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The end of the waterfall: default resources of central counterparties

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16 | 2015

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ISSN 1502-8143 (online)

ISBN 978-82-7553-882-4 (online)

The end of the waterfall: default resources of central counterparties¹

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27. November 2015

ABSTRACT:

Central counterparties (CCPs) have become pillars of the new global financial architecture following the financial crisis of 2008. The key role of CCPs in mitigating counterparty risk and contagion has in turn cast them as systemically important financial institutions whose eventual failure may lead to potentially serious consequences for financial stability, and prompted discussions on CCP risk management standards and safeguards for recovery and resolutions of CCPs in case of failure. We contribute to the debate on CCP default resources by focusing on the incentives generated by the CCP loss allocation rules for the CCP and its members and discussing how the design of loss allocation rules may be used to align these incentives in favor of outcomes which benefit financial stability. After reviewing the ingredients of the CCP loss waterfall and various proposals for loss recovery provisions for CCPs, we examine the risk management incentives created by different ingredients in the loss waterfall and discuss possible approaches for validating the design of the waterfall.

We emphasize the importance of CCP stress tests and argue that such stress tests need to account for the interconnectedness of CCPs through common members and cross-margin agreements. A key proposal is that capital charges on assets held against CCP Default Funds should depend on the quality of the risk management of the CCP, as assessed through independent stress tests.

Keywords: CCP, central clearing, central counterparty, systemic risk, default risk, counterparty risk, default fund, OTC derivatives, mechanism design, regulation, EMIR.

¹ This Working Paper should not be reported as representing the views of Norges Bank. The views expressed are those of the author and do not necessarily reflect those of Norges Bank. This working paper was prepared as part of the author's work at Norges Bank Research. I thank Farooq Akram, Bjorn-Ivar Bakke, Knut Sandal, Nathalie Sorhaug Berner, Eric Schaanning and Karl Ulrich for helpful comments and discussions.

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CONTENTS

1. CCPs: bulwarks against systemic risk or new Too Big To Fail entities?

2. Provisioning for default losses: the CCP loss waterfall

3. Margin requirements

- 3.1 Backtesting of margin requirements
- 3.2. Procyclicality of margin requirements
- 3.2. Exposures to worst-case scenarios and portfolio crowding
- 3.3 Accounting for liquidation costs

4. Mutualizing default losses: the CCP Default Fund

- 3.1. Size of the Default Fund
- 3.3 Allocation of Default Fund contributions across Clearing Members

5. CCP capital and “skin-in-the-game”

- 5.1. Capital requirements for CCPs
- 5.2 Skin-in-the-game

6. Assessing a CCP’s default resources

- 6.1 Stress testing of CCP default resources
- 6.2 Beyond single-CCP stress-tests: accounting for interconnectedness:
- 6.3 How risky are Default Fund assets?
- 6.4 How reliable are unfunded default resources?

7. The end of the waterfall : recovery mechanisms for CCPs

- 7.1 Variation Margin Haircuts (VMGH)
- 7.2 Liquidity provision during recovery
- 7.3 Contract tear-ups
- 7.4. Should ‘initial margin’ be used to fund a CCP’s recovery?

8. When all else fails: failure resolution of CCPs

9. Conclusion: Lessons for CCP design

1. CCPs: bulwarks against systemic risk or new ‘Too Big To Fail’ entities?

Following the financial crisis of 2008, one of the key ingredients in proposals for regulatory reform has been the (mandatory) clearing of over-the-counter (OTC) derivative transactions through central counterparties (CCPs). Guidelines present in Title VII of the Dodd-Frank Act, the Basel Committee’s proposal for regulatory reform (Basel III), and the European Market Infrastructure Regulation (EMIR) emphasize mandatory central clearing of standardized OTC derivatives for regulated financial institutions and capital surcharges for non-centrally cleared derivatives transactions, casting CCPs as pillars of the new global financial architecture.

