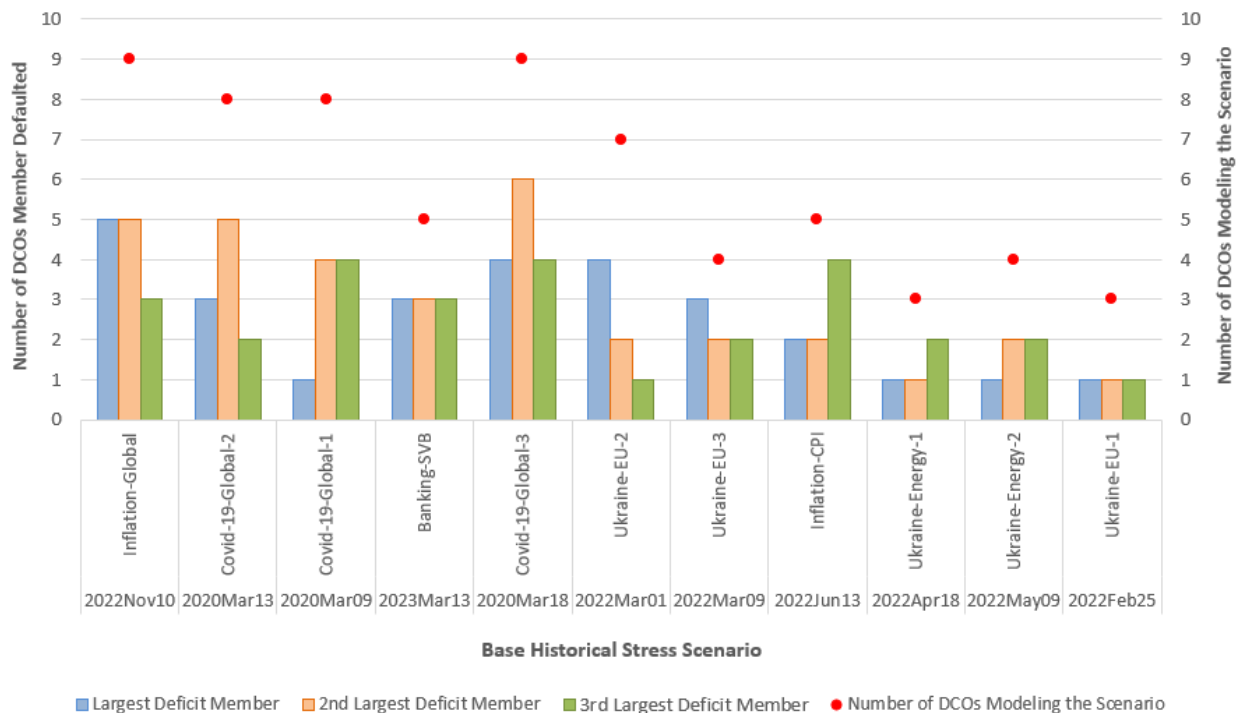
Note: Columns indicate the number of DCOs at which the defaulted member had deficits in that scenario. Not all defaulted members held memberships in all the DCOs that modeled the scenario.

Analysis related to Figure 7:

- Do members often create exposures across the full set of DCOs?
  - No. In no case does a single defaulted member have a deficit at all of the DCOs that modeled that scenario. The count of DCOs at which a given member has a deficit ranges from one to six, with an average of three across all scenarios and all defaulted members.

- Are low numbers in the chart 'good' and high numbers 'bad'?
  - Not necessarily. Unlike deficits, where higher deficits do translate to larger exposures at DCOs, there is not necessarily a positive correlation between counts and exposure. Low counts mean that a given deficit is concentrated in one or a few DCOs – which can result in more significant effects for these entities, but less interconnectedness between them and the larger system. In contrast, high counts may result in higher interconnectedness, but also a diffusion of deficits across many individual DCOs.

- No DCO ran all of the scenarios, nor was there any individual scenario run by all DCOs. Could this have affected the results?

- o Likely not. Staff instructed DCOs to run **only** scenarios that represented stressed market conditions for products cleared at a given DCO with material outstanding positions. Therefore, losses and deficits would likely be low for 'missing' stress scenarios, and counts would not have significantly changed even if all DCOs had run all 11 scenarios.

The figures above primarily focus on the absolute level of DCO exposures to member defaults, *i.e.*, deficits that need to be covered by either defaulter's collateral or mutualized resources. The effect of these deficits on a DCO, however, are more fully represented by comparing these deficits with the DCO resources – *i.e.*, calculating the fraction of mutualized resources that would be used at individual DCOs or in the system as a whole, due to these member defaults. **Figure 8** provides this additional information on the aggregate use of mutualized default resources for the 5X Expanded Stress Scenarios.

