COMMODITY FUTURES TRADING COMMISSION

SUPERVISORY STRESS TEST OF CLEARINGHOUSES



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

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A REPORT BY STAFF

OF THE U.S. COMMODITY FUTURES TRADING COMMISSION NOVEMBER 2016

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Supervisory Stress Test of Clearinghouses

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List of Acronyms

BCBS	Basel Committee on Banking Supervision
CDS	Credit Default Swaps
CEA	Commodity Exchange Act
CFTC	U.S. Commodity Futures Trading Commission
СМЕ	CME Clearing
СРМІ	Committee on Payments and Market Infrastructures
DOJ	U.S. Department of Justice
ESMA	European Securities and Markets Authority
FSB	Financial Stability Board
FSOC	Financial Stability Oversight Council
HHI	Herfindahl-Hirschman Index
ICC	ICE Clear Credit
ICEU	ICE Clear Europe
ICUS	ICE Clear U.S.
IOSCO	International Organization of Securities Commissions
IRS	Interest Rate Swaps
LCH	LCH Clearnet Ltd
PFMI	Principles for Financial Market Infrastructures

Executive Summary

A. Nature and Purpose of the Exercise

The staff of the Division of Clearing and Risk of the Commodity Futures Trading Commission ("CFTC") has conducted an exercise applying a set of eleven internally-developed supervisory stress tests across five derivatives clearing organizations registered with the CFTC.

The purpose of the exercise was to assess the impact of this set of stressed market conditions across multiple clearinghouses, with a focus on firms that hold clearing memberships at more than one clearinghouse. The stressed conditions involved hypothetical, extreme but plausible scenarios. The ability of each clearinghouse to meet the required resiliency levels under such scenarios was evaluated as part of making such assessment. The exercise addressed credit risk; it did not address liquidity, operational, or cyber security risks.

B. Overview of the Procedures

The exercise covered five clearinghouses registered with the CFTC: CME Clearing, ICE Clear Credit, ICE Clear Europe, ICE Clear U.S., and LCH Clearnet Ltd. It encompassed futures, options on futures, and cleared swaps. It included contracts based on financial products and contracts based on physical commodities.

The exercise covered the 15 largest clearing members at each clearinghouse. Because many clearing members were among the 15 largest at more than one clearinghouse, but not at all clearinghouses, the exercise included a total of 23 clearing member firms. The house accounts and the customer accounts of these clearing members at each clearinghouse were analyzed. Because two of the clearinghouses have separate guaranty funds for certain asset classes, the exercise covered a total of eight different guaranty funds.

A total of 11 different stress scenarios were designed. All tests were performed at all five clearinghouses and across all eight guaranty funds. CFTC staff designed and executed the stress tests internally.

Staff primarily used data regularly submitted by clearinghouses pursuant to CFTC regulations and tools that are routinely employed by the CFTC in conducting daily risk surveillance. Staff provided the clearinghouses with the opportunity to review and comment on the methodology before conducting the exercise. After completing the exercise and before issuing this report, staff also provided the clearinghouses the opportunity to review and comment on the inputs and results.

C. Overview of the Findings

The following are the key findings:

1. Clearinghouses had the financial resources to withstand a variety of extreme market price changes across a wide range of products and instruments. They met or exceeded required resiliency levels.

- For all of the stress tests, all the clearinghouses had sufficient financial resources to cover a default by at least the two clearing members (including affiliates) with the largest margin shortfalls (the so-called "cover-two" standard). This is a U.S. and international requirement for certain systemically important clearinghouses.
- For almost two thirds of the stress tests, the applicable clearinghouse had sufficient financial resources to cover a default by every clearing member in the exercise that incurred a loss ("cover-all").
- 2. Clearing member risk was diversified among the scenarios and across the clearinghouses. The exercise covered the house accounts and the customer accounts of 23 corporate groups that hold clearing memberships at the five clearinghouses. Clearing members who were affiliated were aggregated at the corporate group level for purposes of identifying effects across clearinghouses. Staff analyzed which scenarios caused the worst outcomes for each of the 43 house and customer accounts held by the 23 clearing members.
 - Risk was diversified across the scenarios. Generally, the same scenario did not cause the worst outcome for multiple clearing members.
 - No single scenario accounted for the worst outcome at more than 8 clearing member accounts. That is, no single scenario accounted for more than 19% of the worst outcomes.
 - There were ten different scenarios responsible for generating the worst outcome for at least one clearing member account.
 - \circ $\,$ Only one scenario did not generate the worst outcome for any account.
 - Risk was not concentrated among a few firms. That is, 18 of the 23 corporate groups (approximately 78%) were among the two clearing members generating the worst outcome under at least one of the scenarios.
 - Risk was diversified across clearinghouses. Generally, the scenarios did not cause clearing members to incur losses at all clearinghouses.
 - 28 of the 43 clearing member accounts (approximately 65%) never had a net margin shortfall (a loss in excess of the margin requirement) across all clearinghouses under any of the scenarios.
 - Under the 11 stress tests across 23 clearing member corporate groups, there was no scenario where the same two clearing members generated the largest margin shortfalls at more than one guaranty fund.
 - Where a particular scenario was the worst for a clearing member at a particular clearinghouse, the clearing member generally did not experience margin shortfalls at all clearinghouses.
 - If a clearing member incurred a large loss under a particular scenario at one clearinghouse, it generally did not incur losses at all clearinghouses, and in many cases had margin remaining across all clearinghouses under that scenario.

I. Background

A. The Importance of Clearinghouses in the Financial System

Clearinghouses have been an important part of our financial system, and the derivatives markets in particular, for many years. In the United States, futures have been cleared since at least 1891.¹ Indeed, the combination of exchange-based trading and central clearing have been critical factors which propelled the development of the United States futures markets. Even prior to the financial crisis, the five clearinghouses included in this exercise held over \$89 billion in initial margin for cleared futures and swaps.

Clearinghouses have assumed even greater importance in the global financial system following the financial crisis of 2008, as a result of the actions taken to address underlying causes of the crisis. Excessive risk related to the over-the-counter (OTC) swaps market contributed to and intensified that crisis—most notably with the huge losses incurred by the American International Group (AIG) in its portfolio of bilateral, uncleared swaps transactions. In response, the leaders of the G-20 nations agreed to reform the OTC swaps market by, among other things, requiring that more swaps transactions be centrally cleared.

The Dodd Frank Wall Street Consumer Protection Act ("Dodd-Frank") enacted this reform into law in 2010. The law authorized the CFTC to require that certain swaps be cleared. The CFTC issued the first such clearing requirement determination in December 2012 and an additional one this past September.² Many other jurisdictions have taken similar steps.

As a result, the number of swaps cleared and the size of the corresponding payments and margin deposits at clearinghouses have grown dramatically in recent years. Since 2008, the total initial margin for cleared futures and swaps held by clearinghouses that are registered with the CFTC has more than tripled to over \$300 billion.

In light of this increased importance, it is critical that clearinghouses be strong and resilient.

The CFTC has had a regulatory framework in place to oversee clearinghouses since well before passage of Dodd-Frank, and much work has been done since the passage of Dodd-Frank to enhance and strengthen this oversight.

This work has taken place both in the U.S. and internationally. For example, the CFTC adopted detailed new regulations to strengthen clearinghouses risk management, to promote financial integrity, to protect customer funds, and to require systemically important clearinghouses to meet additional standards.³ The CFTC also enhanced its own risk surveillance and oversight practices.

¹ Raymond Leuthold, The Theory and Practice of Futures Markets, Lexington Books (1989), at p. 22.

² Clearing Requirement Determination under Section 2(h) of the CEA, 77 FR 74284 (December 13, 2012); Clearing Requirement Determination under Section 2(h) of the Commodity Exchange Act for Interest Rate Swaps, 81 FR 71202 (Oct 14, 2016).

³ Derivatives Clearing Organization General Provisions and Core Principles, 76 FR 69334 (November 8, 2011); Derivatives Clearing Organizations and International Standards, 78 FR 72476 (December 2, 2013).

Internationally, regulators agreed on global standards set forth in the Principles for Financial Market Infrastructures ("PFMIs"), and have followed up with assessments of implementation of those standards. There is also substantial work taking place today, both domestically and internationally, on clearinghouse resilience, recovery, and resolution planning as well as on interdependencies between clearinghouses and their members.⁴

B. The Roles and Functions of Clearinghouses and Clearing Members

A key function of a clearinghouse is to substitute credit risk between the clearinghouse and its clearing members for the credit risk between the original counterparties to a trade. This process increases the liquidity of markets and enhances their financial integrity.

Only clearing members have settlement accounts with a clearinghouse. Proprietary positions of a clearing member are held in that member's "house" account at the clearinghouse. As discussed below, positions of market participants that are clients of a clearing member (and not affiliated with that clearing member) are held in that member's "customer" account at the clearinghouse.

To illustrate, consider a clearing member that executes a trade on a cleared market opposite a counterparty that is also a clearing member. In that case, the trade would be submitted to the clearinghouse and each clearing member would carry its side of the trade in its house account at the clearinghouse. The two clearing members would have no rights or obligations to one another under the trade. Each would have rights and obligations opposite the clearinghouse. If either clearing member failed to meet an obligation to the clearinghouse, the clearinghouse would nevertheless be required to meet its obligations to the other clearing member.

Now consider a market participant that is not a clearing member and that executes a trade on a cleared market. The market participant must establish arrangements with a clearing member to clear the trade on its behalf in a customer account at the clearinghouse. The clearing member would take on the obligations of the customer under the trade to the clearinghouse. In other words, the clearing member would be responsible for meeting the obligations of the customer under the trade to the clearinghouse regardless of whether or not the customer met its obligations to the clearing member.

The clearing member would carry the trade in its customer account at the clearinghouse.

In sum, a clearinghouse can transform a system that is a complex web of bilateral relationships into a simpler hub-and-spokes arrangement.⁵ This is illustrated in Exhibit 1.

⁴ In early 2015, the Basel Committee on Banking Supervision (BCBS), the Committee on Payments and Market Infrastructures (CPMI), the Financial Stability Board (FSB), and the International Organization of Securities Commissions (IOSCO) (the "Committees") agreed upon a work plan to coordinate their respective international policy work aimed at enhancing the resilience, recovery planning and resolution of clearinghouses, and to work in close collaboration. To support these efforts, the Committees also agreed to establish a joint study group to identify, to quantify and to analyze interdependencies between clearinghouses and major financial institutions and any resulting systemic implications. The work plan focuses on clearinghouses that are systemic across multiple jurisdictions. On August 16, 2016, three reports, covering monitoring of the implementation of the PFMIs, a consultation on further guidance on the PFMIs, and a discussion note on clearinghouse resolution, were issued in furtherance of this work. *See generally* http://www.fsb.org/wp-content/uploads/Progress-Report-on-the-clearinghouse-Workplan.pdf.