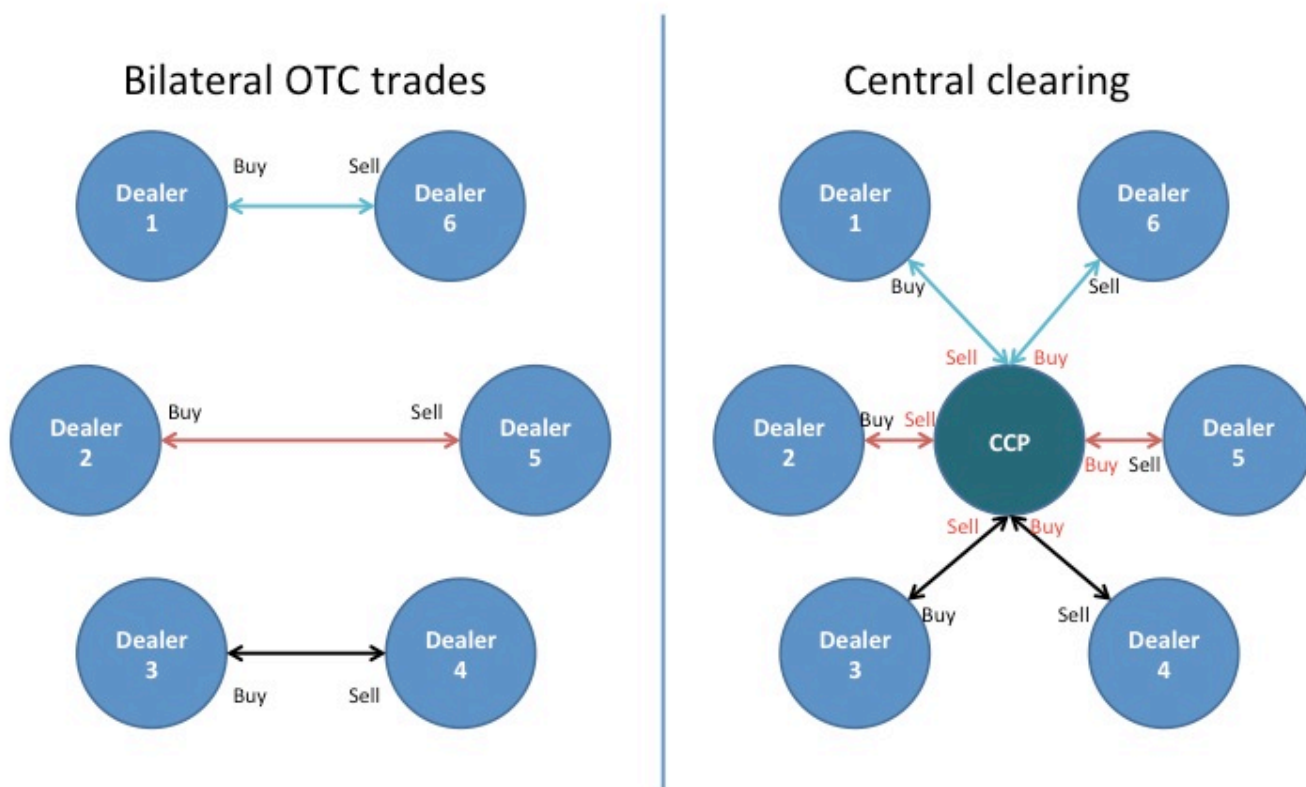


Figure 1: Central clearing involves replacing each bilateral over-the-counter trade by a pair of symmetric trades intermediated by a central counterparty CCP.

Central clearing involves replacing each bilateral trade between a pair of counterparties by a pair of symmetric trades with a *central counterparty* (CCP), which then becomes counterparty to both sides of the trade (Figure 1). Trades cleared through the CCP are subject to collateral requirements: all counterparties, called ‘Clearing Members’, post Initial Margin requirements corresponding to an assessment of the risk of their position with the CCP. Collateral requirements are computed using a standardized approach for all counterparties and regularly updated through (daily or more frequent) margin calls.

Central clearing, when properly implemented and subject to adequate risk management safeguards, can be a powerful tool for mitigating counterparty risk and contagion. The merits of CCPs include the reduction of exposures through multilateral netting across counterparties (Acharya & Bisin 2014; Duffie & Zhu 2011; Cont & Kokholm 2014), the reduction of counterparty risk through transparent collateral requirements, the reduction of operational risk, the enhancement of price discovery and regulatory transparency in OTC markets, and the improvement of risk management standards. These benefits are illustrated by the observation that many OTC markets had implemented central clearing well before being mandated to do so by recent legislation.

Figure 2 illustrates how channeling bilateral OTC exposures through a CCP can reduce the overall level of exposures through multilateral netting (Cont & Kokholm 2014). The same example also illustrates how a chain of exposures, which may potentially lead to contagion in case one element in the chain defaults, is broken by central clearing through a CCP. This feature, together with the fact that all Clearing Members are subject to collateral requirements, helps mitigate the counterparty risk and the associated risk of contagion which may arise from OTC exposures (Cont & Minca, 2014).

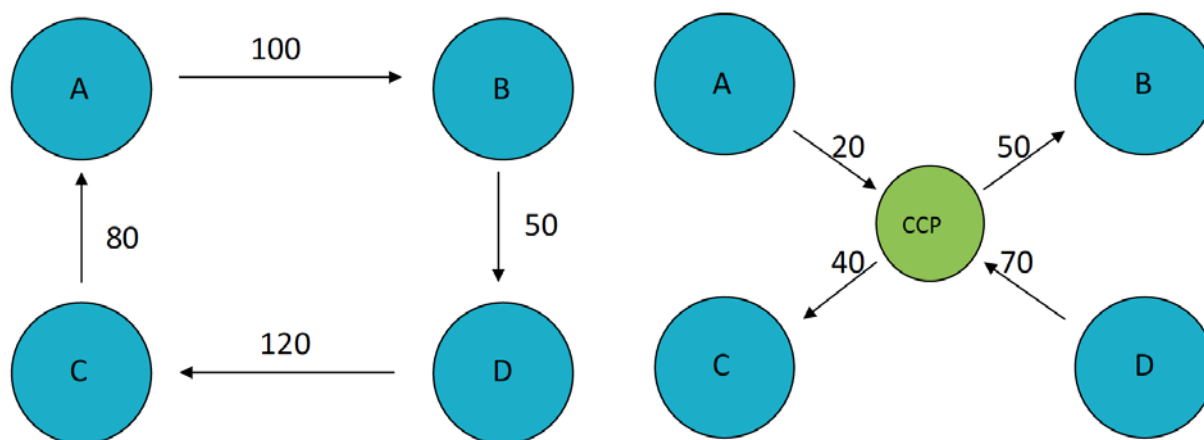


Figure 2: Bilateral vs multilateral netting. When there are a sufficient number of market participants, central clearing leads to a reduction of exposures through multilateral netting across counterparties.

An important feature of central clearing is the standardization –and centralization– of

collateral requirements for all participants in OTC transactions, which has not been the case for bilateral OTC transaction. Although this entails a cost for market participants, it also reduces operational risk and legal risk associated with collateral disputes in bilateral transactions, by deferring margin calculations to the CCP. This may trigger in turn the standardization of data formats and risk models for cleared transactions.

The potential benefits of central clearing are, however, conditional on the availability of sufficient liquidity resources for the CCP to maintain its clearing operations through market stress scenarios, which in turn hinges on the adequacy of the risk management of the CCP. The increasingly important role given to CCPs in mitigating counterparty risk and contagion has in turn cast them as systemically important financial institutions whose eventual failure may lead to potentially serious consequences for financial stability and prompted discussions on CCP risk management standards and safeguards for recovery and resolutions of CCPs in case of failure. By concentrating counterparty risk in CCPs and increasing the range and volume of cleared instruments, central clearing mandates have turned some CCPs into « Too Important to Fail » entities, whose failure would be a catastrophic event. Accordingly, market participants have voiced legitimate concerns about the risk management procedures used by CCPs, the adequacy of their resources in the event of the default of one or several Clearing Members and the procedures to follow in the event of a CCP's failure (BlackRock 2014, JP Morgan 2014).

A CCP may incur losses due to market variations of assets held on its balance sheet (non-default losses) as well losses due to the default of its Clearing Members. Non-default losses are absorbed by the CCP's capital, which in this respect is subject to adequacy rules similar in spirit to that of a bank. What makes a CCP different from a bank is its exposures to losses stemming from the default of Clearing Members, and CCPs have developed various “default resources” to deal with these exposures. The current debate focuses on the adequacy of these default resources and what to do once these resources are depleted.

