Stress This House

A Framework for the Standardised Stress Testing of CCPs

LCH The Markets' Partner

The ability of clearing members to make informed decisions based upon the resiliency of clearing houses is fundamental to minimizing systemic risk and strengthening international financial markets.

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Executive Summary

Central counterparties (CCPs) have assumed a more prominent role at the centre of international capital markets in the years since the financial crisis. The catalyst for this has been a political and economic drive for stability, security and efficiency across global financial markets. This has led to the introduction of mandatory central clearing for certain interest rate and credit derivative indices in the United States and Japan. The central position played by CCPs will be further enhanced by the forthcoming implementation of comparable clearing mandates across the G20 nations over the next few years.

As the use of clearing houses has increased, clearing members have found that there is currently no way for market participants to compare the risk and default management procedures of CCPs on a consistent basis.

The first tentative steps to address this issue were taken on 11 March, 2015, when the Committee on Payments and Market Infrastructures (CPMI) and the International Organisation of Securities Commissions (IOSCO) announced a review of stress testing by clearing houses.

CCPs regularly stress test their default management processes; however, as yet there is no global standard for a stress testing framework.

This paper details LCH's proposed stress testing framework that will inform and assist the review process being undertaken by CPMI-IOSCO. A standardised stress testing methodology will help improve transparency around CCP risk management. It will allow clearing members and regulators to compare different CCPs on a relative basis, to evaluate the strength and resiliency of clearing houses and to assess the extent to which a CCP's pre-funded resources (default fund contributions and CCP skin in the game) would be consumed under a uniform set of stresses. In addition, it attempts to place CCPs on a level playing field regardless of confidence levels used to calculate margin, holding and methodology for sizing default funds, etc.

A harmonised set of stress tests will also create a level playing field across the different regulatory jurisdictions and will present a consistent measure of the relative resilience of competing CCPs. Further, it is LCH's belief that standardised stress testing is wholly achievable for the global market within a reasonable timeframe.

We encourage discussion among CCPs and regulators as a precursor to the establishment of a stress testing framework, driven and designed by clearing experts, that reflects the unique risk management challenges faced by clearing houses and clearing members.

A standardised stress testing methodology for CCPs should be based on three key principles:

TRANSPARENCY

The methodology must ensure that the risk drivers are as transparent as possible.

SIMPLICITY

The methodology should communicate as clearly as possible the complex clearing risks inside a CCP.

COMPARABILITY

The methodology should allow and encourage comparison across CCPs regardless of confidence level employed or the total value of pre-funded resources.

There are five basic elements required to construct the standardised CCP stress testing framework outlined in this paper:

ELEMENT 1

The segregation of assets appropriate to eliminate masking effects within portfolios.

ELEMENT 2

The construction of a standardised stress testing framework using:

01. Historical scenarios
02. Hypothetical scenarios
03. De-correlation stresses within the asset class

ELEMENT 3

Combining the results of the stress testing exercises across the three types of standardised stress scenarios.

ELEMENT 4

Stress testing the cover 2 standard to calculate the maximum number of members that could default simultaneously in each scenario without recourse to the CCP's pre-funded resources.

ELEMENT 5

Evaluating the risk of successfully auctioning defaulted clearing members' portfolio of trades under each cover 2 scenario without exhausting the pre-funded default fund of the CCP.

Our goal is to help policymakers and regulators participating in the CPMI-IOSCO review to develop a harmonised stress testing framework that, once implemented, will be able to demonstrate the relative resilience of clearing houses globally.

Background

Since the financial crisis, regulators have introduced standardised stress testing for banking organisations, many of which having been designated Globally Systemically Important Financial Institutions (G-SIFIs).

Many market participants and utilities have also been designated as systemically important in various jurisdictions. For example, the Financial Stability Board (FSB) has given such a designation to nine insurance companies[1] around the globe and US federal regulators have also designated eight market utilities – several clearing houses among them[2].

As yet, regulators have not chosen to subject CCPs to standardised stress testing. This lack of a harmonised stress testing regime for CCPs makes it harder for clearing members to assess the relative resilience of CCPs globally and consequently make informed decisions.