⁵ Peter Norman, The Risk Controllers, Wiley (2011) at p. 9.



Exhibit 1: Comparison of Uncleared and Cleared Markets

Thus, a clearinghouse, in its role as the "buyer to every seller, and the seller to every buyer," maintains a perfectly balanced book. That is, for all clearing members with long positions in a product, there are clearing members with combined short positions of exactly the same size.

Accordingly, it could be said that a clearinghouse's activity does not itself create new market risk. The market risk associated with clearing is a function of the risk taken on and brought to the clearinghouse by the individual clearing members. A clearinghouse will incur market risk only if and when a clearing member fails to meet a payment obligation to the clearinghouse. The credit risk that a clearinghouse takes is thus also that of its members.

Central clearing also provides a means to monitor and mitigate risk. The role of the clearinghouse is to make sure all members have posted sufficient margin or collateral at all times to cover trades in both their house and customer accounts. Clearinghouses also facilitate significant netting of positions, which tends to further reduce risk.

Although clearinghouses do not create new risk, they may be said to concentrate risk. Under the hub and spoke arrangement, many market participants are exposed to the credit risk of the clearinghouse. Therefore, clearinghouses must be subject to rigorous oversight.

As noted, clearinghouses maintain a balanced book at all times. Although clearing members also may try to maintain a balanced book, the degree of balance will depend on their actual customer and proprietary positions. Any given clearing member may be long or short overall in a particular product as a result of its customer and proprietary positions.

As is evident from the mechanics of the clearing process, clearing members are essential to the functioning of a clearinghouse. The types of measures that clearinghouses employ to protect themselves against the credit risk brought by their clearing members are discussed in the next section. As a general matter, they implement two principles: (i) in the first instance, the resources of a defaulter should be used to cover its obligations ("defaulter pays") and (ii) if, however, the defaulter's resources are insufficient, then a portion of the residual loss may be allocated among other clearing members ("loss mutualization").

C. Clearinghouse Risk Management Tools and Procedures

The Commodity Exchange Act ("CEA"), as amended by Dodd-Frank, requires certain clearinghouses that clear futures or swaps to register as derivatives clearing organizations.⁶ Each of the five organizations subject to this exercise is registered with the CFTC.

As noted above, the CFTC has issued an extensive set of regulations applicable to clearinghouses. They include requirements addressing financial resources and risk management procedures. They also include the reporting requirements that generated the bulk of the data used in conducting this exercise.

CFTC regulations require that clearinghouses that are systemically important or that are involved in activities with a more complex risk profile must have sufficient financial resources to meet what is known as a "cover-two" standard.⁷ All other clearinghouses must meet a "cover-one" standard.⁸

In accordance with these requirements, clearinghouses use a number of tools to minimize the risk that a clearing member will fail to meet a payment obligation. These requirements are also designed to enable the clearinghouse to maintain its business without interruption and to cover any losses if a clearing member does default.

These tools include, among others: (i) rigorous membership standards for clearing members, including capital and operational requirements; (ii) the daily collection and payment of losses and gains through variation margin settlements with all clearing members, which prevents losses from accumulating; (iii) the collection from all clearing members of risk-based amounts of initial margin which serve as performance bonds to cover with at least a 99% confidence level potential future losses and which amounts are adjusted at least daily; (iv) ongoing risk surveillance of clearing member positions and financial resources; (v) daily stress testing; and (vi) regular audits of clearing member financial resources and risk management procedures.

Clearinghouses have further tools and resources to use in the event that there is a default of a clearing member. These resources include: (i) the commitment of certain of the clearinghouse's own resources to cover default losses; (ii) the maintenance of guaranty funds to which all clearing members are required to make pre-funded contributions; and (iii) the ability to impose assessments on clearing members up to a specified amount—that is, to collect additional funds in the event the aforementioned resources are not enough. The clearinghouse also has a variety of actions it can take to deal with a default by a member that may not necessarily require the use of funds of any non-defaulting member, such as the ability to transfer or auction positions of a member in default. In very extreme cases, a clearinghouse has additional tools at its disposal to allocate losses and restore its matched book status in order to be able to continue to operate, as discussed below.

The CFTC's rules also impose requirements on clearing members not only to fulfill their obligations to the clearinghouse, but also to collect sufficient funds from their customers at all times. CFTC rules

 $^{^{6}}$ Section 5b(a) of the CEA. Under the Act, the CFTC has provided limited exceptions to registration for the clearing of proprietary trades in swaps by clearing members. See discussion below in section III A.

 $^{^7}$ CFTC Regulation 39.33(a)(1). See discussion of cover-two below in section II C 5.

⁸ CFTC Regulation 39.11(a)(1). See discussion of cover-one below in section II C 5

also impose other standards on clearing members with respect to, among other things, capital requirements, protection of customer funds and risk mitigation.

In the aggregate, the loss absorption resources of clearinghouses are very large. Unlike a bank, the key component is not the clearinghouse's own capital but rather a multilayered set of resources that includes variation margin, initial margin, clearinghouse capital contributions, guaranty fund contributions, and potential assessments of clearing members. That reflects the nature of the clearinghouse's business—which is essentially to interpose itself between the trades of its members and to implement strict and independent risk management procedures to insure that potential losses are covered.

Several of these tools are particularly relevant in connection with this exercise. Accordingly, they warrant further discussion.

1. Variation Margin

At least once each day, a clearinghouse determines a settlement price for every product that it clears. The settlement price represents the current market value of the product. Clearinghouses consider a number of factors in setting a settlement price. For liquid futures products, it is typically grounded in actual trade prices that occurred at or near the close of a trading session between buyers and sellers.

The clearinghouse then "marks to market" all open positions by calculating the change in value from the previous time that the product was marked to market. All losses are collected and all gains distributed. That is, the clearinghouse requires any clearing member that has a loss—whether on its own behalf or on behalf of its customers collectively—to pay variation margin, and the clearinghouse also pays any clearing member that had a gain for itself or for its customers overall. Because the clearinghouse's book is matched, the losses collected equal the gains paid. Because this process is done for all clearing members, and thus indirectly for all customers of all clearing members, at least every day, it prevents any trader from accumulating losses for more than one day.

The daily transfer of gains and losses is referred to as variation margin. At some clearinghouses, there is also an intraday payment and collection of variation margin. This may occur regularly or only in times of unusual volatility.

2. Initial Margin

A clearinghouse also holds initial margin from its clearing members as a performance bond to cover potential future losses in the value of open positions. Initial margin requirements are calculated using sophisticated statistical models. Pursuant to CFTC regulations, clearinghouses must design their initial margin models to capture at least 99% of all price changes during a set time period known as the margin period of risk. The period typically ranges from one to five days depending on the product. Clearinghouses in some cases collect more than the regulatory minimum.

As market volatility changes, initial margin requirements are adjusted as necessary. Each day, the clearinghouse will collect any shortfall in the initial margin required from each member. In many cases, clearing members post excess funds above the initial margin requirement to the clearinghouse, usually for operational convenience.

CFTC rules require clearing members to collect initial margin from a customer for a customer trade, and to post initial margin (whether for a customer trade or a proprietary trade) with the clearinghouse for every transaction. CFTC rules also require the collection from customers of more margin than is required by the clearinghouse. The amount may vary by clearinghouse and by product but generally it is at least 10% more.

CFTC rules further require that clearing members post initial margin to the clearinghouse on a "gross" rather than "net" basis. That is, a clearing member cannot net the positions of its customers against one another, or net its customer positions with its proprietary positions, and thereby post less initial margin to the clearinghouse.⁹

3. Investment and Value of Margin Held by the Clearinghouse

CFTC rules require that clearinghouses hold initial margin deposited for a clearing member's house account separately from initial margin posted for the clearing member's customer account. CFTC rules also establish restrictions on the types of investments that can be made by a clearing member or a clearinghouse with customer funds that have been deposited with the clearing member or the clearinghouse.

The Federal Reserve System has issued notification stating that systemically important clearinghouses are authorized to maintain accounts for house and for customer funds at a Federal Reserve Bank.¹⁰

CFTC rules require clearinghouses to impose prudent haircuts on the value of non-cash instruments posted as initial margin. When a clearinghouse reports initial margin amounts to the CFTC, it reports the value as reduced by the haircut.

4. Committed Clearinghouse Resources

Each of the clearinghouses included in this exercise has committed a specified amount of its capital for use in covering a default ("clearinghouse contribution"). The clearinghouse contribution would typically be consumed before the guaranty fund contributions of non-defaulting clearing members. This is governed by each clearinghouse's rules.

Current CFTC regulations require that the board of directors of a systemically important clearinghouse, or a clearinghouse that has elected to be subject to Subpart C of Part 39 of the Commission's regulations, shall make certain that the clearinghouse's design, rules, overall strategy and major decisions appropriately reflect the legitimate interests of clearing members, customers of clearing members, and other relevant stakeholders but do not specify that a clearinghouse commit a

⁹ This exercise started before U.S. clearinghouses implemented changes to initial margin related to the CFTC's accord with the European Commission pertaining to clearinghouse oversight and the European Commission's s equivalence determination. See European Commission Implementing Decision (EU) 2016/377 (March 15, 2016), available at http://eurlex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32016D0377. Under this agreement, among other things, US clearinghouses seeking recognition must show that the initial margins collected for house positions use a minimum two-day period of risk as is the case in Europe; and Europe has modified its rules so as to permit European clearinghouses to follow gross rather than net posting for customer accounts.

¹⁰ See Federal Reserve Release H.2. Actions of the Board, Its Staff, and the Federal Reserve Banks: Applications and Reports Received, No. 43 (Oct 22, 2016). The CFTC recently issued an order to facilitate this. Order Exempting the Federal Reserve Banks From Sections 4d and 2d of the Commodity Exchange Act, 81 FR 53467 (Aug 12, 2016).

particular amount of capital.11 The extent to which a clearinghouse should include a specific amount of its own resources is a topic under active discussion in the international regulatory community.

5. Guaranty Funds

A guaranty fund is a mutualized pool of resources that is available to cover defaults. It is pre-funded by clearing member contributions. Each of the clearinghouses included in this exercise has at least one guaranty fund as a component of its financial resources framework. In each case, the clearinghouse requires clearing members to contribute to the clearinghouse's guaranty fund pursuant to a formula that includes the clearing member's trade volume and/or overall initial margin requirement.

Some clearinghouses that clear products in multiple asset classes have established separate guaranty funds for some of the asset classes. For example, some clearinghouses have separate funds for futures products and swaps. This mitigates the chance that clearing members that do not clear certain products would be subject to the risks associated with those products.