A key issue is the regulation and supervision of CCPs and their Clearing Members. Close examination of the incentives of the CCP and its Clearing members reveals that the absence of appropriate regulation may lead to outcomes where the CCP may become a source of systemic risk rather than a safeguard against it (Cont 2010; Murphy 2012; Acharya & Bisin 2014; Cont & Minca 2014). In absence of proper regulation, the presence of multiple CCPs, may generate a “race to the bottom”, allocating the largest market share to CCPs which have the lowest collateral requirements (Santos & Scheinkman, 2001).

This note contributes to the debate on CCP default resources by focusing on the incentives generated by the CCP loss allocation rules for the CCP and its members and discussing how the design of loss allocation rules may be used to align these incentives in favor of outcomes which benefit financial stability. After reviewing the ingredients of the CCP loss waterfall and various proposals for recovery provisions for CCPs, we examine the risk management

incentives created by different ingredients of the loss waterfall and discuss possible approaches for validating the design of the waterfall.

We emphasize the importance of CCP stress tests and argue that such stress tests need to account for the interconnectedness of CCPs through common members and cross-margin agreements. A key proposal is that capital charges on assets held against CCP Default Funds should depend on the quality of the risk management of the CCP, as assessed through independent stress tests.

Finally, we discuss different options for the recovery of a failing CCP, emphasizing the interplay between liquidity and solvency constraints and the risk incentives resulting from each type of recovery mechanism.

2. Provisioning for default losses: the CCP loss waterfall

Clearing Members bring to the CCP a set of bilateral transactions for clearing. In any contract, the sum of long and short positions is zero (clearing condition). Both parties pay an initial margin as well as a contribution to the CCP Default Fund.

Each member periodically pays or receives a *variation margin* corresponding to the variation of the market value of its open positions. The sum across members of all variation margins paid and received is zero due to the clearing condition so, if all members pay in the variation margins due to the CCP, the CCP then simply acts as a pass-thru and transfers it to the members whose mark-to-market variation is positive. As long as members have not defaulted, variation margin payments sum to zero. So the CCPs are affected by market risk of member portfolios only in scenarios where one or more Clearing Members default.

If one or several members default, the margin payments are not zero-sum anymore: defaulting members may fail to pay the variation margin due to the CCP and the CCP then liquidates their open positions, typically through an auction. During this process the CCP continues to honor all variation margin payments to open positions of non-defaulted members, which may entail a loss for the CCP. Due to continuous (e.g. daily) variation margin payments, the CCP is only exposed to losses which occur at or following the member's default.

To fulfill its role, a CCP thus needs to maintain financial resources that can absorb losses in the event of their members defaulting. These include

- margin requirements collected from Clearing Members
- a Default Fund, to which all Clearing Members are required to contribute, designed to absorb losses that exceed the initial margin posted by defaulting members, and
- the CCP's own equity.

The "loss waterfall" describes how these resources available are used to absorb potential losses arising from the default of Clearing Members:

1. The first layer of protection against losses is provided by the margin requirements. Each Clearing Member maintains a margin requirement with the CCP, sometimes called 'Initial Margin', which corresponds to a measure of the risk of the member's portfolio over a risk horizon. The risk horizon ranges from one to several days, depending on the asset class being cleared. The level of margin requirements is typically set to cover potential market losses in the Clearing Member's positions over the risk horizon over a range of scenarios.

End of the Waterfall: Default resources of CCPs

A common approach has been to set the level of margin requirements for a Clearing Member to cover losses of the member's portfolio in a set of risk scenarios corresponding to possible portfolio losses over the risk horizon. This set may be a set of scenarios fixed in advance by the CCP (as in the CME's Standard Portfolio Analysis, or SPAN, approach), a set of historical scenarios (historical Value-at-Risk) or a set of scenarios simulated using a statistical model. The margin requirement may then be computed as the worst case loss (in the SPAN method) a loss quantile (VaR) or Expected Shortfall (tail conditional expectation) at a certain confidence level, which may be 99% or higher. The margin level may then be interpreted as the amount of collateral required to absorb losses in a proportion of scenarios given by the confidence level.

The initial margin paid in by each member may only be used to absorb the losses arising from the member's portfolio, but cannot be used to offset losses of other members or other losses incurred by the CCP.

2. If the loss exceeds the initial margin contribution, the failing member's Default Fund contribution is used to offset the additional losses.
3. If the loss exceeds the sum of the defaulting member's margin and Default Fund contribution:
 - first the CCP makes a limited (capped) contribution to offset the remaining loss: this contribution is sometimes referred to as "skin-in-the-game".
 - if the CCP's contribution is insufficient, the Default Funds of other members are used to absorb remaining losses.
4. If the losses exceed the size of the Default Fund, the CCPs may have recourse to:
 - an additional contribution from the CCP's own capital
 - an additional contribution to the Default Fund by non-defaulting Clearing Members: this "assessment" is sometimes uncapped and sometimes capped by the initial contribution of the members.
5. **Recovery:** If the above resources are not sufficient for absorbing the losses resulting from the default of Clearing Members, then the CCP may take extraordinary measures to replenish its resources and maintain continuity of its clearing operations. These measures are known as the "recovery plan". Some solutions which have been considered are:

- Variation Margin Haircutting (VMGH): during the recovery phase the CCP continues to collect variation margin payments from members with negative P&L but does not transfer them entirely to their counterparties, retaining a portion for replenishing its resources.

- tear-up of contracts: in some cases the CCP may decide to close (i.e. liquidate) some positions of CCP members.

End of the Waterfall: Default resources of CCPs

-“initial margin haircuts”: some proposals include the use of initial margin of non-defaulted members as a source of funds for the CCP’s recovery.

We discuss below the relative merits of these and other recovery provisions.

6. **Failure Resolution:** If recovery measures fail to replenish the resources of the CCP or if the CCP or its members choose not to proceed with recovery measures, the CCP might eventually become insolvent or lack the liquidity resources for continuing its operations, resulting in default or requiring the use of resolution powers by authorities. Alternatively, the regulators may choose to trigger the failure resolution regime before failure actually occurs. The triggers for entry into resolution may vary from jurisdiction to jurisdiction.

The failure of a CCP is an undesirable outcome which may impair the stability of the financial system. It is therefore understandable that failure resolution of CCPs has focused a lot of debate. An important component of this debate has focused on the legal regime most appropriate for the resolution of a CCP, loss allocation in the resolution phase and the legal and financial implications of resolution for CCP members and their clients. Duffie (2014) gives an excellent and up-to-date discussion of these important issues.