The Principles for Financial Market Infrastructures (PFMI) published by the Committee on Payment and Settlements Systems (CPSS) and the International Organisation of Securities Commissions (IOSCO) in April 2012 set out an international framework for CCP risk management. The PFMI includes a minimum regulatory standard that initial margin collected by clearing houses should meet a 99% confidence level for all products. This standard has been adhered to by the Commodity Futures Trading Commission's (CFTC's) clearing rules, which require a minimum 99% confidence level for all cleared swaps.

The PFMI called for CCPs to conduct rigorous stress testing to determine the financial resources necessary to manage both credit and liquidity risk, in a variety of extreme but plausible market conditions. Crucially, the PFMI directed only that a clearing house should "have clear procedures to report the results of its stress tests to appropriate decision makers at the CCP" and did not propose a standardised testing regime that would permit like-for-like comparisons of the resiliency of one CCP versus another.

The European Market Infrastructure Regulation (EMIR) requirement goes further, setting a minimum 99% confidence level for cash instruments and listed derivatives, but 99.5% for OTC derivatives. LCH has gone further still. Its policy is to apply a confidence level of 99.7% across all products, whether cash, listed contracts or OTC derivatives.

EMIR requires that all European CCPs have pre-funded resources to withstand the simultaneous default of the two members of the clearing house posing the largest credit exposure in extreme but plausible market conditions (Cover 2). In the US, CFTC regulations require CCPs that have been designated as systemically important, or that voluntarily comply with the rules for systemically important CCPs and that clear products with a complex risk profile, to meet Cover 2. Similar regulations have been proposed by the SEC but have not been finalised.

[1] The nine insurance companies designated as Globally Systemically Important Insurers by the FSB are: Allianz SE; American International Group inc, Assicurazioni Generali S.p.A; Aviva plc; Axa S.A; MetLife, inc; Ping An Insurance (Group) Company of China; Prudential Financial, inc; Prudential plc.

[2] The eight Designated Financial Market Utilities in the US are: the Clearing House Payments Company LLC; CLS Bank International; Chicago Mercantile Exchange, inc; The Depository Trust Company; Fixed Income Clearing Corporation; ICE Clear Credit LLC; National Securities Clearing Corporation; The Options Clearing Corporation.

Further complicating matters, clearing houses that operate in multiple jurisdictions are regulated or supervised by regulators in each of those countries. Consequently, attempts to gain an empirically valid like-for-like comparison between different clearing houses today is extremely challenging. Risk managers at the clearing members request huge amounts of data about the default fund and margin risk controls in place at each individual CCP, but this information is often not directly comparable.

The lack of standardised metrics across clearing houses makes it significantly more difficult for risk managers to obtain a comprehensive understanding of the clearing member's true aggregate risk exposure across multiple CCPs, however, standardisation may finally be on the horizon.

On 11 March, 2015, the Committee on Payments and Market Infrastructures (CPMI)-IOSCO announced that they would jointly undertake a review of stress testing by CCPs, calling such tests "an essential component of risk management by CCPs"[3].

Implementing standardised stress testing of CCPs using a methodology developed by the clearing community itself is a means to redress this imbalance while simultaneously contributing substantive guidance from industry experts to CPMI-IOSCO to inform their review of CCP stress testing. The ideas and concepts laid out in this paper are designed to serve as a foundation on which CPMI-IOSCO could base their methodology for a global standardised stress test.

Consistency in these stress tests is key to strengthening the ability of clearing member risk managers to prudently price, and manage, the exposure of their respective institutions across clearing houses.

In the absence of standardised stress testing, clearing houses may be incentivised to engage in a race to the bottom, where clearing houses compete on lower margin requirements in order to attract more business, rather than competing with one another on the basis of safety and soundness.

Observable and transparent stress testing can prevent such an outcome. How such a standardised stress testing regimen for the international clearing community should be structured is presented in detail through the five elements detailed in the next section of this paper.

[3] The full CPMI-IOSCO statement announcing the review of CCP stress testing can be found at: **bis.org/press/p150311.htm**

Building a Standardised CCP Stress Testing Framework

We propose that five key elements should form the basis of a standardised stress testing framework for CCPs.