Clearing members are required to pre-fund contributions to the guaranty fund for each asset class that they clear. CFTC regulations, and international standards, require that clearinghouses that are systemically important in multiple jurisdictions, or that clear products with a more complex risk profile, have guaranty funds at least large enough to cover the default of the two clearing members, and their affiliates, that would cause the largest aggregate loss, after deduction of the initial margin of those two clearing members and their affiliates. This is known as the "cover-two" standard. For other clearinghouses, CFTC regulations require a "cover-one" standard. Each of the clearinghouses in this exercise is subject to the cover-two standard.¹²

No guaranty fund of a clearinghouse registered with the CFTC has ever been used to cover a default. Although there have been clearing members that have defaulted on payments, CFTC-registered clearinghouses have uniformly covered losses by using the margin of the clearing member in default, coupled with actions taken to transfer or auction positions. For example, even when Lehman and MF Global were declared to be in default, no mutualized guaranty fund resources were used.

6. Sequence of Resource Use in a Default

In the event that a clearing member fails to meet an obligation to a clearinghouse or is deemed to be insolvent by the clearinghouse, the clearinghouse typically would declare the clearing member to be in default under the rules of the clearinghouse. Clearinghouse rules specify the sequence in which resources are drawn upon and clearinghouses registered with the CFTC follow a similar design discussed below. These generally reflect the "defaulter pays" principle noted earlier.

The initial margin of the clearing member in default is the first resource a clearinghouse would draw upon to cover any loss. The CEA and CFTC regulations contain a number of provisions requiring the segregation of customer positions and funds from house positions and funds. Section 4d(a) of the

¹¹ Clearinghouses that are also subject to European regulations would be required to commit an amount as specified under those rules.

¹² ICEU and LCH are subject to the cover-two standard under European law.

CEA and implementing regulations set forth the requirements for futures. Section 4d(f) of the CEA and implementing regulations set forth the requirements for swaps.

Pursuant to the customer segregation requirements, initial margin in the customer account may not be used to cover losses in a house account. Moreover, in the case of swaps, initial margin attributed to one customer may not be used to cover losses attributed to the positions of another customer. Initial margin in the house account, however, may be used to cover losses in a customer account.

If initial margin were insufficient to cover a loss, the clearinghouse would next draw on the guaranty fund contribution of the clearing member in default. If that was insufficient to cover the remaining loss, the clearinghouse would draw on a pre-determined portion of its own capital. If there was still a loss, the next layer of protection would be the guaranty fund contributions of non-defaulting clearing members.

The resources described above are all pre-funded. Clearinghouses have additional tools that did not come into play in this exercise (and which have never been used by a clearinghouse registered with the CFTC). They include procedures such as "assessment powers" under which a clearinghouse can call on its clearing members to deposit additional funds in the event the guaranty fund is exhausted. The clearinghouse also generally has the right, consistent with CFTC rules to engage in gains-based haircutting under which a clearinghouse can pay less than the full amount of all gains in its daily settlement of gains and losses through variation margin.

Separately, the clearinghouse would try to hedge and then liquidate or auction the house positions of the defaulter. Any customer positions that could not be ported to another clearing member would also be liquidated or auctioned.

Where the clearinghouse is unable to liquidate a defaulter's positions within available resources, the clearinghouse generally would also have the right to "tear up" contracts to restore its matched book. Variation margin haircutting and tear-ups are extreme tools that have also never been used.

7. Stress Testing

Stress testing is a technique used by traders, clearing members, clearinghouses and regulators to estimate potential losses under extreme but plausible market events. Stress tests estimate the potential losses for a house or customer account based on actual positions in such accounts and hypothetical price changes to those positions. It is difficult to assess risk without conducting regular stress testing of positions. The "extreme but plausible" standard attempts to identify the worst outcomes that could reasonably occur in the market based on actual historical, as well as hypothetical, events.

Stress tests can be constructed in many ways. Common stress tests methods include using the largest price change that has occurred historically on a dollar or a percentage basis, using a price change based on a number of standard deviations calculated using historical data, and using a price change that occurred on specific dates such as September 11, 2001.

Stress testing is used to evaluate the sufficiency of financial resources that are available for use by the customer, the clearing member, and/or the clearinghouse to meet obligations under the contract. The changes in value of the position under the extreme scenarios are compared to the financial resources

available to meet any losses. If the stress test identifies a potential shortfall, a reduction in the position or an increase in financial resources may be warranted.

Clearinghouses use stress tests to assess the risks of clearing members and customers, including customers that clear through multiple clearing members. Because some large customers clear positions at multiple clearing members, the only way that a clearinghouse can assess risk of a particular customer is to look at their activity across all clearing members. Clearinghouses also use stress tests to calibrate or adjust initial margin and guaranty fund requirements.

D. CFTC Risk Surveillance Program

CFTC regulations require clearinghouses to make extensive daily reports, containing information on clearing member and customer positions and activity to the Commission. CFTC regulations also require reporting by clearing members and large traders. As a result the CFTC has the benefit of being able to see positions across clearing members and clearinghouses. Therefore, the CFTC can analyze positions and risks at the clearinghouse, clearing member or customer level, including customer positions at more than one clearing member, and clearing member positions at more than one clearing house.

The CFTC risk surveillance program focuses on identifying, quantifying, and monitoring the risks posed by clearinghouses, clearing participants, and other market participants to the financial system. Toward this end, on a daily basis, staff in the CFTC risk surveillance program works to: (1) identify positions in cleared products that pose significant financial risk; and (2) confirm that these risks are being appropriately managed. Staff undertakes these tasks at the customer level, the firm level, and the clearinghouse level. That is, staff identifies both customers that pose risks to clearing members and clearing members that pose risks to clearinghouses.

One or more staff members are assigned to review the risk related to each futures, CDS and IRS asset class covered by this report. Additionally, staff members are assigned to evaluate systemic risk and to manage the large amounts of data received daily.

Staff attempts to be proactive rather than reactive. Accordingly, staff identifies customers and clearing members who might pose risk before a market becomes volatile not just after the volatility appears. A number of different characteristics may trigger further scrutiny.

- a. Absolute size of position
- b. Size of short option position
- c. Size relative to the market
- d. Size relative to the clearing member's capital
- e. Size relative to the initial margin on deposit
- f. Size relative to the customer's assets
- g. Size relative to a clearinghouse's resources
- h. Cumulative size across multiple markets
- i. News about a particular trader or clearing member

Staff engages with customers, clearing members and clearinghouses to follow up on issues of concern. After identifying potential risks at customers or clearing members, staff estimates the magnitude of the risk and compares the calculated risk to available assets. Stress testing applications enable the staff to estimate how much a position would lose in a variety of circumstances such as extreme market moves. Staff is continually refining stress test scenarios for the wide range of markets subject to CFTC oversight.

E. Objectives of the Supervisory Stress Testing in this Exercise

The objective of the stress tests in this exercise was to analyze the effects of a set of uniform scenarios across multiple large clearinghouses and clearing members. Staff calculated the potential losses or gains that large clearing members would face under such scenarios, and evaluated those losses or gains across multiple clearinghouses. In addition, staff evaluated the sufficiency of the pre-funded resources of individual clearinghouses in the context of a multi-clearinghouse exercise in the event clearing members defaulted on their positions under such scenarios.

An important difference between the stress tests described in this exercise and those required by prudential regulators for banking institutions is the time period covered. Generally, under prudential stress tests for banking institutions, the time period covered is longer and intended to reflect a more gradual deterioration in economic or business conditions. This in turn may lead to decline in asset values and an increase in delinquency rates which is then assessed in relation to bank capital. For systemically important institutions that have large trading activity, however, the prudential stress tests also include shocks to the trading book that are assumed to occur instantaneously.

As discussed earlier, a clearinghouse marks to market on a daily basis every product it clears, and it requires all clearing members to pay additional variation margin as well as to post additional initial margin as necessary. If that margin is not provided immediately the clearinghouse would then take action to deal with the default, using the defaulter's resources and then the mutualized resources described earlier. Losses cannot be allowed to accumulate. Thus, stress testing typically focuses on extreme single day movements rather than more gradual declines in order to determine appropriate margin and guaranty fund levels.

The stress tests conducted by the European Securities and Markets Authority ("ESMA") in its 2015 stress test exercise ("ESMA Report"),¹³ measured the impact of extreme price movements in a single trading day.¹⁴ The price changes were applied as instantaneous shocks, but were calibrated using a liquidation period of at least two days. Similarly, the stress tests in this exercise were applied as instantaneous shocks but in many instances were calibrated using a liquidation period of more than one day.

¹³ ESMA, Report on EU-wide Stress Test (April 29, 2016).

¹⁴ This is not to suggest that multi-day tests would not also be useful. ESMA also noted that in the future, it would be beneficial to conduct a clearinghouse stress test over more than one day. The CFTC agrees with ESMA in that extreme market movements can often cover more than one trading day. Although futures and option risk can usually be managed within a single trading day, swaps risk can extend to two or more trading days. Therefore, it would be beneficial to stress test for a period of risk of two or more days. The CFTC intends to do this in future exercises.

As noted previously, international groups are currently engaged in developing standards related to stress testing. First, CMPI-IOSCO has published guidance on the PFMIs for consultation by the public. This guidance addresses, among other things, stress testing by clearinghouses. Second, CPMI-IOSCO also has formed a working group to address supervisory stress testing of clearinghouses by regulators. This effort is in the early stages. Members of the CFTC staff are active participants in and strongly support both efforts.

In both cases, this international work was not as far along when this exercise was commenced as it is now. The approaches taken by CFTC staff in the course of conducting this exercise should not be construed as expressing a final view on issues that may arise in the course of completing the international work. The experience gained by staff in this exercise may be helpful in moving that work forward and the analysis developed by the international groups will be taken into account by the CFTC in future exercises.

In addition, the approaches taken in this exercise should not be construed as establishing standards for clearinghouses in conducting their own stress testing. This exercise was undertaken to assess systemic risk, not to grade individual clearinghouses. Moreover, a number of simplifying approaches were taken to facilitate completion of the exercise. Staff intends to apply additional levels of complexity in future exercises. Each clearinghouse should continue to conduct its own rigorous stress tests in accordance with applicable legal standards.

This exercise addresses the risks of clearing member default. Clearinghouses also face other types of risk such as liquidity risk, operational risk, and cyber security risk. Those risks are outside the scope of this report.

F. Size and Composition of Markets Subject to the Exercise

As noted above, the size of cleared markets has grown significantly in light of the reforms adopted after the financial crisis. Exhibit 2 below shows the total initial margin in the covered products by asset class at the five clearinghouses on April 29, 2016, the as-of date for this exercise.¹⁵

¹⁵ The selection of this date is explained in section III.D below.



Exhibit 2: Total Initial Margin Requirements on April 29, 2016

Exhibit 3 shows the breakdown between futures and swaps initial margin as of the end of each of the last three years and the date of this exercise. The figure illustrates that both aggregate futures and aggregate swaps margin have increased in recent years and that swaps margin has increased more dramatically over this period and is now on a par with futures margin.