Figure 8: Aggregate and Maximum DCO Resource Erosion with Three Synchronized Defaults and 5X Expanded Stress Scenarios
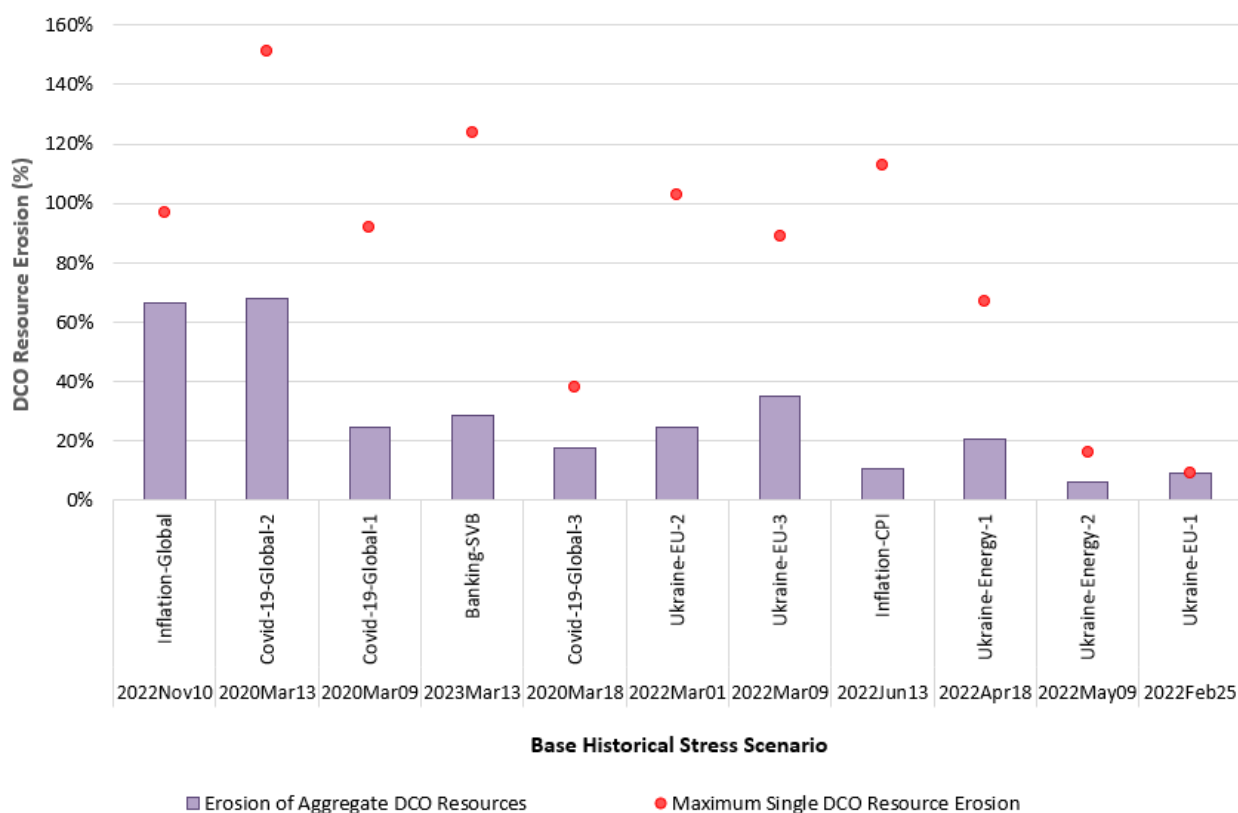
Note: Erosion of aggregate DCO resources in a synchronized scenario is defined as the percentage of total available mutualized resources across applicable DCOs that would be exhausted by the sum of deficits across DCOs at the three defaulted members. Maximum DCO erosion refers to the highest erosion at a single DCO in that synchronized scenario.

In this chart, each bar represents the percentage of total resources that the largest three members exhaust across the relevant DCOs. Only resources of those DCOs that modeled the scenario and at which at least one of the three defaulters had a deficit were included. The figure also shows (using red dots) the maximum amount of resources used at any one DCO by the three defaulted members.