By contrast, less discussion has been devoted to preventive measures which could reduce the likelihood of failure in the first place. These measures relate to the design of the loss waterfall, not only in terms of the loss absorbing capacity of its various components but also in terms of the resulting incentives for the CCP and its Clearing Members.

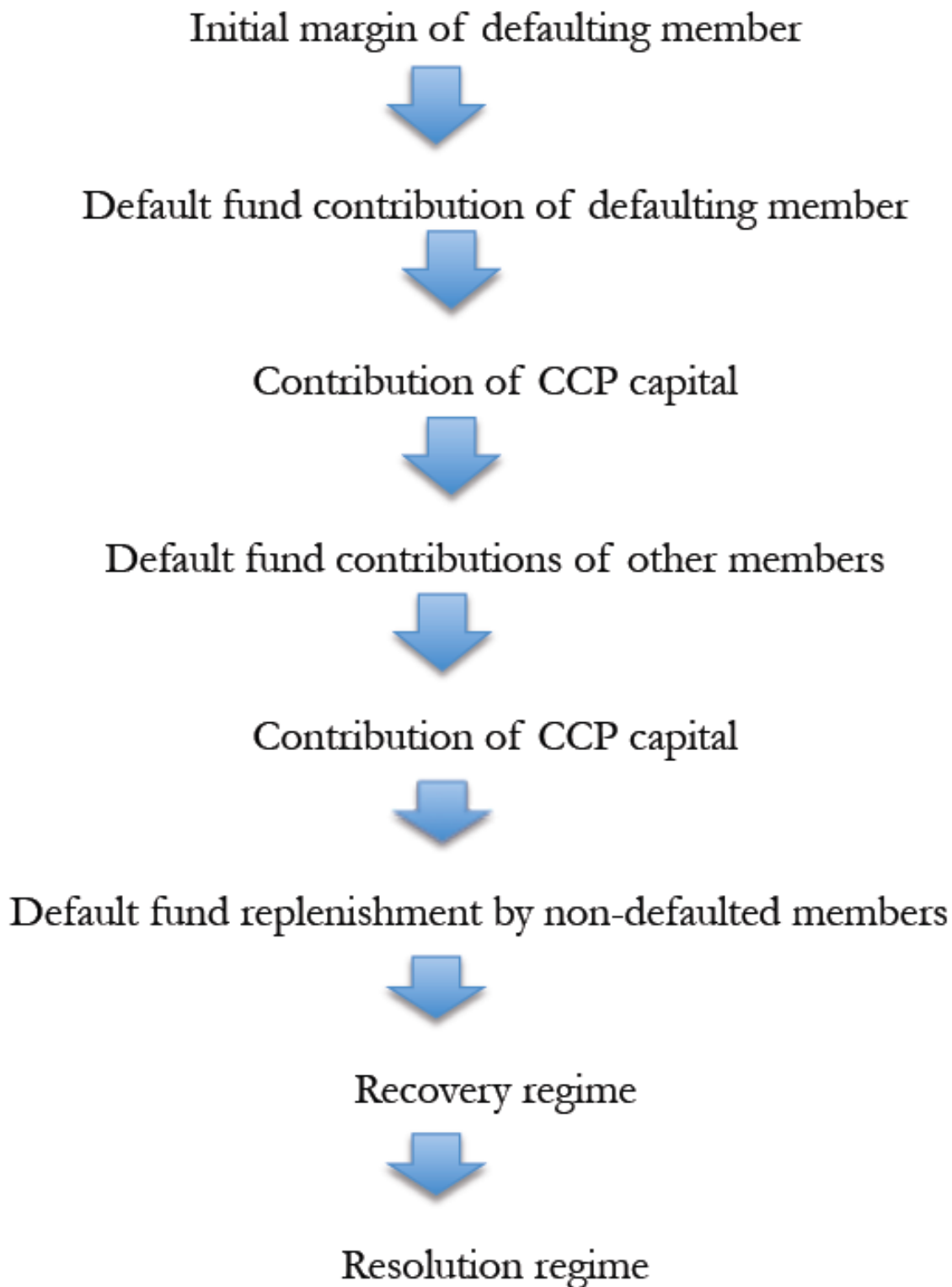


Figure 3: The loss waterfall of a CCP.

CCP risk management systems are subject to approval and periodic review by regulators. In practice, such reviews have typically focused on backtesting of margin levels for clearing member portfolios and assessing whether the size of the Default Fund corresponds to the regulatory guideline of covering the liquidation costs for one (or two) clearing member defaults. Such backtesting procedures assess the effectiveness of the waterfall design in covering losses in stress scenarios and are necessary for the validation of a CCP's risk management model.

However, an equally important issue in assessing the design of the waterfall concerns the risk management incentives it provides to the CCP and the clearing members in advance of such stress scenarios. A well-designed loss waterfall should provide the right risk management incentives to Clearing Members and the CCP to steer away as much as possible from configurations that may lead to failure of the CCP. We will now examine the ingredients of the loss waterfall from the perspective of the incentives they generate for the CCP and its members.

3. Margin requirements

Margin requirements for Clearing Members are typically computed based on a measure of market risk for the Clearing Member's positions over the risk horizon. The risk horizon, in current practice, depends on the asset class being cleared and ranges from one to several days.

Choices for the risk measure include:

- scenario based approaches, such as CME's "Standard Portfolio Analysis approach" (SPAN), which evaluate the worst loss of the portfolio across a range of scenarios;

- statistical risk measures, such as Value at Risk (VaR) or Expected Shortfall (ES) or variants of these, such as "truncated Tail Conditional Expectation", which is a robust version of Expected Shortfall (Cont, Deguest & Scandolo, 2010). These risk measures are usually computed at a confidence level which ranges from 99% to 99.75%, depending on CCPs. The estimation of these risk measures is either done using historical data or using a model-based simulation involving statistical assumptions on the risk factors affecting the Clearing Member's portfolios.

While all methods end up computing the worst loss across a set of scenarios, a key difference is that in scenario-based approaches such as SPAN the set of scenarios does not depend on the portfolio, whereas in the statistical approach (Value at Risk) the set of scenarios depends on the portfolio and corresponds to the tail of the loss distribution for

the specific portfolio considered.