Exhibit 3: Increase in Futures and Swaps Margin

Within the swap category, most of the increase in aggregate margin can be attributed to interest rate swaps ("IRS"). Cleared IRS margin has increased from \$54 billion in 2013 to \$110 billion at CME and LCH on the as-of date of this exercise. ¹⁶ By contrast, cleared credit default swaps ("CDS") margin has seen smaller increases. Cleared CDS margin has increased from \$23 billion in 2013 to \$28 billion on the as-of date of this exercise.



Exhibit 4: Relative Growth of IRS and CDS Margin

The CFTC's first clearing requirement determination for specified classes of IRS and CDS took effect over the course of 2013, but market participants had begun clearing some IRS and CDS voluntarily prior to that year. In addition, the markets for IRS and CDS differ in terms of use by type of market participant and use of particular products.

¹⁶ Changes in margin requirements can be due to changes in the size of cleared positions or changes in volatility and margin rates.

II. Methodology

A. Clearinghouses

The clearinghouses included in the exercise are set forth in Exhibit 5.

Clearinghouses	Acronym
CME Clearing	CME
ICE Clear Credit	ICC
ICE Clear Europe	ICEU
ICE Clear U.S.	ICUS
LCH Clearnet Ltd	LCH

Exhibit 5: List of Clearinghouses

CME, ICC, and ICUS are based in the U.S. CME and ICC have been designated as systemically important by the Financial Stability Oversight Council ("FSOC") pursuant to Section 804 of the Dodd-Frank Act along with six other financial market utilities. The statutory criteria under which FSOC considered whether a clearinghouse or other financial market utility might be or become systemically important included factors such as monetary value of transactions processed, exposure to counterparties, and effects that failure could have on the markets, institutions, and the broader financial system. As a result of FSOC's designation, the designated entities are subject to heightened supervision and requirements by their primary regulator and supervision by the Federal Reserve Board.

CME clears futures in multiple asset classes, as well as IRS and CDS. ICC clears exclusively CDS products. ICUS clears futures in several asset classes.

ICEU and LCH are based in London. ICEU clears futures in several asset classes as well as CDS. LCH clears futures and swaps as well as other products such as repurchase agreements.

As measured by initial margin required on April 29, 2016, these five clearinghouses cumulatively cleared approximately 98% of all futures contracts cleared by CFTC-registered clearinghouses and approximately 98% of all cleared swaps cleared by CFTC-registered clearinghouses. (Those percentages refer to the total futures and swaps that are required to be cleared at a registered derivatives clearing organization; clearinghouses may also clear other products.¹⁷) The remainder of

¹⁷ Three of the clearinghouses also clear other products that are not required by the CEA to be cleared at a registered derivatives clearing organization. ICC clears single-name CDS products which are security-based swaps subject to the jurisdiction of the Securities and Exchange Commission. ICEU clears non-U.S. futures as well as single-name CDS. LCH clears repurchase agreements. Those products were not included in calculating the 98%. The products included in the exercise are discussed further in section III B below.

the volume of cleared futures and swaps products cleared by CFTC-registered clearinghouses is distributed among 9 other clearinghouses. 18

These five clearinghouses operate a total of eight guaranty funds for the covered products. CME has separate guaranty funds for IRS, CDS, and a base guaranty fund covering futures and options and certain commodity swaps. ICEU has separate guaranty funds for futures and CDS. LCH has a guaranty fund for IRS that is segregated from its guaranty funds for other products. ICC has a guaranty fund for CDS, and ICUS has a guaranty fund for futures. Exhibit 6 summarizes this information.

Guaranty Funds	Clearinghouses					
	<u>CME</u>	<u>ICC</u>	<u>ICEU</u>	<u>ICUS</u>	<u>LCH</u>	
Credit Default Swaps	\checkmark	\checkmark	\checkmark			
Interest Rate Swaps	\checkmark				\checkmark	
Futures	\checkmark		\checkmark	\checkmark		

Exhibit 6: Guaranty Funds by Clearinghouse

B. Products

1. Futures

The clearinghouses that clear futures list a total of more than 1800 products that have open interest.¹⁹ Some products have very large amounts of open interest and consequently represent large amounts of margin collected, while others may have little trading and consequently little or no open interest or margin. Products in the latter category do not pose significant risk to a clearinghouse.

The contract set in this exercise includes futures and options on futures in the following commodity groups: agriculture (including "softs"),²⁰ currency, energy, equity, interest rates, and metals. Some clearinghouses do not clear products in all six product categories, and thus the product categories covered vary by clearinghouse.

At CME, the exercise covered futures products in all six commodity categories. Staff selected the contracts representing the largest positions in each product category. For example, the exercise included corn, wheat, and soybean futures but not oat futures.

¹⁸ Cantor Clearinghouse, L.P.; Eurex Clearing AG; LCH Clearnet SA; Minneapolis Grain Exchange, Inc.; Natural Gas Exchange, Inc.; Nodal Clear, LLC; , North American Derivatives Exchange, Inc.; Options Clearing Corporation; and Singapore Exchange Derivatives Clearing Limited. This exercise also does not include exempt derivatives clearing organizations. Under section 5b(h) of the CEA, the CFTC has exempted certain foreign clearinghouses from the requirement to register as a derivatives clearing organization with respect to the clearing of swaps for their clearing members who are U.S. persons as long as they comply with certain limitations on their business and other requirements. These entities today are ASX Clear, Japan Securities Clearing Corporation, Korea Exchange Inc, and OTC Clearing Hong Kong.

¹⁹ The term "product" is defined by reference to the essential economic terms and conditions of the contract. A single futures product can have multiple delivery months. Similarly, a single option product can have multiple strike prices.

²⁰ "Softs" is a term used in the industry in reference to certain agricultural commodities such as coffee, sugar, and cocoa.

At ICUS, the exercise covered agricultural, equity, and foreign exchange futures products. Again, staff selected the contracts representing the largest positions in each product category. Staff also added less liquid, related contracts that, when traded, are frequently included in spread positions with the more liquid contracts. For example, staff selected the Russell 2000 contract and the MSCI Europe and MSCI Emerging Markets contracts.

At ICEU, the exercise covered only energy futures products. Again, staff selected the contracts representing the largest positions. It did not include futures in other asset classes. Those contracts are traded on non-U.S. exchanges and are not required by U.S. law to be cleared at a clearinghouse registered with the CFTC.

At LCH, the exercise did not include any futures products. As with ICEU, staff did not include futures that are traded on non-U.S. exchanges and are not required by U.S. law to be cleared at a clearinghouse registered with the CFTC.

A complete list of the futures contracts included in the exercise is shown in Exhibit 8.

2. Swaps

The CDS products cleared by CFTC-registered DCOs are broad-based index CDS, in which the seller writes protection on a basket of underlying corporate or sovereign debt instruments. Single-name CDS are subject to the jurisdiction of the U.S. Securities and Exchange Commission. Some clearinghouses, however, calculate initial margin for CDS indices on a portfolio basis along with CDS single name products. In addition, those products are cleared by the same clearing members and are in the same guaranty fund as the CDS index products. Therefore, as described below, the single-name CDS products were included in the exercise at some clearinghouses.

At CME, the exercise covered IRS and index CDS. CME does not clear single-name CDS. The exercise did not cover commodity swaps because they do not have large volume or open interest.

At ICC, the exercise covered CDS, both index and single-name. At ICEU, the exercise also covered CDS, both index and single-name.

At LCH, the exercise covered IRS. The exercise did not include foreign exchange swaps. Staff excluded these because (i) they are in a separate default fund and (ii) initial margin for these products as of the exercise date was not material relative to the other clearing services included in the exercise.

C. Clearing Firms

The exercise covered the house accounts and the customer accounts of 23 corporate groups that hold clearing memberships at the five clearinghouses. In light of the computational complexity of the exercise, the analysis was limited to the clearing members that hold the positions requiring the largest amount of initial margin, and the members were chosen as described below. Collectively, these 23 corporate groups post approximately 88% of the total initial margin required by the five clearinghouses.

Large financial institutions often hold multiple clearing memberships at clearinghouses. For instance, a bank might clear proprietary positions directly while customer positions would be cleared

through an affiliate. Consistent with both CFTC regulations²¹ and international standards,²²clearing members who were affiliated were aggregated at the corporate group level for purposes of identifying effects across clearinghouses.

To determine which firms would be included in the exercise, DCR staff ranked clearing members at each clearinghouse according to the amount of initial margin required on the as-of date. House and customer accounts were combined for purposes of identifying the largest firms. If a clearing member was in the top 15 clearing members by amount of initial margin required at any clearinghouse, it was included in the analysis not only for that particular clearinghouse, but for all five clearinghouses. This was done in order to allow for an analysis of the impact of a default by that clearing member across all five clearinghouses. This analysis resulted in the inclusion of 23 firms.

D. Data Sources

In conducting this exercise, staff primarily used data that is routinely reported by clearinghouses pursuant to CFTC regulation 39.19 and by large traders and clearing members pursuant to Part 15 of CFTC regulations. Among other things, these regulations require daily reporting of position and margin information and quarterly reporting of guaranty fund information. In a few instances involving non-U.S. clearinghouses, that data was supplemented by additional information provided by the clearinghouses upon the request of DCR staff.

The as-of date for positions and margin was April 29, 2016. This was the most recent month-end date at the time staff work on the exercise commenced in the spring of 2016. The amount of initial margin held on that date was not unusual relative to recent periods. To confirm that this date was not unusually high or low, the staff also compared month-end amounts from January 2016 through June 2016 and found that they did not vary by more than 3% from the month-end amount for April 2016.

The as-of date for guaranty fund information was March 31, 2016. This was the quarterly reporting date nearest to the position and margin as-of date. Similarly, the guaranty fund amount on that date was representative. The quarterly amounts from December 2015 and June 2016 did not vary dramatically from the amount for March 2016. 23

E. Stress Test Scenarios

1. Factors Considered

Staff constructed several hypothetical scenarios for purposes of these tests. In developing the scenarios, staff took a number of factors into account. First, staff identified the largest historical oneday price changes for each of the products included in the exercise. Second, staff reviewed the internal catalogue of stress tests that it has developed for the daily risk surveillance of individual clearinghouses, clearing members, and large customers. Third, staff reviewed the price changes used

²¹ See Reg. §39.33(a)(4) ("For purposes of this section [on financial resource requirements and coverage requirements], if a clearing member controls another clearing member or is under common control with another clearing member, such affiliated clearing members shall be considered to be a single clearing member." ²² See PFMI Principle 4, Key Consideration 4 (referring to "participant(s) and its (their) affiliates").

²³ For example, the amounts as of June 30, 2016 differed by less than 1% in four cases. In three cases, they differed by less than 5%. In one case, the guaranty fund changed by 14%. Of course, positions and margin would have changed as well.

by the clearinghouses in their internal stress testing. Fourth, staff reviewed the price changes used in the ESMA Report.