Clearing member portfolios of trades within CCPs need to be separated by asset class. Once segregated, the portfolios are subjected to three sets of stress scenarios: historic, hypothetical and de-correlated stress scenarios. Once the scenarios have been applied to the portfolio, the impact of the stresses are recorded on the portfolio's profit and loss as well as the resulting erosion of margin, and usage of default fund contributions and of the CCP's own skin in the game.

The stress testing methodology is used to test the cover 2 requirement that many CCPs are required to meet. To do this, the stress test is applied to additional clearing member portfolios until the pre-funded default fund is depleted. This demonstrates how many clearing member defaults the CCP can endure before its financial resources are exhausted under each particular scenario.

Finally, the framework should assess the likely success or failure of an auction of a defaulted clearing member's portfolio, using certain standardised parameters.

The end result should be a comparable and consistent barometer of CCP resilience that risk managers can quickly and easily comprehend, and that international regulators can use as the basis on which to develop the CPMI-IOSCO review of CCP stress testing.

Key elements forming the basis of a standardised stress testing framework:

ELEMENT 1

Segregating Clearing Member Assets

As a first step, a CCP portfolio must be appropriately segregated into default funds prior to the application of any stress test exercise. It is critical that this be performed correctly in order to prevent a potentially serious underestimation of how a portfolio would perform under a real world stress event.

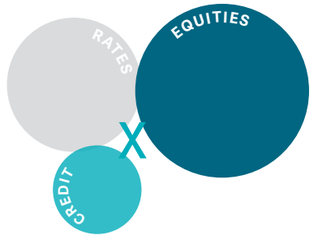
There are two ways to achieve this appropriate segregation:

A. Allow uncorrelated products in the same default fund, but do not allow any portfolio margining or offset of default fund contributions between them. This would ensure that each individual component of the default fund is sized to a cover 2 standard on a standalone basis as no inadvertent offsets are allowed.

OR

B. Different products can be placed in the same default fund and portfolio margining and offsets can be allowed among them if they meet the following criteria: the products must be highly structurally correlated and there must be an economic rationale to have the products in the same product class. A high correlation in its own right cannot be used to justify the inclusion of multiple products in the same product class. The correlation between the products must also be stable.

These conditions allow the correct sizing of the default fund, since they rule out masking risks through inadvertent correlations. For example, a clearing house might want to stress test a portfolio of rates and equities positions simultaneously. This might be justified on pure mathematical grounds given that there is a non-zero correlation between them, but the economic and structural link between the two products is more tenuous.



If both were placed in the same default fund with portfolio margining and offsets allowed, then sizing the resulting fund to a cover 2 standard would mean, at the very least, estimating the likelihood that both products would experience the largest extreme move on the same day. Historically, such an extreme stress occurring in both equities and rates on the same day has never been observed. Consequently, the default fund would effectively be sized based on the impact of an historical extreme move in one product.

Essentially, unless the portfolio of products is properly segregated, their individual contribution to the financial assets of the CCP could be understated. Regardless of the default fund structure of the CCP, portfolio margining and offsets should not be allowed between the following three product classes (as a minimum):

01. **RATES** (including Government bonds, Sovereign repos, swaps & foreign exchange)
02. **EQUITIES**
03. **CREDIT** (including corporate bonds, credit default swaps)

Note that each class has a common set of risk factors.

ELEMENT 2

Constructing Standard Stress Scenarios

The segregated asset classes should be subjected to three defined categories of standardised stress scenarios:

A. HISTORICAL STRESS SCENARIOS

This is a relatively non-controversial and well-recognised set of past stresses in use today by most financial institutions, which include the following scenarios:

2011 Eurozone Crisis *(start 09-Nov-11, end 30-Nov-11)*

2010 Global Financial Crisis *(start 01-Apr-10, end 31-May-10)*

2008 Global Financial Crisis *(start 08-Oct-08, end 01-Jan-09)*

2008 Lehman Default *(start 01-Sept-08, end 28-Nov-08)*

2007 Start of Credit Crunch *(start 01-Aug-07, end 30-Sept-07)*

2001 Twin Towers Attack *(11-Sept-01)*

2000 Dot Com Collapse *(start 01-Mar-00, end 01-May-00)*

1998 Russian Financial Crisis *(start 01-Aug-98, end 31-Oct-98)*

1998 LTCM Collapse *(start 01-Sept-98, end 01-Nov-98)*

1997 Asian Financial Crisis *(start 15-Apr-97, end 15-Jul-97)*

1994 Bond Crisis *(start 01-Feb-94, end 30-Apr-94)*

1992 ERM Exit *(16-Sept-92)*

1987 Stock Market Crash *(19-Oct-87)*

B. HYPOTHETICAL STRESS SCENARIOS

As per the old investing dictum, past performance is not indicative of future results. The same principle should be applied in stress testing. The simplest method to supplement the above historical stress list with a comprehensive set of hypothetical scenarios is to add antithetical scenarios; if there was a historic scenario where a key risk factor jumped up over a certain period, this framework would include the opposite move, where the key risk factor would jump down by the same magnitude.

This methodology probes the CCP portfolio for risk factor moves in both directions. However, there can be quite specific member portfolios which carry disproportionate risks not picked up by general market moves. As such, it is necessary for the stresses modeled in the hypothetical scenarios to go beyond the antithetical of the historically observed stresses and factor in additional degrees of stress to account for such outliers.

C. DE-CORRELATION STRESS SCENARIOS

These are scenarios designed to break historic correlations and have the effect of unmasking risks that would otherwise be obscured. The approach to generating the de-correlation scenarios varies by product class.

In addition to the tests outlined above, it is also necessary to apply additional and separate measures to the respective asset classes as we now explain.

Rates Products

Rates products are priced from various tenor points along shared benchmark market curves. Historical stresses and their antitheticals do not necessarily fully capture the potential changes in correlations between the tenor buckets along such market curves. As such, it is necessary to add de-correlation scenarios to the historical and hypothetical scenarios in a standard way.

The basic idea is to break the historically observed correlation between the large number of individual tenors, exploiting the correlation along such curve(s) using a Principal Component Analysis (PCA)[4].

Thus the number [n] of historical changes driving the moves in the underlying curve(s) are systematically replaced by a much smaller number of independent directions (called Principal Components). Each Principal Component is then stressed independently according to its historically observed range. Thus if there are m Principal Components, this will result in 2m new stress scenarios, where each Principal Component is set to either the maximum or minimum of its historically observed range.

This procedure may generate more scenarios than those already recounted in the list of historical and antithetical scenarios. The central point is that new scenarios are being developed by stressing each Principal Component, not just assuming the historical correlation structure remains stable. Essentially, the greater the number of Principal Components, the greater the confidence level the stress test can achieve.

This procedure is manageable if the number m of Principal Components can be chosen to be much smaller than the original number of spot changes driving the movement of the underlying curve.

In fact, the number of Principal Components chosen involves a trade-off. On the one hand, one wants to explain as much variability in the data as possible, while on the other, one wants to have a significant reduction in the independent variables to make the process as manageable as possible. A practical choice might be to select that number of Principal Components which explains 95% of the data variability.

To be more explicit, suppose that R = (r(1),...r(n))T is the vector describing spot changes at key tenor points along the rate curves in question. If S is the covariance matrix of these spot changes, then S is a symmetric nxn matrix which can be diagonalised as S = UTDU, where D is the diagonal matrix of positive eigenvalues, U is the vector of eigenvalues and UT is the transposed row vector.

In essence, the entire stress methodology for rates products can be expressed succinctly as follows: The vector C of n Principal Components (arranged by order of contribution to total variance) is then

$$C = U R$$

of which we only need the first ***m*** components according to the threshold explained above.

4 For details, see Market Models: A guide to Financial Data Analysis by Carol Alexander, September 2001, ISMAIL Centre

Finally, this equation shows how, at any point in time the value of the Principal Components can be recovered from R, so that one can observe the range of values of each Principal Component over time. The maximum and minimum values of each Principal Component then define the set of 2m de-correlation scenarios.

EQUITIES

The historical stresses and their antitheticals are also not enough on their own to fully capture the potential exposure in the equities space. One needs to supplement these by a "correlation" stress.