Analysis related to Figure 8:

- In the 5X Expanded Stress Scenarios, with three defaults, were resources exhausted at any individual DCOs?

  o In short, yes. In four of the 5X Expanded Stress Scenarios, at least one DCO would have had total deficits greater than 100% of available resources. In one of the scenarios (Covid-2), total deficits resulting from three defaults equal 151% of available resources at one DCO. In cases where deficits exceed resources, the DCOs would need to use recovery tools in their rulebooks, such as VM gains haircutting.

  o This finding is to be expected, due to the extraordinary implausibility of the 5X Expanded Stress Scenarios (and three defaults). This coincides with the results of the single DCO analysis, where a few individual DCOs exhaust resources (assuming three defaults) at multipliers less than five.[28]

- Are there any cases where available resources were exhausted at all of the DCOs that ran a scenario?

  o No. The share of the mutualized resources across the DCOs that, in aggregate, would be required to cover member deficits did not exceed 68% in any of the scenarios. In nine of 11 scenarios, this fraction was less than 35%. For example, eight DCOs calculated results for the Covid-2 scenario. The three defaulters had deficits at five of these DCOs. The total of these deficits was 68% of the total of available resources across the five DCOs in that scenario. Granted, resources are not transferable across DCOs, but this aggregate ratio could be considered a proxy for how stressful the scenario might be from a systemic perspective.

- Is the exhaustion of resources at one DCO usually correlated with high resource use at other DCOs?

  o Not necessarily. In the four scenarios with maximum resource exhaustion at one DCO above 100%, the aggregate resource exhaustion across DCOs ranges from 11% to 68%, compared to a range of 6% to 66% across the other seven scenarios.

  o This can help to illustrate a truism of the diversity in derivatives clearing services: because of differences between DCOs in terms of members and their portfolio compositions, the most impactful combination of market scenario and defaulted members at one DCO will likely not be the most impactful combination at other
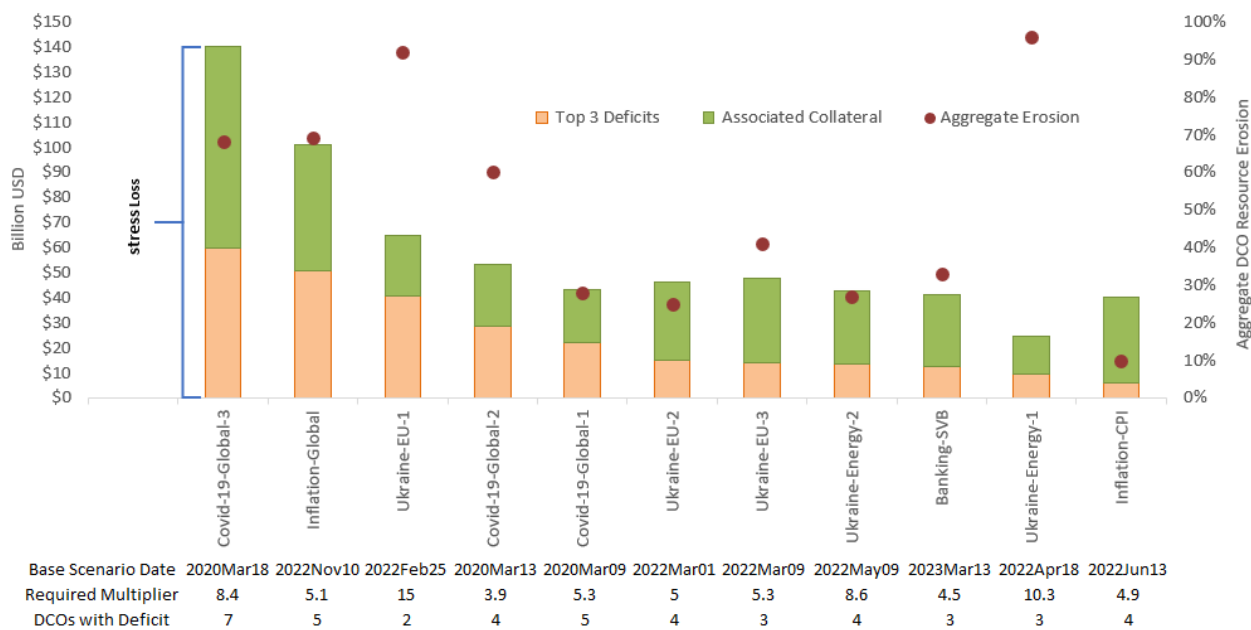
---

[28] See Figure 3 and Figure 4.

DCOs, and thus the worst scenario systemically will be less damaging than the sum of the worst case at each DCO.

  o   This observation is similar to the results shown in Figure 7, where members that defaulted in individual scenarios never had deficits at all of the relevant DCOs, and often had deficits in only half, or even fewer, of the set. So, though there can be interconnectedness in the clearing ecosystem due to common membership and deficits at more than one DCO, often this interconnectedness is mitigated by the characteristics of individual scenarios and portfolios.

2.2.a.ii Resource Exhausting Stress Scenarios

Continuing the cross-DCO analysis of three defaults in extreme scenarios, **Figure 9** switches from the 5X Expanded Stress Scenarios to the Resource Exhausting Stress Scenarios. Here, for each scenario, the multiplier used is the minimum multiplier required to exhaust all resources at one of the DCOs. This methodology of exhausting resources is more consistent with the aims of a reverse stress test, now applied to the cross-DCO rather than the single-DCO analysis.