Fifth, staff reviewed the price changes and correlations across markets that occurred on specific dates when there was extreme volatility. For example staff looked at September 15, 2008 (the default of Lehman Brothers), October 13, 2008 (worldwide action to address financial crisis), October 21, 2008 (post-crisis recession fears), and June 24, 2016 (the day after the Brexit vote).

Exhibit 7 gives price changes expressed as percentages of the prior day's price across various products for a few of these historical events. Numbers in parentheses represent downward movements.

Futures	Event/Date							
	Lehman Collapse	Worldwide Action to Address Crisis	Post Crisis Recession Fears	Brexit				
	9/15/2008	10/13/2008	10/21/2008	6/24/2016				
S&P 500 Futures	-5.0	14.1	-3.1	-4.1				
10 Year Treasury Futures	1.9	-1.1	1.3	1.2				
WTI Crude Oil Futures	-5.4	4.5	-4.5	-4.9				
Gold Futures	3.0	-1.9	-2.7	4.7				
Soybean Futures	-4.5	2.0	-2.3	-1.9				
Sugar Futures	-1.8	4.2	-2.3	-0.2				

Exhibit 7: Price Changes on Dates of Extreme Volatility (as percentage of prior day's price)

2. Magnitude of Price Changes

Staff applied extreme price changes on a product by product basis. In most cases, the size is expressed in terms of percentage of value, but in a number of instances it is expressed in basis points ("bps") in accordance with conventional usage in the industry.

The futures stress test amounts are set forth in Figure 8. In most cases, the price changes equal or exceed the largest observed in the last 30 years. In a few cases, staff considered whether the largest historical move was appropriate given the current macroeconomic context. For example, in the case of stock index futures, changes since 1987 include the addition of exchange circuit breakers and the emergence of electronic trading. While the S&P 500 declined over 28% in one day in October of 1987, it has not declined over 10% on any day in the last 20 years. In the fourth quarter of 2008, a period of high volatility, the S&P 500 experienced some the largest daily price changes since 1987 and the largest three up and down moves in the last 20 years. None of these price changes exceeded the S&P levels used in this exercise.

Similarly, the largest historical increase in the Eurodollar futures price was 116 bps. But this occurred in 1987 when interest rates were above 9 percent. A price change of 116 bps would represent a much larger change as a percentage in the current low interest rate environment. Therefore, staff designed

a stress test that shocked Eurodollar futures up and down 40 bps, which is comparable as a percentage move.

In addition to stresses on futures prices, staff applied a 50% increase in the implied volatility of all options on the futures contracts in Exhibit 8. For example, a contract with an implied volatility of 30% would be increased to 45% after applying the stress. This is the shock used by several clearinghouses in their internal stress tests. It is also the increase in implied volatility that accompanied Brexit, as measured by the CBOE Futures Exchange Volatility Index contract commonly referred to as the VIX. By way of comparison, at the time of the Lehman collapse implied volatility increased by 23%.

Exhibit 8: Futures Stress Test Amounts (as percentage of prior day price except where noted)

Contract	Stress Up	Stress Down	Highest Historical Change		Lowest Historica Change	
S&P 500	15	-20	10/21/1987	19.4	10/19/1987	-28.6
Russell 2000	15	-15	10/28/2008	10.0	12/1/2008	-11.9
S&P 400 Midap	15	-20	10/13/2008	10.5	12/1/2008	-10.9
MSCI EAFE	10	-10	10/29/2008	8.6	10/10/2008	-8.4
MSCI Emerging Markets	11	-11	10/30/2008	10.6	10/6/2008	-9.5
MSCI Europe	10	-10	10/13/2008	10.1	10/6/2008	-7.6
Nasdaq 100	20	-20	1/3/2001	18.8	9/29/2008	-10.5
10 YR	2.5	-2.5	3/18/2009	3.6	9/19/2008	-2.4
5 YR	2	-2	3/18/2009	2.0	9/19/2008	-1.9
Eurodollar	0.4 (price)	-0.4	10/20/1987	1.16 (price)	3/17/1989	-0.40 (price)
30 year	3	-3	3/18/2009	4.1	9/19/2008	-3.0
2-year	1.15	-1.15	9/15/2008	0.9	3/1/2002	-1.0
30-day fed funds	.22 (price)	22	1/22/2008	0.52 (price)	9/19/2008	-0.22 (price)
Natural Gas	25	-25	7/31/2006	14.3	2/5/2001	-15.4
Crude Oil	20	-20	12/31/2008	14.3	1/7/2009	-12.3
Heating Oil	20	-20	9/19/2005	11.0	11/15/2001	-9.0
Gasoline	20	-20	7/8/2008	13.9	3/9/2015	-14.9
Brent Oil	15	-15	12/11/2008	11.8	9/24/2001	-13.4
GasOil	15	-15	1/5/2009	11.9	9/24/2001	-13.2
Gold	10	-10	9/17/2008	9.0	4/15/2013	-9.4
Copper	13	-13	10/29/2008	12.4	10/13/2004	-11.1
Silver	18	-18	3/19/2009	13.0	9/23/2011	-17.8
Corn	15	-15	9/15/2009	9.0	4/1/2013	-7.6
Wheat	17	-17	10/29/2008	9.2	1/12/2009	-9.5
Live Cattle	10	-10	6/15/2006	3.8	12/30/2003	-6.2
Soybean	15	-15	10/8/2010	6.6	6/30/2014	-5.8
Soybean Meal	15	-15	10/27/2014	7.6	7/16/2007	-7.5
Soybean Oil	10	-10	2/22/2005	8.4	10/22/2008	-7.0
Sugar	15	-15	2/23/2016	11.0	7/26/1988	-16.7
Coffee	20	-20	10/13/1999	23.6	7/20/2000	-12.1
Cotton	12	-12	6/25/2001	12.0	11/23/2010	-7.2
Сосоа	10	-10	10/5/2009	8.0	10/18/2002	-9.5
Hogs	10	-10	12/14/1998	7.1	12/15/1998	-6.7
Euro	6	-6	12/3/2015	3.4	12/19/2008	-3.0
GBP	6	-6	10/29/2008	3.4	1/20/2009	-5.0
U.S. Dollar	3	-3	12/19/2008	2.3	3/18/2009	-2.7
Yen	6	-6	5/6/2010	5.3	10/28/2008	-3.9
Mexican Peso	10	-10	10/9/2008	7.3	10/13/2008	-6.4
Aussie Dollar	10	-10	10/13/2008	8.6	10/24/2008	-7.0

The IRS stress test amounts are set forth in Exhibit 9. For U.S. dollar-denominated swaps, staff used a 60 bp move. The largest 1-day historical change in IRS rates at any single tenor point in the past 30 years has been 46 bps. IRS were shocked more than the largest historical one-day change under the presumption that it would take longer to resolve a default in the IRS portfolio than a default in the interest rate futures portfolio because of the depth of liquidity in the futures markets and the comparative standardization of futures products.

For Euro-denominated IRS, staff used 30 bps. The largest 1-day historical change in EURdenominated IRS rates at any single tenor point in the past 30 years has been 40 bps. However, that occurred when the level of rates for the 30-year tenor was 3.23% compared to approximately 1.24% on April 29, 2016.

For GBP-denominated IRS, staff used 30 bps. On the day following the Brexit referendum in the United Kingdom, the largest change in any single tenor point for GBP-denominated IRS was 31 bps. The average across all tenors was 26 bps.

This exercise included parallel shifts in the interest rate yield curve but it did not include changes in its shape. For that matter, changes in shapes of forward curves were not stressed for any products. Capturing curve risk and spread risks within product groups would require an exponential increase in the number of scenarios, especially considering that scenarios were synchronized across asset classes. Nevertheless, staff expects to include those types of scenarios in future exercises.

Currency	Jurisdiction	Interest Rates (bps)	FX (%)	
AUD	Australia	60	10	
BRL	Brazil	60	10	
CAD	Canada	60	1.5	
CHF	Switzerland	30	0	
CZK	Czech Republic	30	0	
DKK	Denmark	30	0	
EUR	Europe	30	6	
GBP	Great Britain	30	6	
HKD	Hong Kong	60	2.4	
HUF	Hungary	30	0	
JPY	Japan	15	6	
MXN	Mexico	90	10	
NOK	Norway	30	0	
NZK	New Zealand	60	2.9	
PLN	Poland	30	0	
SEK	Sweden	30	0	
SGD	Singapore	60	2.4	
USD	United States	60	0	
ZAR	South Africa	60	2.6	

Exhibit 9: Interest Rate Swaps Stress Test Amounts

The CDS stress test amounts set forth in Exhibit 10 represent CDS spread moves expressed as percentages. In the parlance of the CDS markets, widening means that the risk of default by the issuers of the instruments has increased; tightening means that the risk has decreased. For widening, staff used extreme moves that occurred over several days during the 2008 - 2009 financial crisis. For tightening, staff used extreme hypothetical moves that are larger than the most extreme historical moves, but are nonetheless plausible. These shocks have been used by relevant clearinghouses in their own stress testing.

Sectors	Widening (%)	Tightening (%)
Asia Pacific Sovereigns	75	
Basic Materials	75	-40
CDX	45	
CDXEM Sovereigns	60	-45
CDXNAHY	45	
CDXNAIG	45	-20
CDXNAIGHVOL	45	
Consumer Goods	50	-25
Consumer Services	70	
Corporate	65	-40
Emerging Market Sovereigns	100	
Energy	70	-30
Financials	120	
Healthcare	65	-30
Industrials	75	
iTraxx	50	-25
iTraxx Asia IG	50	
iTraxx Australia	50	-25
iTraxx Eur	50	
iTraxx Eur HiVol	40	-20
iTraxx Eur Xover	30	
ITRAXX FINSEN	60	-30
Technology	65	
Telecommunications	65	-30
Utilities	75	
Western European Sovereigns	75	-30

Exhibit 10: Credit Default Swaps Stress Test Amounts

3. Correlation Across Markets

In designing scenarios, staff reviewed historical correlations across markets. For example, in a "flight to quality" scenario, equity futures would be down while interest rate futures would be up. By contrast, in a scenario where financial firms were trying to raise cash, both would be down.

In determining the direction of the stress test price shocks, staff focused on the most liquid futures contracts within each asset class. These contracts were used as a proxy in determining the direction of price shocks for equities, energy, metals, agriculture, softs,²⁴ interest rates, and currencies.

 $^{^{24}}$ As noted, "softs" is a term used in the industry in reference to certain agricultural commodities such as coffee, sugar, and cocoa.

Staff compiled over 20 years of historical futures price data. From this data set, staff examined the historical daily correlation between and among asset classes to determine the most plausible combinations of directional price changes. The staff focused on the most volatile market days and analyzed the relative performance across asset classes.