As opposed to a suite of rates products of different maturities that all price off of a single curve, individual equities introduce a much higher degree of variability into the stress testing process. In this case, the presence of equity specific risk greatly increases the number of risk variables to be analysed and can make even the PCA process unmanageable.

The basic problem is that the historical and antithetical stresses described thus far are general market stresses and assume implicitly that all stocks are behaving together according to a market-wide move. This completely ignores the possible idiosyncratic move of a particular stock that does not follow the general market trend.

For example, a group of airline stocks may gain or lose value in a correlated fashion in response to an underlying move in crude oil prices or a reduction in refining capacity. Such a broad correlation cannot legislate, however, for the idiosyncratic risks to an individual airline stock posed by union action, a terrorist event or an incident of pilot error, unique to that individual name that could skew the risk.

This risk is especially important if there is a large concentrated position in that stock, where a sudden idiosyncratic jump can have a disproportionate impact in terms of risk exposure.

For this reason, it is necessary to supplement the historical and antithetical scenarios outlined above with a de-correlation scenario to capture the potential for such outliers. The process is described as follows:

01. Segment the equities portfolio by country, industry and large/medium/small cap.
02. In each of the resulting segments, select the largest equity position (both long and short).
03. For each of the historical and their antithetical general market moves listed above, apply a de-correlation stress for the largest equity position selected which is opposite to the general market move. Thus if the historic (or its opposite) scenario suggested a general market move down of 17% in a particular segment, this would be replaced by a new scenario where the largest stock position would move up by 17%. (i.e. 100% de-correlation) and all other positions would move according to the original historical scenario (or its antithetical).

There are more sophisticated ways of modeling equity correlation shocks, but this simple approach satisfactorily uncovers any masked or hidden correlations, and is readily comparable across CCPs.

CREDIT

Here we suggest a procedure similar to that of equities, as the fundamental problem of idiosyncratic risk is similar: a single concentrated exposure to the credit of one debt issuer could again run counter to the overall correlated performance of the other names in a portfolio of bonds, thereby skewing the risk profile. The procedure is as follows:

01. Segment the credit portfolio by country, industry and large/medium/small cap.
02. In each of the resulting segments, select the largest credit exposure (both long and short).
03. For each of the historical and their opposite general market moves listed above, apply a de-correlation stress for the name selected which is opposite to the general market move. Thus, if the historic (or its opposite) scenario suggested a general market move down of 10% in a particular segment, this would be replaced by a new scenario where the largest position would move up by 10%. (i.e. 100% de-correlation) and all other positions would move according to the original historical scenario (or its antithetical).

The above describes the procedure for single name credit positions. For credit indices, it is necessary to decompose the index into single names and then apply this procedure.

This new de-correlation scenario is then added to the historical scenarios (and their antitheticals) for the credit portfolio.

ELEMENT 3

Combining the Stress Scenarios

Having defined the stress scenarios by product class within each default fund, there is now an obvious way to proceed:

01. For each default fund, list all the stress scenarios described above; historical, antithetical and de-correlation scenarios.

02. Under each scenario, record each member P/L should that scenario happen and calculate the resulting margin erosion and the corresponding usage of default fund (both funded and unfunded) and the usage of skin in the game.

This results in the following stress template, with the second row to be filled out for each scenario:

Default Fund Name	Scenario Number	IM Erosion	Funded Default Funds Used	Unfunded Default Funds Used	Skin in the Game €	% of Skin in the Game Used

ELEMENT 4

Stress Testing the Cover 2 Condition

Since each major CCP must be cover 2 compliant under regulatory rules currently in force in many G20 nations, this question really becomes one of measuring the excess of a clearing house's financial strength over the regulatory minimum condition. The simplest method to gauge this is to start with the stress tests described in Section 2 and for each scenario ask how many counterparties would need to default to exhaust the funded portion of the default fund(s).

The minimum number of counterparties observed under this process across all scenarios would then provide a clear picture of the buffer built into the pre-funded portion of the default fund(s). This would be of immense interest to clearing members who have mutualised the default fund with others, especially if there were plausible scenarios in which the CCP may have to call on the unfunded resources of the default fund.