Figure 9: Stress Losses and Resulting Deficits Related to Three Synchronized Defaults When Each Base Market Scenario is Expanded Until Total Resources are Exhausted at One DCO

	Covid-19-Global-3	Inflation-Global	Ukraine-EU-1	Covid-19-Global-2	Covid-19-Global-1	Ukraine-EU-2	Ukraine-EU-3	Ukraine-Energy-2	Banking-SVB	Ukraine-Energy-1	Inflation-CPI
Base Scenario Date	2020Mar18	2022Nov10	2022Feb25	2020Mar13	2020Mar09	2022Mar01	2022Mar09	2022May09	2023Mar13	2022Apr18	2022Jun13
Required Multiplier	8.4	5.1	15	3.9	5.3	5	5.3	8.6	4.5	10.3	4.9
DCOs with Deficit	7	5	2	4	5	4	3	4	3	3	4

The figure provides a summary of both absolute and relative resource use. The height of each bar represents the aggregate stress loss for the three defaulted members in the expanded scenario. The green portion reflects the portion of the loss which is not mutualized,[29] and the

---

[29] Put differently, the portion of the losses that is covered by the initial margin and DF contributions from the defaulted members.

orange portion shows the remaining deficit, the portion which needs to be covered by DCO capital and resources from non-defaulted members.

In other words, the full columns in **Figure 9** are equivalent to the information shown in **Figure 6** above, just with multipliers changed. The orange portion of the columns is equivalent to the information shown in **Figure 5.** Finally, like **Figure 8**, the red dots show the percentage of total mutualized resources that are exhausted at the DCOs collectively in the given scenario.

Analysis of Figure 9:

- Do the Resource Exhausting Stress Scenarios always require a higher multiplier than the 5X Expanded Stress Scenarios shown in the prior charts?

    ○ Not always. **Figure 8** showed the maximum resource use at any DCO. In cases where this number is at least 100%, the Resource Exhausting Stress Scenario will necessarily require a multiplier no larger than 5X (four of the 11). In the seven others, the multiplier needed to exhaust resources exceeds five.

- Do the Resource Exhausting Stress Scenarios often result in losses/deficits significantly different than those for the 5X Expanded Stress Scenarios?

    ○ Not usually. For seven of the eleven scenarios, the multiplier is higher than 5X, translating to higher losses/deficits on an aggregate basis. However, in general, these higher levels are not significantly different than that seen in Figures 5 and 6, with perhaps the exception of Covid-3. Outside of this scenario, losses for both scenario sets peak at around $100 billion, and deficits peak at around $50 billion.

- Could any of these highly-implausible scenarios cause more widespread disruptions to the financial system?

    ○ Though challenging to answer, much of the analysis points to the ability of DCOs, and members, to smoothly respond to the resource demands related to these extreme market movements and defaults. Analysis related to the most severe of the Resource Exhausting Stress Scenarios which speaks to the potential effects on the broader system, is included in the next section.

- Does resource exhaustion at one DCO often coincide with high resource use at other DCOs?

    ○ Usually, no. Though the methodology used ensures that one of the included DCOs has approximately 100% of its resources used, in aggregate a majority of the scenarios (six of the eleven), use half or less of the aggregate resources available to cover deficits. In the case where the highest amount of aggregate resources is used (2022Apr18, 96% of resources), two of the three relevant DCOs used only 37% and 10%, respectively, of their total resources. Excluding those DCOs using approximately 100% of available resources (one DCO in each scenario), on average the other DCOs used 34% of their resources (median = 33%).

2.2.b Impact on Non-Defaulted Clearing Members

The prior section focused on the effects of the defaults of members on DCOs and their available resources. However, the default of a member or members can also impact non-defaulted members. These members might face costs associated with the DCO's use of DF contributions or assessment calls.

In order to analyze the hypothetical financial impact on non-defaulted members, staff selected the 2020Mar18 scenario (the scenario in **Figure 9** with the highest associated deficits), at a multiplier of 8.4X. Here again, the analysis assumed three defaults to quantify potential resource draws. This base market scenario represented the third largest aggregate sum of daily total VM payments across the in-scope DCOs since at least January 2020, based on data collected from DCOs pursuant to CFTC regulations.

For context, the 8.4X multiplier shocks are equivalent to equity index futures moving down between 28% and 74%, swap rates on 30-year EUR IRS moving up 180 basis points, and crude oil falling to zero, all in a single day – clearly an extremely implausible scenario. With these market and member default assumptions, all prefunded and a sizeable portion of unfunded resources were used at five DCOs, and some of the DF was used at two DCOs.