3.1 Backtesting of margin requirements

Different assumptions lead to different values for margin requirements and, even within an asset class, there is often no consensus on model and parameter choices. As a result, margin requirements for identical portfolios cleared in different CCPs may be quite different and one may observe differences up to 50% in some cases. Given the difference in assumptions across models, a higher confidence level does not necessarily imply higher margin requirements: for example, a 99.75% Value at Risk computed in a Gaussian model may be in fact less conservative than a 99% Value at Risk in a model with heavy-tailed risk factors. Thus, the adequacy of margin requirements must be assessed using an objective criterion which is comparable across models.

A common approach to the validation of margin requirements is ‘historical back testing’: the margin requirements are computed for a set of portfolios (often, the Clearing Member portfolios) every day using historical data and compared with the subsequent (out of sample) T-day realized, where T is the risk horizon. Various criteria, such as the frequency and the clustering in time of loss in excess of margin, are used to assess the adequacy of the level of margin requirements. This procedure, similar to the one used for backtesting risk models for bank portfolios, leads to a result which is comparable across models if the same historical data set is used. CCPs should be equipped with the necessary data and computational resources for performing such backtests systematically on Clearing Member portfolios, as some already do.

Historical backtesting, though necessary and useful, yield an incomplete assessment of the adequacy of margin requirements: they are restricted to a set of historical scenarios which may or may not be representative of potential stress scenarios facing the CCP, and only consider current positions of Clearing Members.

A more comprehensive validation should involve not just current Clearing Member portfolios but also hypothetical ‘test’ portfolios which may represent possible positions that members may bring to the CCP. This allows to track potential weaknesses in the margin calculations and identify “worst-case portfolios” whose risk may not be captured by the margin requirements.

3.2. Pro-cyclicality in margin requirements

Margin requirements are computed, either directly through historical simulation or indirectly through a statistical model, using recent market data. Regulatory guidelines recommend to use at least 2 years of (recent) historical data for parameter estimation and in practice the

data set used for model estimation ranges between 2 to 5 years. The use of (a sliding window of) recent market data introduces procyclicality in the margin requirements (see e.g. Murphy et al 2014). Margin levels increase following an episode of market turbulence, due to updating of risk factor volatilities. Conversely, episodes of severe market turbulence, such as the crisis of 2008, are ‘forgotten’ by the model once they are not part of the estimation window. Accordingly, recent regulatory guidelines (in particular EMIR) have recommended to introduce ‘pro-cyclicality adjustments’ in margin requirements.

When margin requirements are computed through historical simulation (for example, historical VaR), a simple way to avoid pro-cyclicality is to include a (fixed) set of ‘stress scenarios’ in the scenarios being used for the margin calculation. These stress scenarios may either correspond to historical episodes of market stress which may fall outside the estimation window, or correspond to counterfactual, but realistic, co-movements of risk factors.

When margin requirements are computed using model-based calculations or simulations, pro-cyclicality may be attenuated by using a floor (minimum value) for risk factor volatilities. These floors may be estimated using a longer data set including past episodes of market stress, thus rendering them robust to changes in the data set. Using such floor levels also makes the initial margin requirements more stable and less sensitive to day-by-day market fluctuations (which should be primarily be captured by the variation margin).

The use of similar models for margin calculations across different CCPs is also a factor of pro-cyclicality: models using similar methodologies or based on similar inputs will lead to simultaneous increases in margin requirements. Although regulators tend to be reassured by the use of ‘commonly used’ models for margin calculations, the diversity of models is in fact desirable from the perspective of mitigating pro-cyclicality.

3.3. Correlation breakdown, worst-case scenarios and portfolio crowding

When initial margin is computed at the portfolio level, rather than at single instrument level, the calculation involves assumptions on correlations, or ‘offsets’, of gains and losses across different instruments. Historical risk calculations implicitly assume that the historical dependence structure of risk factors will remain stable; model-based or simulation-based margin calculations may involve explicit assumptions on the dependence structure of risk factors, typically estimated from recent market data. We will refer to these assumptions as the ‘baseline scenario’. However, empirical studies and theoretical models both point to the possibility that ‘historical correlation’ assumptions may fail to hold in market crisis scenarios leading either to sharp increase or decrease in correlation levels (Cont & Wagalath, 2013), for reasons which are endogenous to the origin of market correlations. It is therefore important to consider, when computing initial margin requirements, ‘correlation stress

scenarios' where the dependence structure of risk factors may be stronger or weaker than the baseline scenario based on historical data. Considering such scenarios, which are not based on recent market data, also has the benefit of reducing the pro-cyclicality of margin requirements by attenuating their dependence on recent market moves which affect correlation levels used in the baseline scenario.

Another useful complement to historical back-testing is 'reverse stress testing': instead of verifying the frequency of excess losses above margin across a given set of scenarios, one attempts to identify extreme but plausible scenario(s) which maximize excess losses above margin for current member portfolios.

The nature of these 'worst case scenarios' give an insight into the risks the CCP is exposed to. When derivatives positions are involved, these 'worst case scenarios' may be in fact quite different from tail scenarios for the underlying risk factors. For example, the worst case scenario for a 'straddle position' (long position in an out-of-the money call and an out-of-the-money put) is that the underlying asset does not move. Similarly, when several correlated risk factors are involved, worst case scenarios may involve complex co-movements in the risk factors which may correspond to typical, rather than 'tail', scenarios.

Examination of 'worst case scenarios' is also useful for assessing the dependence of tail risks across Clearing Members: if many Clearing Members are exposed to the same 'worst case scenarios', this reveals a 'crowding risk' across member portfolios which implies that these Clearing Members may be simultaneously subject to large margin calls if such scenarios occur. Clearing Members, being unaware of other members' positions, may fail to take this risk into account. This should prompt the CCP to increase the margin requirements for such portfolios.

3.4. Accounting for liquidation costs

It should be clear from the description of the CCP loss waterfall that the only scenarios in which the CCP is exposed to losses in a Clearing member's portfolios are scenarios where this Clearing Member defaults. In this case, the CCP typically liquidates the defaulting member's positions. Any loss incurred in the process of liquidation is therefore realized as a *liquidation cost*. Whereas the margin requirements are computed by assessing the market risk of a Clearing Member's position over a (fixed) risk horizon T , the result may be substantially different from the liquidation cost due to several reasons:

-*Bid-ask spreads*: the liquidation of a portfolio with long and short positions involves an unwinding cost which, for small positions, is proportional to the bid-ask spread of the instruments involved. Thus, two positions with the same market risk but different bid-ask spreads entail different liquidation costs, which is not accounted for in margin requirements

End of the Waterfall: Default resources of CCPs

based on market risk measures such as VaR or Expected Shortfall.