Effectively, this procedure finally results in one column being added to the stress table below, to assess the maximum number of members who could default under each scenario without depleting the funded portion of the default fund.

Default Fund Name	Scenario Number	IM Erosion	Funded Default Funds Used	Unfunded Default Funds Used	Skin in the Game €	% of Skin in the Game Used	Max Number Defaulted Members Without Depleting Funded Default Fund

If all CCPs engages the same methodology, clearing members would be able to observe – perhaps on a single sheet of paper for each clearing house – the resiliency of their default funds at each CCP in a transparent, and most importantly, truly comparable manner.

ELEMENT 5

Auction Risk

Having assessed the level of stress necessary to exhaust both the CCP's own skin in the game and member default contributions, the final element in a stress testing framework is to ascertain whether a defaulted member's cleared positions could be successfully auctioned without recourse to unfunded resources.

The first step is to deal with the clients of the defaulting member. If these positions can be ported to a non-defaulting member, no further work is necessary. If this turns out not to be possible, then client positions need to be auctioned off alongside the defaulting member's portfolio.

Understanding the circumstances under which an auction would succeed or fail for each portfolio under these stress scenarios allows clearing members and regulators to assess ex-ante whether that portfolio could be successfully auctioned or whether members would be required to provide additional capital to support such an auction.

Members of the CCP are motivated to contribute to a successful auction – not least because they may be further assessed if the auction fails– but there are additional incentives driving clearing member participation:

01. The financial resources posted by the defaulted members, plus the mutualised default fund resources, can be used to make the auction price more attractive to bidders.

02. Members who do not bid or "bid to miss" can be penalised in the loss allocation procedure according to some CCP rules – LCH being one example.

03. If the auction were to fail, a member would potentially see larger unfunded assessments as the CCP would call for more financial resources to ensure the defaulted member's portfolio can be sold off at a lower market price.

04. Ultimately, failure to meet these assessment calls would result in the CCP placing in default any members who did not meet this obligation.

While these considerations ensure that CCP members are willing to bid, the auction may still not succeed for structural reasons beyond the incentives driving members to participate:

A. After a particular scenario is applied to the CCP, there may be only a few non-defaulted members left (concentration risk).

B. A large proportion of the non-defaulted members may be on the same side of the market as the defaulted member (these members are said to be "aligned") so these non-defaulted members would not be able to bid without increasing their risk to the CCP.

C. There may also be a capacity concentration risk. Non-defaulted members on the opposite side of the market may only have the capacity in aggregate to barely absorb the defaulted members' portfolio, making the success of the auction highly dependent on a small number of individual members.

If the structural conditions above exist in the advent of a particular scenario, then the likelihood of a successful auction is low. Conversely, in the absence of these conditions, the auction is likely to succeed.

To make the presence or absence of these conditions more concrete, one can perform a Principal Component Analysis to express the defaulted and non-defaulted members' portfolios as a linear combination of the Principal Components. Focusing on each Principal Component in turn, one can then identify those non-defaulted members that are on the other side of the market as those members whose sign is the opposite to that of the defaulted members' portfolio. This will give a potentially different set of aligned members for each Principal Component.

A simple way to rule out whether the conditions a) to c) above occur is to calculate whether:

01. Any individual non-defaulted member on the opposite side to the defaulted members' portfolio has a concentration of greater than 25% of the exposure to the defaulted members' portfolio in a particular material risk component.

02. Excluding the largest non-aligned member, there is enough capacity among the remaining aligned members to absorb the defaulted members' portfolio.

This calculation is done for each Principal Component and the probability of a successful auction is high if both conditions hold. Of course there may be Principal Components along which the defaulted member's portfolio does not have a large position and these should be omitted from the above considerations. The word "large" here means that the exposure from that Principal Component is greater than 5% of the aggregate exposure of the defaulted members.