Figure 10 summarizes the amounts of assessments paid and DF contributions consumed from non-defaulted members, under three different market shock scenarios. The 8.4X scenario corresponds with the values in **Figure 9**. This scenario is paired with two additional, less extreme scenarios (5X and 3X) to provide additional context. In all cases, these are extreme expansions of an already extreme historical date.

Figure 10: Distribution of Non-Defaulted Member Losses of Default Fund Contributions and Assessments (million USD)

	2020Mar18 Base Scenario - Equities & Energy Down, Interest Rates Up		
	8.4X	5X	3X
Largest payer	7,738	2,048	170
Members 1-20	2,277	560	57
Members 21-40	402	82	8
Members 41-60	102	18	2
Members 61-80	46	9	1
Members 81-100	23	5	<1
Members 101-120	6	2	<1

(Rows "Members 1-20" through "Members 101-120" are labeled "Average per group")

Note: The group "Members 1-20" includes the "Largest payer" shown in top row.

For the most extreme (8.4X) multiplier (which exhausts all assessment powers at one of the DCOs and 68% of aggregate resources across seven DCOs), the top 20 non-defaulted members would have lost between $0.7 billion and $7.7 billion each, for an average of $2.3 billion.

Cumulatively, these 20 members represent 80% of the total mutualized resources used by the DCOs.[30] The remaining 20% was spread out over the remaining 100 members, each paying no more than 1.2% of the total. This distribution of resources is to a large extent commensurate with the initial margin posted by these members. For many DCOs, the calibration of both DF and assessment contributions is similar to that of initial margin, meaning that members contribute proportionally more or less based on their market positions.

Members with parents located in the United States paid approximately 50% of the total, and 40% was paid by members with E.U. or U.K.-based parents. DF usage accounted for one-third of the total, with the remaining being assessments.

The 5X Expanded Stress Scenario is included to correspond with **Figure 5**. The market shocks are 40% less than the 8.4X scenario, but the amounts that non-defaulted members must contribute to cover the deficits decrease by approximately 76%. While stress losses tend to be fairly linear with respect to the magnitude of the market shocks, the deficits borne by members are not, because mutualized losses do not begin until the stress loss is large enough to exhaust all of the collateral posted by the defaulted member (as well as the DCO's contribution to the DF).

The 3X Expanded Stress Scenario represents market shocks that are less implausible for many of the most widely cleared products at these DCOs, although shocks to some material products are still highly implausible. The costs to non-defaulted members decrease by approximately 90% when the market shocks are decreased from 5X to 3X (and decrease by approximately 98% from 8.4X to 3X). Under the 3X scenarios, prefunded resources were used at four DCOs, and no unfunded resources were required.

The top 20 non-defaulted members under the 8.4X scenario (*i.e.*, those that face the largest resource demands) are all part of banks or bank holding companies that publicly report Tier 1 capital levels. Comparing the two measures, the costs due to DF and assessment use for each of these members, even in this highly implausible scenario, represent between 0.8% and 6.2% of their Tier 1 capital, with a weighted average of 2.5%, as shown in **Figure 11**. Note that the maximum costs in **Figure 10** and the maximum percentage use of Tier 1 capital in **Figure 11** do not necessarily correspond to the same parent entity.

---

[30] Initial margin requirements are concentrated among these same members.

Figure 11: Default Fund + Assessment Costs Relative to Tier 1 Capital, Top 20 Members

	2020Mar18 Base Scenario - Equities & Energy Down, Interest Rates Up		
	8.4X	5X	3X
Maximum	6.2%	2.5%	0.29%
Minimum	0.8%	0.2%	0.03%
Weighted average	2.5%	0.6%	0.07%

Given these highly implausible market shocks and the concurrent default of three large global members, the capital at these members would likely be under additional stresses. However, the marginal effect of resource requirements due to obligations to contribute to DCO default management appears, in all cases, to be small fractions of what is available.

Just as was illustrated in **Figure 10**, at 5X[31] the costs relative to Tier 1 capital decrease significantly, and at 3X, which in terms of market shocks remains implausible, but less so, they become much less significant for these top 20 parent entities.

2.2.c Interconnectedness

This section focuses on the interconnectedness in the derivatives clearing system that results from many of the same members clearing at multiple DCOs. **Figure 12** shows the distribution of the 124 members that clear at one or more of the included DCOs. The chart groups these firms by the number of DCOs at which they are members. While half of the firms (62) use only one of the included DCOs, 25% have accounts at four or more DCOs, 10% have accounts at eight or more DCOs, and one has accounts at all eleven DCOs.