Based on this analysis, the staff created a set of extreme but plausible hybrid stress scenarios for this exercise that included historical and hypothetical elements. All of the directional scenarios actually occurred at least once in the last 20 years although the magnitude of the price changes was never as large in all products simultaneously as in this exercise. The scenarios are set forth in Exhibit 11.

Sector	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8	Scenario 9	Scenario 10	Scenario 11
Equity Futures	UP	DOWN	DOWN	DOWN	UP	UP	DOWN	DOWN	DOWN	DOWN	UP
Rate Futures	DOWN	UP	DOWN	UP	DOWN	DOWN	DOWN	UP	DOWN	UP	DOWN
IRS	UP	DOWN	UP	DOWN	UP	UP	UP	DOWN	UP	DOWN	UP
CDS	DOWN	UP	UP	UP	DOWN	DOWN	UP	UP	UP	UP	DOWN
Energy	UP	DOWN	UP	DOWN	DOWN	DOWN	UP	DOWN	UP	DOWN	UP
Metals	UP	DOWN	UP	UP	DOWN	DOWN	UP	UP	UP	FLAT	UP
Ags	UP	DOWN	FLAT	DOWN	FLAT	DOWN	DOWN	DOWN	UP	DOWN	DOWN
Softs	UP	DOWN	FLAT	DOWN	FLAT	DOWN	DOWN	DOWN	UP	DOWN	DOWN
Currency	UP	DOWN	UP	UP	DOWN	DOWN	DOWN	DOWN	UP	UP	UP

Exhibit 11: Sector Directional Stress by Scenario

4. Application of Tests Across Clearinghouses and Clearing Firms

Staff ran 11 unique scenarios at each of the eight guaranty funds operated by the five clearinghouses. This enabled the staff to measure the effects of various market events both at each clearinghouse individually and cumulatively across all five clearinghouses. This also enabled the staff to measure the effects for particular corporate groups of clearing members across all five clearinghouses. For example, under each scenario, staff determined whether a particular corporate group of clearing members that had losses at one clearinghouse also would have losses at the other clearinghouses or would instead have gains at one or more of the other clearinghouses.

Many of the scenarios were redundant from the perspective of the individual clearinghouses. This is because each clearinghouse has its own distinct product mix.

For example, at LCH, the relevant variables are changes in IRS prices and changes in currency exchange rates because only IRS swaps that are denominated in various currencies, were subject to

the exercise. Therefore, changes in the prices of other products do not directly affect the positions held by LCH clearing members, although underlying market forces implied by a scenario may drive changes in the products cleared. Thus, at LCH scenarios 1, 3, 9, and 11 were all effectively the same. Duplication of scenarios also occurred at ICEU, ICC, and ICUS because of the particular product mix offered for clearing at each clearinghouse.

Nevertheless, it was necessary to run each scenario at each clearinghouse in order to gauge the cumulative impact across clearing member groups. For example, although scenarios 1 and 3 are the same at LCH, they are not the same at CME and ICUS because CME and ICUS clear futures contracts that are affected differently by those scenarios. Therefore, those scenarios would have different cumulative effects at firms that had clearing members at all three clearinghouses.

Exhibit 12 shows the number of relevant scenarios for each clearinghouse after duplicative tests are eliminated. There were a total of 36 tests across the five clearinghouses that involve distinct or unique scenarios.

Derivatives Clearing Organizations	Stress Scenarios
CME Futures	11
CME Interest Rate Swaps (IRS)	4
CME Credit Default Swaps (CDS)	2
LCH Interest Rate Swaps (IRS)	4
ICEU Futures	2
ICEU Credit Default Swaps (CDS)	2
ICC Credit Default Swaps (CDS)	2
ICUS Futures	9

Exhibit 12: Unique Stress Tests per Clearinghouse

F. Calculation of Gains and Losses

For each scenario, staff calculated the gains or losses for each clearing member at each clearinghouse. The calculations reflected the gains or losses in the mark-to-market value of the positions. In accordance with CFTC regulations, staff calculated gains and losses separately for house and customer accounts.

G. Comparison of Losses to Financial Resources

After the staff computed mark-to-market losses under each scenario for each clearing member at each clearinghouse, it then compared those losses at a particular clearinghouse to the pre-funded financial resources of that clearinghouse. As discussed above, these include initial margin, financial contributions of clearinghouses, and guaranty funds.

1. Initial Margin

a. Margin Required and Margin on Deposit

CFTC regulations and clearinghouse rules set forth the minimum level of initial margin a clearing member must post with the clearinghouse. For example, for swaps, the CFTC regulations require that the margin must cover at least a confidence level of 99% for a 5-day liquidation period. As previously noted, some clearing firms keep more collateral than is required on deposit at the clearinghouse, usually for operational convenience. Others keep only the minimum amount of collateral at the clearinghouse. As noted earlier, clearing members are required to collect more initial margin from customers than they are required to post at the clearinghouse.

On the as-of date, the total margin on deposit at the clearinghouses included in this analysis was 8% greater than the total requirement. At individual clearinghouses that figure ranged from 2% to 13%. In dollar terms, the amount ranged from \$300 million to \$7.9 billion in initial margin.

These figures are representative of what typically occurs. Over the last year, the total margin on deposit at these clearinghouses, on average, was 9% greater than the total requirement. At individual clearinghouses that figure ranged from 3% to 14%. In dollar terms, the amount ranged from \$500 million to \$8.9 billion in initial margin.

The CEA and CFTC regulations permit clearinghouses to use initial margin on deposit in the calculation of overall financial resources. Thus, in sizing the guaranty fund, a clearinghouse may take the margin on deposit into account.

The rationale is that if a default occurs, the clearinghouse is entitled to take all initial margin on deposit. Consistent with the current regulations and the approach taken in compliance examinations, staff used margin on deposit in this exercise for purposes of assessing the coverage at clearinghouses.

As part of the daily risk surveillance program described in Section II.D above, staff routinely conducts stress testing at the clearing member and customer levels. In this context, staff applies the amount of initial margin required, not the amount on deposit. This is a more conservative approach. The rationale is that, although clearing members and customers often have substantial amounts of excess initial margin on deposit above their respective requirements, there is no statutory or regulatory requirement that they do so and one should not count on assets that might not be available in conducting daily risk surveillance. Consistent with that approach, staff used margin required in this exercise (rather than amount on deposit) for purposes of assessing the coverage at each individual clearing member.²⁵

b. House Accounts and Customer Accounts

Staff calculated gains and losses in accordance with statutory and regulatory segregation requirements. This means that, in the first instance, losses in a house account would be compared to initial margin in that account and losses in a customer account would be compared to initial margin in

 $^{^{25}}$ As noted, use of margin on deposit is permitted under the regulations for assessing clearinghouse financial adequacy. There is no corresponding standard under the regulations on this point for clearing members. Staff chose to apply the more conservative standard that it uses in daily risk surveillance.

that account. Of the 23 clearing member corporate groups, 20 had both house and customer accounts and 3 only had house accounts. Thus, the 23 clearing member corporate groups had 43 margin accounts in total (23 house plus 20 customer).

If there is a shortfall in a house account, customer gains and initial margin may not be used to offset the shortfall and, consequently, such margin was not applied by staff in this exercise. On the other hand, if there is a shortfall in a customer account, any gains in the house account as well as available house initial margin may be used to offset it. Accordingly, such margin was applied by staff in this exercise.

Staff also applied regulatory differences between the treatment of futures customer accounts and swap customer accounts. In futures, clearinghouses are required under CFTC regulations to collect gross initial margin for a clearing member's customer account, i.e., to collect the sum of each individual customer's initial margin.26 However, in the event of a default in that account, clearinghouses are not required to trace losses to individual customers. Therefore, all of the customer account initial margin at the clearinghouse is available to offset the losses of all customers.

By contrast, for swaps, a clearinghouse is not permitted to use initial margin attributable to one customer to cover another customer's loss. Therefore, in calculating losses in swap customer accounts, initial margin must be allocated on a customer by customer basis. As a result, each individual customer portfolio was stressed separately to determine whether that customer had a margin shortfall for that scenario. All margin shortfalls within a clearing member's customer account were summed.

For both futures and swaps, customer positions at different clearing members were treated separately. That is, if a particular customer had losses at one clearing member and gains at another the two were not offset. This is a conservative approach because in an actual market event the customer might use the gains to cover the losses.

2. Clearinghouse Contributions

Each of the clearinghouses in this exercise has committed a specified amount of its own capital to be available in the event of a default as set forth in Exhibit 13. Under the rules of the clearinghouses, these funds would be tapped after the initial margin and the guaranty fund contribution of the firm in default were exhausted but before the guaranty fund contributions of other clearing members were used. Staff included these funds in its calculations.

²⁶ See footnote 9 above regarding requirements under EMIR.

Derivatives Clearing Organizations	Committed Amounts
CME Futures	\$100 Million
CME Interest Rate Swaps (IRS)	\$150 Million
CME Credit Default Swaps (CDS)	\$50 Million
LCH Interest Rate Swaps (IRS)	\$63 Million
ICEU Futures	\$100 Million
ICEU Credit Default Swaps (CDS)	\$50 Million
ICC Credit Default Swaps (CDS)	\$50 Million
ICUS Futures	\$50 Million

Exhibit 13: Clearinghouse Committed Amounts

3. Guaranty Fund

Staff used the guaranty fund amounts as of March 31, 2016. These are the amounts in the quarterly reports closest to the position and margin as-of date.

A critical part of stress testing of clearinghouses is to determine whether the guaranty funds are adequate under applicable standards. As noted above, these five clearinghouses operate a total of eight guaranty funds. For each scenario, staff calculated whether the guaranty fund would cover the losses of the clearing members with the largest two losses after application of their initial margin (cover-two). Then staff looked at how many clearing members would have to default before the clearinghouse's guaranty fund was exhausted.

For ICEU futures, staff did not use the entire guaranty fund in its calculations. As noted above, the exercise did not include certain non-U.S. futures contracts cleared at ICEU. These products are in the same guaranty fund as the energy futures that were part of the exercise. But because those contracts are not ones whose trading is regulated under the CEA, the CFTC has not yet developed stress testing tools for them. Staff calculated the pro-rata share of the guaranty fund attributable to the products that were included in the exercise (based on the relative stress test amounts for the included contracts and the non-U.S. contracts) and used that amount in the computations.

Exhibit 14: Guaranty Fund Amounts

Clearinghouses	Guaranty Funds
CME Futures	\$3,276,154,755
CME Interest Rate Swaps (IRS)	\$2,809,806,311
CME Credit Default Swaps (CDS)	\$650,000,000
LCH Interest Rate Swaps (IRS)	\$4,623,066,349
ICEU Futures	\$1,912,270,426
ICEU Credit Default Swaps (CDS)	\$1,317,968,400
ICC Credit Default Swaps (CDS)	\$1,863,647,000
ICUS Futures	\$478,182,000

III. Results

The results of the stress tests are discussed below. In order to preserve confidential information, the results are presented in an anonymized manner, and certain results have been aggregated. Names of clearing members are not used. The identities of the clearinghouses are not given in certain instances, such as when describing which scenarios are worst for a particular clearinghouse. In addition, the manner in which the 11 scenarios are labeled varies in different sections.