-Liquidation horizon for large positions: orderly unwinding of positions whose magnitude is large compared to the market depth may not be feasible over the (pre-specified) risk horizon and may require more time. For example, if a CDS position whose size is twice the magnitude of daily trading volume is liquidated at the rate of 20% of daily volume, its orderly liquidation requires 10 days, rather than the 5-day risk horizon conventionally used for CDS margin calculations. As observed in this example, for large positions the liquidation horizon may be larger than the risk horizon for margin calculations and increases proportionally to the position size.

A consequence of this is a nonlinear scaling of liquidation costs with portfolio size. Recall that commonly used risk measures such as standard deviation, VaR or Expected Shortfall, when computed over a fixed horizon T , are proportional to the notional size N of the portfolio and typically have a square-root (\sqrt{T}) dependence with respect to the horizon. If the liquidation horizon itself increases linearly with the notional size N , as explained above, then the overall dependence of the risk measure with respect to the position size N will be proportional to $N\sqrt{N} = N^{3/2}$. Thus, if the notional size of the position is increased by a factor 4, standard deviation, VaR or Expected Shortfall would increase by a factor 4 but the liquidation cost typically increases by a factor $4\sqrt{4}=8$.

These arguments show commonly used market risk measures such as VaR or Expected shortfall do not yield a proper evaluation of liquidation costs: they do not use any information on market depth or bid ask spreads and scale linearly with positions size.

Collateral requirements for CCP members should not be solely based on an evaluation of the market risk of their portfolio but include an additional *liquidity charge* which corresponds to the potential additional cost incurred by the CCP for liquidating the member's portfolio in an extreme but plausible market scenario. In the example above, the liquidity charge would correspond to the difference between an estimation of the liquidity cost of the portfolio and a measure of its market risk (VaR, Expected Shortfall, etc) over the standard risk horizon T :

$$\text{Collateral Requirement} = \text{Market Risk requirement} + \text{Liquidity Charge over standard risk horizon}$$

Whereas the first component typically increases proportionally with position size, the Liquidity Charge should increase faster than linearly, as argued above, reflecting the higher liquidation cost per dollar notional for large, concentrated positions. Thus, when applied to portfolios which have the same market risk measure, a properly calculated liquidity charge should be

-higher for portfolios with positions whose sizes are large relative to market depth, and

End of the Waterfall: Default resources of CCPs

-higher for portfolios with positions in less liquid instruments.

A properly calibrated liquidity charge should therefore deter members from accumulating concentrated exposures and illiquid positions, and provides incentives to the Clearing Members for managing their exposure to liquidity risk.

The list of centrally cleared OTC derivatives is steadily expanding and for many of them liquidity is an essential component of the risk, which cannot be ignored. It is our opinion that the incorporation of a liquidity charge as described above in margin requirements is an essential step towards a sound risk management of CCPs clearing such instruments. A corollary to this remark is that, when establishing the eligibility of a new class of instruments for clearing, a necessary condition should be the availability of a methodology for evaluating the liquidation cost for these instruments.

A correct evaluation of the liquidation cost needs to account for market depth of each instrument held in the portfolio and can be a challenging task for complex, multi-asset portfolios. An integrated approach to the evaluation of margin requirements, which simultaneously addressed market risk and liquidation cost, is the CloseOut Risk Evaluation (CORE) method described in (Avellaneda & Cont, 2012), which has been implemented in some major CCPs (Vicente et al, 2015).

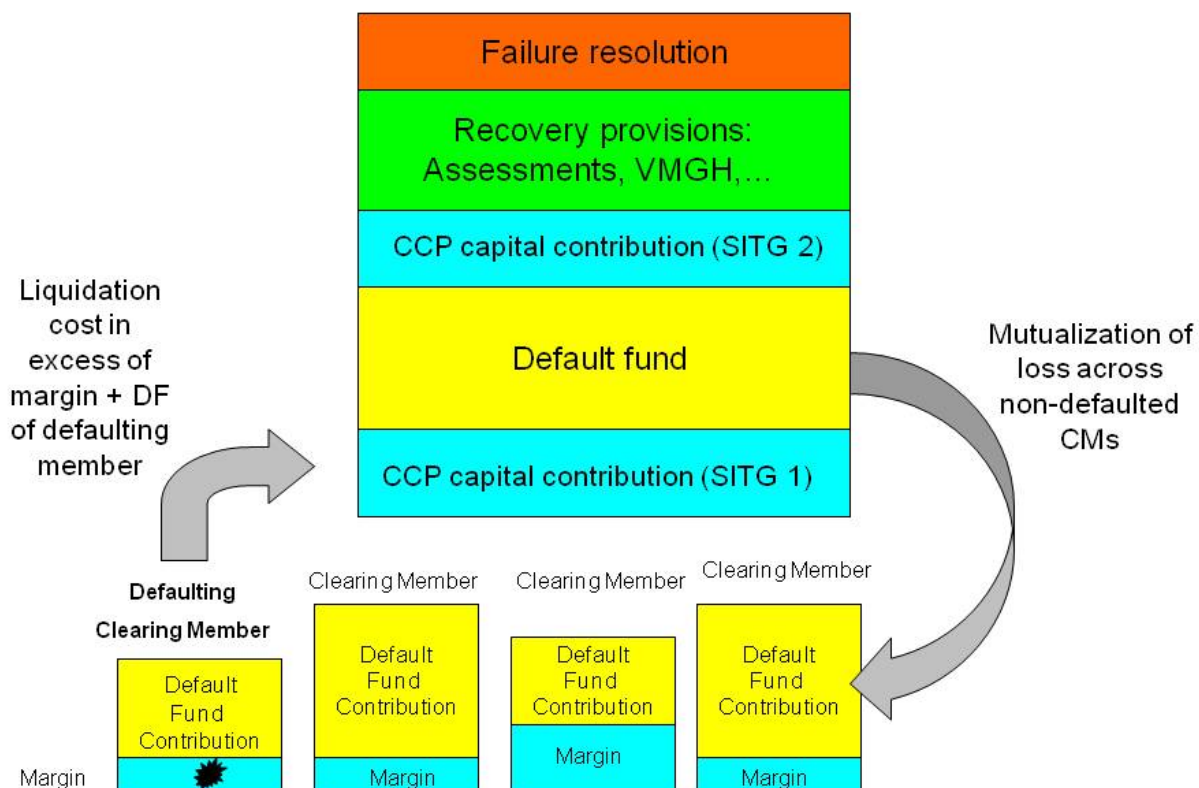


Figure 4: Allocation of default losses in the event of a Clearing Member default.