Figure 12: Distribution of Members by Number of DCOs

DCOs	1	2	3	4	5	6	7	8	9	10	11
Members	62	17	14	5	7	4	3	1	3	7	1
Percentage	50%	14%	11%	4%	6%	3%	2%	1%	2%	6%	1%
% in N or more DCOs	50%	36%	25%	21%	15%	12%	10%	9%	7%	1%

For **Figures 3 and 4**, staff identified the most stressful scenario for each DCO as the one in which prefunded resources were exhausted with two defaults at the lowest multiplier. In all cases, the scenario (combination of base market scenario and pair of defaulted members) that

---

[31] There is slight variation in the top 20 members using the three different multipliers. Under the 5X Expanded Stress Scenario, one member does not report Tier 1 capital so those percentages are based on 19 members. Under the 3X scenario, all 20 members reported Tier 1 capital.

was most stressful for one DCO did not coincide with the most stressful scenario for any other DCO. The closest instance was the 2022Nov10 base market scenario, which was the most stressful market scenario for three DCOs. However, even for this common market scenario, the only overlap was a single member at two of the DCOs (which were in different asset classes), as illustrated below:

	Largest Deficit	2nd Largest Deficit
DCO 1	Member 1	Member 2
DCO 2	Member 3	Member 1
DCO 3	Member 4	Member 5

This helps to explain why the worst plausible cross-DCO scenario is almost certain to be less stressful than the result of the sum of losses from the individual DCO default funds would imply.

Zooming out to view interconnectedness more broadly, members with portfolios at multiple DCOs could, under stressed market conditions, incur deficits at multiple DCOs (as shown in the prior section). Analysis presented in **Figures 5 through 8** quantified the stress losses and deficits associated with the three members that represent the largest aggregate deficits across all DCOs in specific scenarios. Because this analysis requires that the three members be the same across all DCOs, these three members may not represent the largest three deficits at a specific DCO in a given market scenario.

In the following analysis, staff paired the prior analysis with interconnectedness analysis that loosens this constraint, by examining the distribution of members with the three largest deficits under each expanded base market scenario using a 5X multiplier at each individual DCO (representing a total of 65 DCO and base market scenario pairs).

When each DCO scenario is assessed separately, a maximum of 195 (65 x 3) unique defaulted members are possible (if there are no common defaulted members across the 65 pairs). Given the stress scenario construction and the overlapping member portfolios across DCOs, the actual number is a notably lower 35, indicating a moderate level of correlation between the members with largest deficits across DCOs and scenarios.

Figure 13 depicts metrics related to the level of overlap across DCOs for these 35 members. Each member's appearance is categorized in terms of the number of distinct DCOs (x-axis) and the number of distinct scenarios (y-axis) where it appears as one of the top three members with deficits. The size of each bubble in **Figure 13** corresponds to the number of members under each combination of these two categories.

There is a positive relationship between the metrics; members with large deficits at more DCOs also have large deficits in more scenarios. Roughly a third of members (13 of the 35) are seen at only one DCO and in one scenario, while on the other end of the spectrum is one member that is a defaulter at six DCOs and in eight scenarios, and one member at seven DCOs and in seven scenarios.

Figure 13: Distribution of Top Three Defaulted Members Under 5X Expanded Stress Scenarios
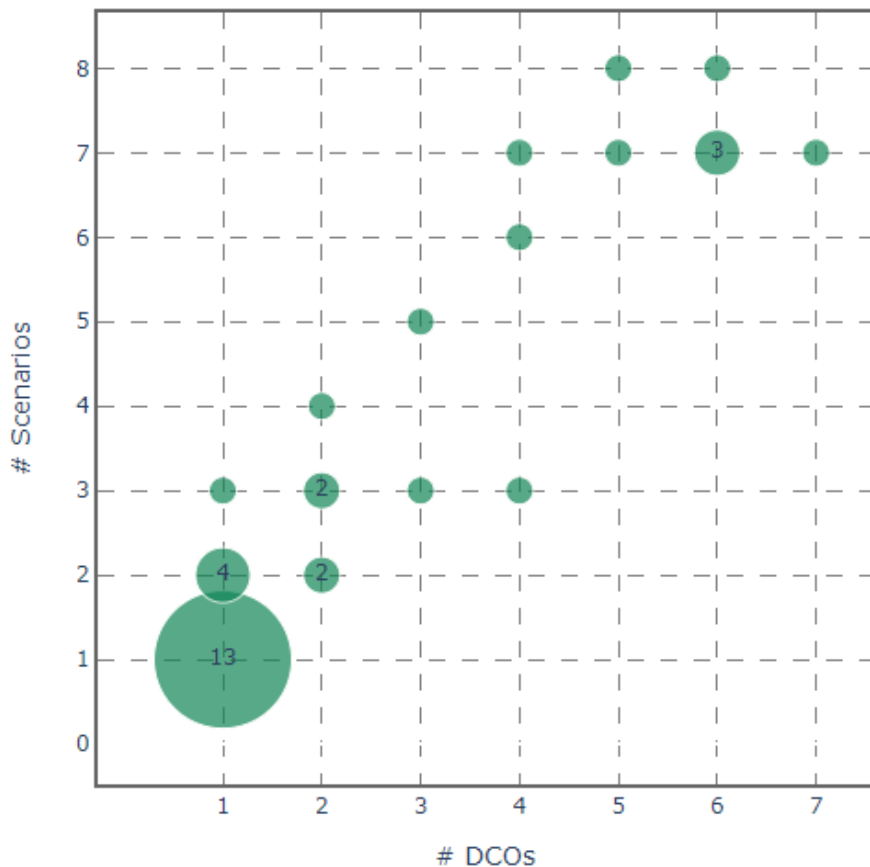
Finally, to display interconnectedness in multi-dimensional data through network maps, staff used a specific base market scenario (5X the 2022Nov10 base market scenario) run by nine of the in-scope DCOs. **Figure 14** shows, for this scenario, stress test results for members (the middle and outer rings) and DCOs (inner ring). The 12 members on the middle ring represent those with one of the three largest deficits at one or more of the nine DCOs. These members are connected to the DCOs by a line in cases where they clear at the respective DCO. The connecting line is red when the member has one of the three largest deficits.