The results are based on the assumption that no clearing member is capable of covering any margin shortfall. That is, staff assumed static conditions in which no clearing member that has a margin shortfall provides any additional funds beyond what was already at the clearinghouse once the shortfall had been identified. Staff views this as an extreme assumption in light of practical experience. No clearinghouse registered with the CFTC has ever experienced the simultaneous default of two clearing members.

By way of illustration, consider what happened in one of the most recent actual highly stressful cases—the so-called "Brexit" vote in the United Kingdom. On June 24, 2016, the day after the vote, a number of products had price moves that were in excess of margin required or a high percentage of margin required. On that day, clearing members paid \$27 billion in variation margin across the five clearinghouses.

This \$27 billion total was \$22 billion greater than the previous 12-month average, that is, over five times larger. Each clearinghouse paid and collected variation margin that was several times larger than its 12-month average. Many of the firms included in this analysis had very large variation margin payments. All variation margin payments were made on time.

Nevertheless, staff believes the assumption that no clearing member makes any payment to any clearinghouse is appropriate for purposes of this stress test in order to examine worst case consequences across clearinghouses.

A. Level of Coverage at Clearinghouses

Staff ran all 11 scenarios across the five clearinghouses and eight guaranty funds. Staff compared the stress test losses of each clearing member to the initial margin on deposit. Staff first analyzed whether each clearinghouse met the "cover-two" standard in each scenario. That is, assuming that the clearing members with the two largest losses (including their affiliates, and after deduction of their initial margin on deposit) default, were the clearinghouse's financial contribution together with the guarantee fund sufficient to cover such losses?

Staff then computed how many clearing member defaults the clearinghouse's pre-funded resources would cover under each scenario starting with the largest shortfall. As noted earlier, the tests assumed that no clearing member made any additional margin payments. In other words, it was

assumed that all clearing members that incurred losses as a result of a scenario could not cover those losses— except to the extent margin was already on deposit—and would be declared to be in default.²⁷

The clearinghouses achieved at least cover-two in all scenarios. Moreover, they achieved "cover-all" in 23 of the 36 tests. That is, in those cases, the clearinghouses' funded resources were sufficient to cover all losses by every clearing member that incurred a loss under the scenario.²⁸ In four of these 23 cases, losses were covered by initial margin on deposit; that is, there was no margin shortfall and, therefore, no need to draw on the clearinghouse's financial contribution or the guarantee fund to cover the losses of every single clearing member that had losses. The results are summarized in Exhibit 15.

Cover Ratio	No. of Tests	% of Tests
At Least Cover 2	36	100%
At Least Cover 3	30	83%
At Least Cover 4	25	69%
Cover All	23	64%
Total	36	100%

Exhibit 15: Level of Clearinghouse Coverage

This level of coverage was achieved even though the extreme price changes that were applied arguably push the boundaries of plausibility. While elements of these extreme price changes have occurred individually or in a few markets at the same time, they have never all occurred simultaneously as they do in these scenarios.

B. Diversification of Risk

1. Clearing Member Risk Was Diversified Among Scenarios

As noted above, staff used 11 different scenarios. Applying these across the five clearinghouses and eight guaranty funds generated a total of 36 unique tests across guaranty funds.²⁹ This is because some scenarios produced identical effects on a particular guaranty fund.

An initial question is therefore whether certain scenarios tended to produce losses at many or most clearing members. In fact, the opposite was true. Staff identified the scenario causing the largest shortfall for each clearing member account in order to determine how many clearing members might

 $^{^{27}}$ The exercise did not adjust the value of margin on deposit to reflect possible losses in value under the scenarios of securities held as margin. However, the totals for margin on deposit that were used had already been reduced pursuant to the applicable haircuts.

 $^{^{28}}$ As explained previously, this exercise only covered potential defaults by the largest 15 clearing members at each guaranty fund. The other clearing members, of course, also contribute to the guaranty fund. Their contributions would be available in the event of a default and were included in these calculations.

²⁹ As noted earlier, some scenarios produced identical effects on a guaranty fund and thus there were a total of 36 nonduplicative tests across the eight guaranty funds. See discussion in section II E 4 above.

have a similar risk profile, in the sense of being susceptible to similar losses based on a common set of market moves. For this purpose, clearing member account refers to either a customer or a house account. Thus, for the 23 firms, there were 43 accounts (23 house and 20 customer accounts, as noted earlier).

Two clearing members could be said to have a similar risk profile if one particular scenario from the set of 11 scenarios drove similar losses. Since clearing members do not have the same size portfolios, similarity of losses would be measured on a percentage rather than an absolute basis.³⁰

The results showed that no single scenario accounted for more than 19% of the worst outcomes. That is, no scenario generated the worst outcome for more than eight clearing member accounts. Moreover, ten different scenarios out of the 11 scenarios generated the worst outcome for at least one of the clearing member accounts.

The scenarios were distributed among the 43 clearing member accounts as set forth in Exhibit 16. (The scenarios have been relabeled and reshuffled in this exhibit from the labeling and sequencing in other exhibits.)

Scenario	No. of Accounts
Scenario A	8
Scenario B	7
Scenario C	7
Scenario D	6
Scenario E	5
Scenario F	3
Scenario G	3
Scenario H	2
Scenario I	1
Scenario J	1
Scenario K	0

Exhibit 16: Number of Worst Outcomes for 43 Clearing Member Accounts by Scenario

The distribution of the worst outcomes among the scenarios set forth above shows that the clearing member risk profiles are not concentrated. The 43 clearing member accounts had diverse risk profiles.

Even when several clearing members' largest shortfalls are driven by the same scenario, they are not likely to have the exact same risk profile. Clearing members may have different combinations of

³⁰ Staff notes that other factors could cause this. For example if one firm clears only a single product and another clears only a different single product and each goes down 15% in one scenario, the results would be similar. In this context, looking across the effect of the full set of scenarios helps to distinguish the difference.

profits and losses within the eight asset classes within each scenario. Moreover, within a single asset class there may be differences. For example, the largest shortfall for two clearing members may occur in a scenario in which IRS prices move up. But one clearing member's loss may be driven by a U.S. dollar-denominated position and the second clearing member's loss may be driven by a British pound-denominated position.

Staff also analyzed whether the firms with the largest losses tended to be the same from scenario to scenario. This was not the case.

No single clearing member group had the largest loss in more than 6 of the 36 unique tests. No pair of clearing member groups had the two largest losses in more than three scenarios. The maximum hypothetical degree of diversity would have been that for 36 unique tests involving 23 clearing members, the largest loss would be held by a different firm 23 times. The actual number was 18.

2. Clearing Member Risk Was Diversified Across Clearinghouses

a. Worst Net Shortfalls Across the Clearinghouses

One of the most interesting results of the tests was with respect to whether clearing members tended to suffer losses across clearinghouses at the same time. That is, if a particular scenario was the worst for a clearing member, did that mean the clearing member incurred losses at all clearinghouses? Or, put another way, if a clearing member incurred a large loss at one clearinghouse, did it incur large losses across all clearinghouses? The answer to both questions was generally no.

These results are set forth in Exhibit 17. For each clearing member account, staff determined which scenario produced the worst net result across all clearinghouses and guaranty funds. The first column lists the 43 clearing member accounts. This includes the 23 house and 20 customer accounts covered by the tests. The second column shows the net margin shortfall or margin remaining after the application of gains and losses across all five clearinghouses in the applicable scenario. In computing shortfalls at clearinghouse by guaranty fund, house gains were used to offset customer losses if the clearing member had both house and customer accounts at the same clearinghouse, but not vice versa. The columns labeled 1 through 8 show the eight guaranty funds but do not identify them.

A minus sign indicates that a particular clearing member account had a margin shortfall at a particular guaranty fund (after taking into account application of any excess house funds against customer losses at the same clearinghouse as noted above). A plus sign indicates that it had margin remaining at the guaranty fund. A blank indicates that it did not participate in that guaranty fund because it does not clear products in that asset class at that clearinghouse.

The total in the left column is the net of each clearing member's margin shortfalls and remainders across clearinghouses. This is intended to illustrate the cumulative effect of the scenario. Funds at one clearinghouse, of course, would not be immediately available to offset losses at another. Moreover, a customer margin surplus at one clearinghouse could not be used to offset a margin shortfall at another clearinghouse for different customers.

To illustrate, account 1 was subject to five of the eight guaranty funds. It incurred a margin shortfall at three of them, and maintained a margin remainder at the other two. (A margin remainder can represent either a loss that was less than the required initial margin or a gain for that account.) It had a net margin shortfall of \$1.8 billion. By contrast, account 19 was also subject to five of the eight guaranty funds. It incurred a margin shortfall at two of them and maintained margin remainders at three of them. The net result was that it ended up with a margin remainder of \$319 million across the five clearinghouses.

Exhibit 17 shows that 15 of the 43 accounts, or 35%, had net shortfalls across the five clearinghouses while 28 of the accounts, or 65%, had net remainders. It should be emphasized that each row in this table shows the scenario that was the worst one for that account. In each case, there were 10 other scenarios that generated equal or better results for that account across all eight guaranty funds.

This means that the majority of the accounts never had a net margin shortfall across all five clearinghouses in any of the 11 stress tests. In many cases, the accounts always had substantial amounts of margin remaining. For example, account 43 always had at least \$11 billion remaining across the clearinghouses after application of the stress tests.