4. Mutualizing large losses: the CCP Default Fund

The second layer in the loss waterfall of a CCP is the Default Fund. When the initial margin contributions of a defaulting member is insufficient to cover the liquidation costs, the Default Fund contribution of the Defaulting member is used as a first recourse. However, unlike the initial margin contributions which may only be used for covering the contributing member's losses, the Default Funds may be also used to cover other member's losses: the Default Fund mutualizes large losses across all Clearing Members. Two important questions regarding the CCP Default Fund are its size and the allocation of Default Fund contributions across Clearing Members.

4.1. Size of the Default Fund

CPSS-IOSCO regulatory guidelines require CCPs to maintain a Default Fund whose size suffices for covering liquidation costs of any member of the CCP in extreme but plausible market scenarios. This provision, known as “cover one”, implies that the CCP should assess its exposure to the default of each Clearing Member, by evaluating the potential liquidation cost of the member's portfolio across a range of plausible stress scenarios. The CCP should then ensure that the size of the Default Fund exceeds the largest exposure to any member. Following multiple failures of Clearing Members in 2008, this requirement has been strengthened to “cover two” for systemically important CCPs (CPSS-IOSCO 2012): such CCPs should provision for two member defaults. The recent European Market Infrastructure Regulation (EMIR) now requires all CCPs to cover “the default of the clearing member to which it has the largest exposures or of the second and third largest clearing members, if the sum of their exposures is larger » (EU Regulation 648/2012 Article 42 §3).

These requirements are sometimes described as “covering the default losses from the (two) largest member(s)”. This interpretation is not correct: the spirit of the guideline (CPSS-IOSCO 2012) is clearly to provision for the (possibly simultaneous) default of the two members *to which the CCP has the largest exposure*. Since the initial margin of each member is offset against its loss, this may or may not correspond to the member(s) with the largest initial margin or the member(s) with the largest open interest. For example, if the member with the largest (notional) position has also posted a large amount of initial margin, the exposure of the CCP to its default may in fact be quite small.

This remark is important, since it entails that Clearing Members to which the CCP will be most exposed are typically not those with large directional positions (and equally large margin requirements) but rather those who have ‘well-balanced’ portfolios with large long and short positions and small ratio of net-to-gross notional value. When margin requirements are computed at the portfolio level, such portfolios may end up with a low

ratio of margin to gross notional; however the liquidation of multiple long and short positions typically entails a liquidation cost which is proportional to the gross notional, hence the possibility of a large shortfall for the CCP.

The necessity of considering more than one default emerged following the recent crisis during which several large financial institutions failed or encountered severe liquidity problems simultaneously. ‘Simultaneous’ refers here to the possibility that a second default occurs before the Default Fund can be replenished following the first default. Whereas standard default correlation models, such as those used for credit rating of such financial institutions, would attach an extremely low probability to the simultaneous default of large Clearing Members, the near failure of several large financial institutions during the 2008 debacle indicates that such scenarios may be a real possibility.

The criterion of “two defaults” has been criticized as being arbitrary and unrelated to the number of Clearing Members or their creditworthiness. Indeed, it has been proposed (Ghamami 2014) to use instead assumptions on default probabilities and default correlations of Clearing Members and determine the Default Fund size as a tail risk measure quantifying losses from joint member defaults. This approach, while more appealing from a quantitative perspective, requires (unobservable) joint default probabilities for Clearing Members, which are often large financial institutions whose creditworthiness is difficult to assess, making this approach difficult to validate. The “cover N” approach, on the other hand, offers a robust alternative which considers the worst-case scenario across all possible member defaults without making (unverifiable) assumptions on their joint default probabilities.

The choice of $N=2$ seems somewhat arbitrary: some CCPs have a dozen Clearing Members, others more than a hundred. CCPs with a broad membership also have a high degree of heterogeneity in the sizes and open positions of the Clearing Members and exposures to the largest Clearing Members typically dominate the risk of the CCP. But the focus on ‘cover one’ or ‘cover two’ scenarios neglects the possibility of a large number of small member defaults, which may occur in a CCP with a broad membership: such a scenario deserves to be considered if there is a high degree of overlap (or concentration) across many Clearing Member portfolios, a possibility that the CCP can identify by monitoring the portfolio overlaps between members positions on an ongoing basis. A methodology for measuring such overlaps and the resulting exposure to crowding risk is proposed in (Cont & Wagalath, 2013). If a large number of members develop concentrated, overlapping positions, then the CCP may consider increasing the Default Fund to provision for their joint failure.

Another important issue in the calculation of the Default Fund size is the calculation of the default losses in the event of the default of a large Clearing Member. The scenarios based on which the Default Fund is sized involve the default of members with large positions with the CCP. These members often turn out to be large broker-dealer banks, whose default is very

likely to be associated with a high level of market volatility (Duffie 2010) and/or widened bid-ask spreads. The calculation of liquidation costs for Clearing Member portfolios should therefore go beyond the current mark-to-market value of the portfolio and account for adverse market moves and widening of bid-ask spreads in a market stress scenario.

Although margin requirements are updated daily by most CCPs, the Default Fund is sometimes updated less frequently. Whatever method is used to compute the size of the Default Fund, it should be clear from the discussion above that it depends on the configuration of Clearing Member portfolios. Thus, substantial changes in the positions of clearing members warrant a recalculation of Default Fund contributions. The size of the Default Fund should therefore be updated as frequently as required by the turnover of member portfolios. The frequency of these adjustments may vary according to the asset class. There may also be particular dates, such as index option maturity dates for equity options, index roll dates for credit default swaps and LIBOR fixing dates for interest rate swaps, on which one expects a high turnover of positions; it is then important to readjust Default Fund contributions at these dates to take into account possible changes in portfolios.