Note that, for example, Member 10 is one of the top three defaulters at DCOs 1, 2, 6 and 9. This helps to explain why there are only 12 members shown, instead of the maximum possible 27. One member can often be one of the largest defaulters at more than one DCO. The line is yellow when the member has a deficit at the DCO but is not a top three defaulted member, and the line is grey when the member does not have a deficit at the DCO. Any member that is not among the three largest defaulters at any DCO are plotted on the outer ring. Those with deficits in at least one DCO are marked in red while those with no deficits are in green.

Figure 14: Interconnectedness, Top Three Defaulted Members Under 5X 2022Nov10 Scenario
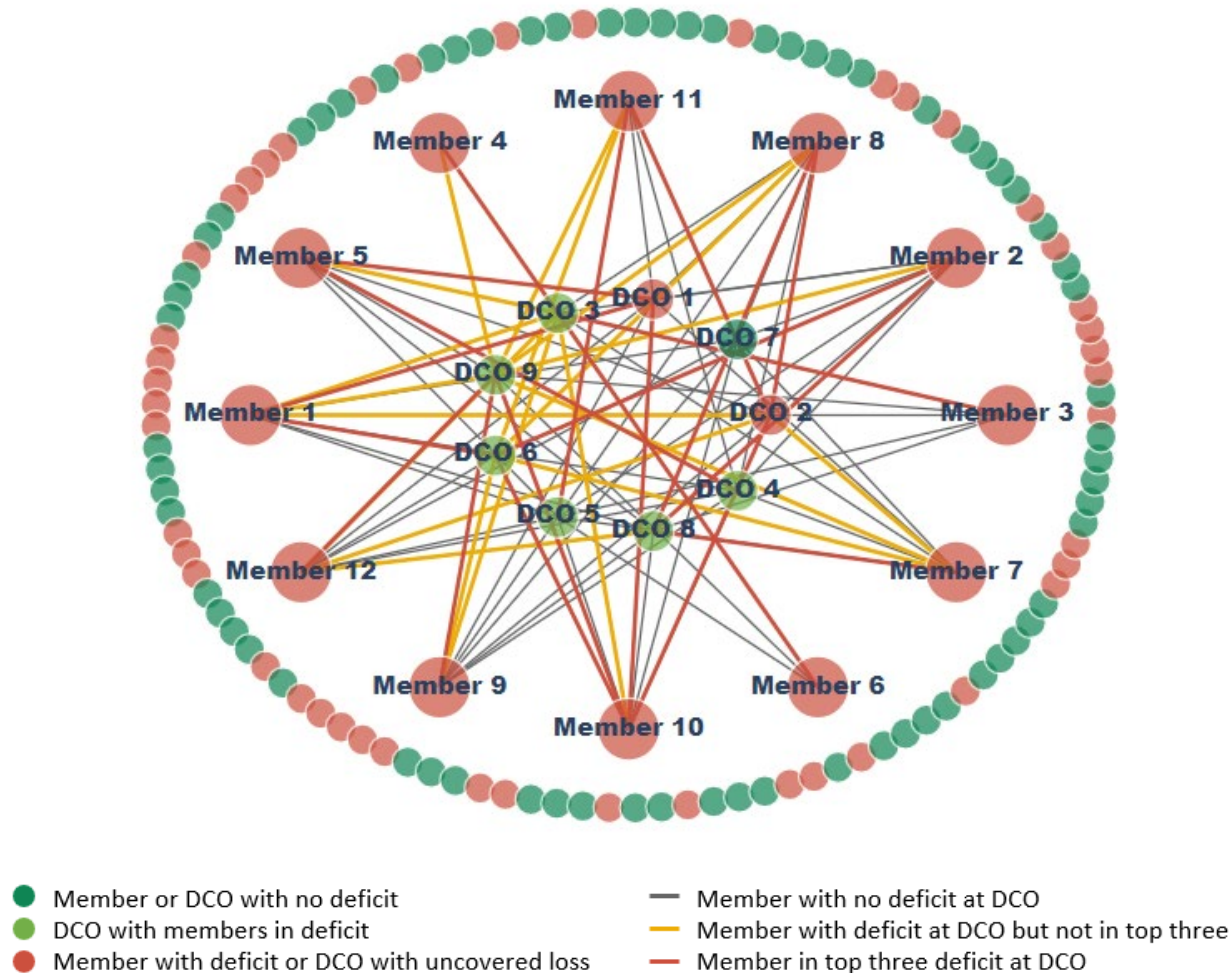
Even in the depicted scenario, which is extreme and implausible, less than half of the members have deficits at one or more DCOs - 57 members out of 124. In addition, in this implausible scenario, one of the nine DCOs has no member with a deficit. The largest three deficits, across all eight DCOs with deficits, come from 12 members. In this scenario, two DCOs would not have sufficient financial resources to cover the top three members' deficits (a result similar to those shown in section 1 for the 5X multiplier[32]).