In conclusion, the stress table in Element 4 can now be supplemented by an additional column indicating whether after each scenario is applied, the resulting auction has a high or low probability of being successful. The final table now looks as follows, with each row labeling a different standardised scenario:

Default Fund Name	Scenario Number	IM Erosion	Funded Default Funds Used	Unfunded Default Funds Used	Skin in the Game €	% of Skin in the Game Used	Max Number Defaulted Members Without Depleting Funded Default Fund	Chance of Success for Resulting Auction (high/low)

The importance of the auction success is key in that the higher the chances of success for the auction, the lower the need for additional capital to be held for a "tail of the tail" event, which would see additional assessments made on non-defaulted clearing members.

The concept of "aligned members" uncovers a new and pernicious risk to a CCP: member portfolios can become exposed to a small subset of underlying risks through accidental alignment, with no coordination among members. This risk is manifested in the resulting difficulty in holding a successful auction.

The same framework can be used to test ex-ante the likely success of any auction, though the focus here is on the auction resulting from a cover 2 event.

Conclusion

The ability of clearing members to make informed decisions based upon the resiliency of clearing houses is fundamental to minimizing systemic risk and strengthening international financial markets.

Using the methodology outlined in this paper, clearing member risk managers that today struggle with the opacity of non-compatible and non-standardised reports supplied by CCPs, would instead benefit from a single readily understandable framework, detailing in plain language how each of their default funds would endure under the same series of hypothetical stresses at each clearing house.

Using the same historical and antithetical events stressed at each CCP, and subject to the same standardised de-correlation exercises, the only variable exposed in the results will be the robustness of the financial resources at each clearing house, plainly expressed and easily understood by financial market participants.

The principles of transparency, simplicity and comparability are the three precepts that underpin this paper. We encourage and invite debate within the clearing community and within the CPMI-IOSCO CCP stress testing review currently underway, about the ideas and concepts raised in these pages. We believe this is a first step toward ultimately crafting a truly transparent clearing landscape across the globe.

If you have any questions please email: stresstesting@lch.com

Glossary

Aligned Clearing Member a member of the clearing house whose portfolio is structurally similar to that of a defaulted clearing member. Alignment of members is problematic since any member already aligned with the defaulter's cleared position has reduced capacity to help auction the defaulted members portfolios, and is therefore unable to act as a solvent counterparty to which those positions could be ported, without increasing the risk to the CCP.

Assessment an unfunded contribution to the default fund by clearing members. This would be in addition to the pre-funded contribution that non-defaulting clearing members have already made. Generally only required in severe default situations where the mutualised default fund has been depleted entirely and the CCP requires immediate recapitalisation.

Auction a process where a defaulted clearing member's portfolio of cleared positions is auctioned off to non-defaulting members of the clearing house.

CCP Central counterparty – another term for a clearing house.

Cover 2 a standard of CCP resiliency under which the clearing house would be able to withstand the simultaneous default of its two largest clearing members and their affiliates.

CPMI Committee on Payments and Market Infrastructures - a standard setting body for global financial markets which is a subset of the Bank for International Settlements. Formerly the Committee on Payment and Settlement Systems (CPSS).

Default Fund the pre-funded contributions all direct clearing members make into a clearing house to pay for the potential default of another clearing member.

EMIR European Market Infrastructure Regulation – the piece of European Union regulation designed to strengthen the stability of OTC derivatives markets across Europe, including central clearing of derivatives. It came into force on August 16, 2012.

G-SIFI Globally Systemically Important Financial Institution - a designation made by the Financial Stability Board signifying financial entities of sufficient magnitude, complexity and interconnectedness that their failure could have a potentially destabilising effect on the global financial system.

IOSCO International Organisation of Securities Commissions – an international regulatory standard setting body comprised of securities regulators from around the world which sets internationally recognised securities standards.

Masking Effects the inadvertent offset of correlated variables that have no causal or connecting relationship.

PFMI Principles for Financial Market Infrastructures – a set of standards published in April 2012 by CPSS and IOSCO to establish minimum requirements and risk management standards for CCPs and over-the-counter derivatives markets.

Porting the process of transferring a cleared trade facing the clearing house from a defaulted member to a non-defaulted member.

Principal Component Analysis a statistical method to identify the independent risk factors in a portfolio.

Skin in the Game a colloquial term for a clearing house's own capital at stake in the default waterfall should one or more clearing members fail.