Exhibit 17: Worst Net Shortfall Across All Clearinghouses (shows position for each guaranty fund)

Clearing	Worst Net Shortfall Across	Ren	nainder o	or Shortf	^f all at Ea	ch Indiv	idual Gu	aranty F	und
Member Account	All Clearinghouses	1	2	3	4	5	6	7	8
	0.00g								
1	(1,724,399,671)	(-)		(-)	(+)	(+)		(-)	
2	(1,296,896,175)	(-)	(-)	(-)	(+)	(+)	(+)	(-)	(+)
3	(1,195,029,470)	(-)	(+)	(-)	(+)	(-)	(+)	(-)	(-)
4	(1,050,726,441)	(-)		(-)		(-)		(-)	(+)
5	(805,606,822)	(-)		(+)		(-)			(+)
6	(502,241,996)	(-)				(+)		(+)	
7	(365,240,667)	(+)				(-)		(-)	
8	(341,904,566)	(-)						(-)	
9	(322,644,015)	(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)
10	(310,484,500)	(-)				(+)		(-)	
11	(292,259,072)	(-)		(-)		(-)		()	
12	(144,683,197)	(-)				(-)		(-)	
13	(126,596,254)	(-)				()		(+)	
14	(001,903)	(+)				(-)		(-)	
16	12 502 136	(-)				(土)		(-)	
17	86 513 679	(-) (+)				(+)		(-)	
18	190 393 693	(+)						(-)	
19	319 496 066	(-)		(-)	(+)		(+)	()	(+)
20	567.079.071				(.)		(.)		(+)
21									(+)
22	1,378,255,178	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)
23	1,404,095,021	(+)	(-)		(+)			(+)	
24	1,610,515,750	(+)	(+)	(+)	(+)	(-)	(+)	(+)	(+)
25	1,664,597,019	(+)	(+)		(+)	(-)	(+)	(-)	
26	1,725,577,649	(-)	(+)	(+)	(+)	(+)	(+)	(+)	(+)
27	1,750,123,798	(-)		(+)		(-)			(+)
28	1,771,180,814	(+)				(+)		(+)	
29	1,810,410,790	(+)		(-)	(+)	(+)		(+)	(-)
30	1,943,276,443	(-)	(+)		(+)	(+)	(+)	(-)	(+)
31	2,517,914,443	(+)			(+)	(+)		(+)	-
32	2,657,061,905	(+)	(+)	(-)	(+)	(-)	(+)	(-)	(+)
33	2,751,769,880	(-)	(+)	(+)	(+)	(+)	(+)	(-)	(+)
34	3,071,510,201	(+)		(1)	(+)	(+)	(1)	(+)	(1)
30	3,110,130,991	(-)		(+)	(+)	(1)	(+)	(-)	(+)
37	3 522 120 212	(+)		(-)	(+) (+)	(+) (+)		(+)	
38	3 632 373 270	(+)		(-)	(+)	(+)		(+)	
39	3 911 904 461	(-)	(+)	(+)	(+)	(-)	(+)	(-)	(+)
40	4.919.045.537	(+)	(')	(-)	(+)	(+)		(+)	
41	6,402.580.285	(+)		(-)	(+)	(+)		(+)	(-)
42	7,627,877,534	(+)			(+)	(+)		(+)	.,
43	12,245,020,985	(+)			(+)	(+)		(+)	

b. Net Shortfall Across All Clearinghouses for Clearing Members with the Worst Shortfall at a Single Clearinghouse

Diversification across clearinghouses is illustrated from a slightly different perspective in Exhibit 18. To prepare Exhibit 18, staff identified the clearing member account that had the largest shortfall at each guaranty fund under any of the 11 scenarios.³¹ Again, in calculating losses, house gains were offset against customer losses, but not vice versa. Staff then identified that account's shortfall or remainder at the other guaranty funds under that scenario.

In preparing Exhibit 18, staff used the gains and losses calculated for each guaranty fund in preparing Exhibit 17 to identify the clearing member account with the largest shortfall at each guaranty fund under any scenario. Staff then computed the net shortfall or remainder for that clearing member account at the other guaranty funds under that same scenario. Staff then compared the shortfall at the original guaranty fund to the net shortfall or remainder across the other five guaranty funds.

The red bar shows the shortfall for that clearing member account at the guaranty fund where the clearing member incurred the largest shortfall under any scenario. The green bar shows the cumulative remainder across all the other guaranty funds. For example, in the first graph, the clearing member had a cumulative shortfall of \$365 million at the guaranty fund where it had its largest shortfall but a cumulative remainder of \$745 million at the other guaranty funds.

³¹ Two guaranty funds are not included in this exhibit. In those cases there were no shortfalls under any scenarios.



Exhibit 18: Level of Coverage Across Guaranty Funds





This figure illustrates that a very large shortfall at one clearinghouse was accompanied in most cases by significant remainders at other clearinghouses. In five of the six instances, the cumulative remainders at the other clearinghouses exceeded the largest loss at one clearinghouse. In all six cases, there was a cumulative remainder at the other clearinghouses.

As discussed earlier, although gains and losses at different clearinghouses cannot be netted by the clearinghouses themselves, the fact that a clearing member had a gain at one clearinghouse would presumably increase its ability to cover a loss at another clearinghouse. Proceeds of the gains, however, might not readily be available to a clearing member due to timing of clearinghouse settlement cycles or other factors.

Staff performed a similar analysis looking at the two largest clearing member group losses at each clearinghouse. That is, for each clearinghouse, staff determined which scenario created the largest two shortfalls. Staff then looked at the aggregate shortfalls and aggregate remainders of each of those clearing members at all clearinghouses under that same scenario. Under the 11 stress tests across 23 clearing member corporate groups, there was no scenario where the same two clearing members generated the largest margin shortfall at more than one guaranty fund.

c. Concentration as Measured by Herfindahl-Hirschman Index

Staff also adapted the Herfindahl-Hirschman Index ("HHI"), a commonly used method of measuring market concentration, to assess whether risk, as measured by the initial margin required for each clearing member, is concentrated at a few clearing members at these clearinghouses. The HHI was not devised for measuring risk at clearinghouses, of course, but staff believed that it provided a useful alternative perspective on concentration of risk. The HHI is described on the United States Department of Justice ("DOJ") website as follows:

The HHI is calculated by squaring the market share of each firm competing in the market and then summing the resulting numbers. For example, for a market consisting of four firms with shares of 30, 30, 20, and 20 percent, the HHI is 2,600 (30 squared +30 squared +20 squared+ 20 squared= 2,600).

The HHI takes into account the relative size of distribution of the firms in a market. It approaches zero when a market is occupied by a large number of firms of relatively equal size and reaches its maximum of 10,000 points when a market is controlled by a single firm. The HHI increases both as the number of firms in the market decreases and as the disparity in size between those firms increases. ³²

The DOJ and the Federal Trade Commission ("FTC") generally consider markets in which the HHI is between 1,500 and 2,500 points to be moderately concentrated and consider markets in which the HHI is in excess of 2,500 points to be highly concentrated.³³

Staff calculated a "Clearinghouse Risk HHI" of the clearing members at each of the clearinghouses and across the clearinghouses. First, staff calculated the total initial margin required for each clearing member group at each clearinghouse. To do this, staff added the initial margin required at the clearinghouse for all futures and swaps products across both customer and house accounts. For this particular calculation, staff included the smaller clearing members that were not otherwise part of this exercise.

Staff next calculated the share of total initial margin posted by each clearing member group as a percentage. Staff then calculated the clearinghouse Risk HHI for each clearinghouse as described above. Staff also calculated a clearinghouse Risk HHI for the futures and swaps markets covered in this exercise by combining the clearinghouses and computing the share of initial margin for each clearing member corporate group. The results are shown in Exhibit 19.

³² U.S. Department of Justice, Antitrust Division, Herfindahl-Hirschman Index, available at <u>https://www.justice.gov/atr/herfindahl-hirschman-index</u>.

³³ See U.S. Department of Justice & FTC, <u>Horizontal Merger Guidelines §5.2 (</u>2010).

Clearinghouse	Herfindahl-Hirschman Index (HHI)
CME	707
LCH	437
ICC	1033
ICUS	930
ICEU	808
Combined	591

Exhibit 19: Concentration of Clearing Members Under Clearinghouse Risk HHI

All of these numbers are well below the level for being considered concentrated under the usual HHI standard. However, as noted above, the HHI was not designed for measuring clearinghouse risk, and this analysis is purely to give a different perspective.

IV. Conclusions

These results of this stress testing exercise show that clearinghouses had the financial resources to withstand a variety of extreme market price changes across a wide range of products on the as-of date and for the hypothetical scenarios used. Cover two was met in every test. For almost two-thirds of the tests, the clearinghouse had sufficient resources to cover a default by every clearing member subject to the exercise, without resorting to assessments or other measures. This also assumed no transfers of positions or posting of additional margin by any clearing member.

The results of the tests also show that clearing members positions were highly diversified, so that whether they had a loss or gain varied greatly among these risk scenarios and across clearinghouses. No single scenario produced the worst result for more than 8 of the 43 clearing member accounts, and 65% of the accounts did not have a shortfall under any scenario. When considered after combining house and customer accounts for each corporate group, the results were similar. There was no scenario where the same two firms generated the largest losses at more than one guaranty fund. Of the 23 firms, 18 were among the two firms generating the largest losses in at least one scenario.

The tests also show that a clearing member can be one of the two largest defaulters at one clearinghouse, and yet not necessarily incur losses across all clearinghouses. In fact, it may experience significant gains elsewhere and be a net winner on the day. This is an important finding in light of the fact that the same firms generally are the largest clearing members across multiple clearinghouses.

Although these results are positive, staff recognizes that the exercise had a number of limitations. For example, it only analyzed a limited number of scenarios. It only applied the impact of extreme price changes over a one-day period. It did not take into account strains on liquidity. As discussed in the next section, there are a number of ways in which future exercises can be enhanced.

V. Next Steps

Staff plans to conduct exercises of this nature on a regular basis. There are many types of enhancements that can be incorporated into the program in the future, including the following.

First, extreme market conditions could be projected over several days. This exercise measured the ability of clearinghouses and their clearing members to deal with single-day events. But extreme volatility often lasts longer. Such an exercise would attempt to project market moves over several days. Staff would look at price changes on the days following extreme historical market moves to determine the size and direction of price changes on those days. Staff would then construct hypothetical 3-day scenarios. Staff would analyze the ability of clearinghouses to withstand defaults under those scenarios. The analysis would include the effects upon non-defaulters of draws upon their guaranty fund contributions.

Second, additional stress scenarios could be added. For example, this exercise included parallel shifts in the interest rate yield curve but it did not include changes in its shape. Similarly, in the energy asset class, changes in various correlations among products could be stressed.

Third, additional products could be added. In particular, this would be useful in cases where the guaranty fund covers non-U.S. products.

Fourth, the exercise compared losses to margin on deposit in testing clearinghouse resiliency. Future exercises could also compare losses to required margin at clearinghouses.

Fifth, many clearinghouse margin models include additional charges such as concentration charges and liquidation charges. In this exercise, these funds were treated as being available to cover losses from market moves. The intent was to make the size of the price changes so large that the types of risks that these charges reflect would be included. Future exercises could be refined further to develop additional steps in the scenarios to test the adequacy of these funds.

Sixth, this exercise did not address liquidity concerns. This could be incorporated into future exercises.

Seventh, reverse stress testing could be conducted. Essentially, this entails using the available resources of a clearinghouse as the starting point and identifying scenarios that would lead to losses in excess of that amount.

The CFTC will also explore conducting joint tests with other regulators in the future. This could broaden the clearinghouses covered or explore the impact of stress scenarios not only on clearing activities but also on other lines of business of the same institutions. Such joint exercises would likely reflect the results of the international work on supervisory stress tests referred to above.

As noted at the beginning also, these stress tests look at default losses only. Non-default losses—that is, losses that might be generated by operational events, clearinghouse investment losses, or other events or circumstances—are not studied. The CFTC is focused on making sure clearinghouses are resilient in the face of those challenges as well.