The top three members with deficits are summarized in **Figure 15**. In addition, a similar set of information is provided for the 5X Expanded Stress Scenario using 2020Mar18 as a base date. This second scenario depicts a reversed set of market conditions to November 10 (*e.g.*, equities up vs equities down, etc.).

---

[32] Results displayed in Figure 8 assume the same three defaulters across DCOs, which is not the case with Figure 14, so the two figures aren't fully comparable.

Figure 15: Top Three Defaulted Members at Each DCO, by 5X Expanded Stress Scenario

DCO #	Top 3 Defaulters 2022Nov10	Top 3 Defaulters 2020Mar18
1	1,5,10	9,13,14
2	8,10,11	8,12,14
3	3,4,6	8,17,18
4	5	
5	11	9,13,15
6	1,2,10	9,10,16
7		
8	2,7,8	
9	9,10,12	9,11,16

■ No member with deficit
■ At least one member with deficit, loss can be covered by all available financial resources
■ Financial resources not sufficient to cover top 3 deficits, VMGH would be required

Consistent with the pattern shown in **Figure 13**, the largest deficits at multiple DCOs are generated by a small set of members. For example, under both the 2022Nov10 and 2020Mar18 scenarios, a single member (#10 and #9 respectively) appears in the top three at four different DCOs. In addition, because gains and losses do not offset among customer accounts at many clearing services,[33] members with large customer portfolios could be the members with the largest deficits at the same DCO in both up and down market conditions (*e.g.*, members #8, #9, and #10 are the members with the top three deficits at the same DCO under both scenarios in **Figure 15**).

---

[33] Client gains and losses do offset within the same F&O Customer Segregated Account.

3. Conclusions

This SST was CFTC staff's most extensive to date, including 11 clearing services across nine DCOs. Eleven volatile dates from the period 2020 through 2023 were chosen as base scenarios, and those market shocks were expanded using multipliers. Combinations of expanded market shocks and hypothetical clearing member defaults that could exhaust DCO resources, including defaults funds and assessments, were identified to form "frontiers of coverage" for each DCO separately. Cross-DCO analysis assessed interconnectedness due to firms clearing at multiple DCOs, and included potential impacts on non-defaulters.

The results of this 2024 reverse stress test analysis show:

- All individual DCOs hold sufficient financial resources to withstand many extreme and implausible price shocks, along with multiple defaults of their members. In some cases, DCOs can withstand the default of all members that have losses resulting from highly implausible price shocks.
- Potential costs to non-defaulting members do not appear to be problematic. Under a very extreme and likely implausible scenario, with shocks three times one of the most volatile days in recent years, concurrent with three synchronized defaults, costs at the 20 parent entities paying the vast majority of default funds and assessments represented only 0.07% of the Tier 1 capital, on average.
- The effects of interconnectedness were muted across DCOs, except for extremely implausible scenarios. Extreme events for one DCO are not commonly extreme events at the other DCOs, nor are the extreme losses for members at one DCO experienced to the same extent at other DCOs at which they are a member.

Looking forward, staff is working to ensure that the tools developed for this reverse SST and the knowledge gained will help to advance the CFTC's risk surveillance program. Staff is also considering either expanding the current work or conducting novel exercises/risk assessments for the focus of the next SST. Staff welcomes any and all feedback both on this exercise as well as any thoughts or suggestions regarding future work. Please send these comments to:

2024_SST_Comments@CFTC.gov