4.2. Allocation of Default Fund contributions across Clearing Members

Regulatory oversight of the Default Fund is often limited to inspection of its size, using a “cover one” or “cover two” criterion. However, the allocation of Default Fund contributions across Clearing Members plays an important role in the incentives it generates for Clearing Members and should fall within the scope of any validation of default resources.

The discussion above shows that exposure of the CCP to the default of the Clearing Member, not the level of margin or open interest, should be the primary driver of Default Fund contributions. The members most likely to draw on the Default Fund in case of failure are not necessarily those with large initial margins, but those who entail a large liquidation cost at default for the CCP once margin is accounted for. To be clear, what we are advocating here is that the allocation of Default Fund contribution of a Clearing Member be proportional to the exposure of the CCP *to* the Clearing Member, rather than the market risk or margin level of the Clearing Member’s portfolio.

Surprisingly, CPSS-IOSCO does not provide any regulatory guideline regarding the allocation of Default Fund contributions across Clearing Members and many CCPs actually use other, ad-hoc, allocation rules ranging from a fixed amount to weighted averages of open interest, clearing volume and initial margin. EMIR (EU Regulation 648/2012 Article 42 §3) states that Default Fund contributions « shall be proportional to the exposures of each clearing member » which refers to the exposures *of* the Clearing Member rather than the exposure of the CCP *to* the Clearing Member. Though most regulators understand the issue

to be the exposure of the CCP *to* clearing members, not the (market) exposures of the Clearing Members, the wording of EMIR (Title 42 §3) is unfortunate and deserves to be clarified.

It should be clear from the above discussion that such allocation schemes may provide distorted incentives to Clearing Members. Consider the example of a large Clearing Member maintaining a large ‘spread trade’ positions: large, symmetric positions in different but similar, correlated instruments, such as interest rate swaps or credit default swaps with the same underlying but different maturities (curve trades). Such a portfolio has a low ratio of ‘net notional’ to gross notional; this ratio can even be zero in principle if the long and short positions are well-balanced. If the instruments involved in the spread trade are highly correlated, such a portfolio will have a low volatility and the member’s “exposure” -and therefore its initial margin calculated at the portfolio level- will then be small, and proportional to the net, rather than gross, notional.

However, if the notional sizes of these long/short positions are large, the liquidation of such a portfolio may turn out to be extremely costly for CCP in case of the Clearing Member’s default, and such a large portfolio may be very well the one to which the CCP has the largest exposure. Thus, in a scheme where Default Fund contributions are allocated proportional to initial margin or a market risk measure of the member’s portfolio, a Clearing Member with a well-balanced long/short portfolio may be simultaneously the one which determines the size of the Default Fund (by generating the largest liquidation cost) while contributing to it the least (by minimizing its margin requirement) (Cont 2010)! More generally, the issue is that margin is an evaluation of ‘typical risks’ while the Default Fund is designed to cover ‘tail risk’: using margin or volume as a basis for allocation generates incentives for ‘free-riding’ for Clearing Members, by exposing themselves to tail risk which is then mutualized through the Default Fund, while maintaining a low contribution in terms of margin or volume.

5. CCP capital and “skin-in-the-game”

5.1. Balance sheet structure of CCPs

Much recent debate has focused on the question of moral hazard and capital adequacy for CCPs, as well as incentives for CCPs to implement proper risk management procedures. Such discussions typically point to the fact that CCPs typically maintain equity levels which are quite low compared with the large pool of assets they clear and have principally relied on collateral posted by members, rather than their own capital, for absorbing losses. This reflects the nature of a CCP’s activity as a pure intermediary: although it collects revenue proportional to the volume of assets it clears, it does not own these assets and is only exposed to losses of Clearing Members in excess of their margin and Default Fund requirements.

Regulatory discussions often refer to the ‘financial resources’ that the CCP can use to ‘absorb losses’. In the bank regulation terminology, this would refer to the capital of financial institution and its role as a buffer against insolvency. However, in the case of a CCP, this rather vague terminology fails to distinguish liquidity risk from solvency risk, a distinction which is important for our discussion. To understand this point, let us take a closer look at the balance sheet of a CCP.

Figure 5 displays a stylized balance sheet of a CCP. A CCP collects Default Fund contributions from its members, and invests them in low-risk, liquid assets, which constitute the asset side of the balance sheet. The CCP may also hold other liabilities in the form of external debt, but the liability side of the balance sheet is typically dominated by liabilities to Clearing Members stemming from margin balances and, to a lesser extent, Default Fund contributions.

ASSETS	LIABILITIES
Long-term assets	Long-term Liabilities to Clearing Members: -Default Fund contributions
Current assets: -margin balance with CMs	Short-term liabilities: -margin balance with CMs
	CCP capital

Figure 5: Balance sheet of a CCP.

Assets	Liabilities
231,919.7 M EUR	231,495.2 M EUR
Non-current assets 115.3 M EUR	Long-term liabilities 4146.5 M EUR
Liquid assets 231,804 M EUR (99.95 % of assets)	Short-term liabilities 227258.7 M EUR (98 % of liabilities)
	EQUITY: 514 M EUR (0.22 % of total assets)

Figure 6: Balance sheet of LCH (December 2013). Source: LCH Annual Statement 2013.

End of the Waterfall: Default resources of CCPs

The assets of the CCP are subject to market fluctuations and, as in a bank portfolio, this leads to a prudential requirement that the CCP's capital be sufficient to absorb these losses across a set of extreme but plausible scenarios, that is, to prevent insolvency due to market losses. But, given that CCPs typically invest in low-risk, high quality assets, the level of capital needed for this type of insolvency risk is a very small fraction of the balance sheet.

The balance sheet of many CCPs closely resembles this “liquidity pass-through” model: the bulk of the assets and liabilities is composed of balances of short-term payables/receivables with Clearing Members and the equity is quite small compared to other elements of the balance sheet. Figure 6 shows the 2013 balance sheet of LCH, one of the world's largest CCPs. In 2013, LCH cleared more than \$ 57.4 trillion in swaps through SwapClear and held an average cash collateral amount of 29.9 billion Euros. As seen in Figure 6, 99.95% of the assets in the balance sheet are liquid assets, 98% of liabilities are short-term liabilities (mostly to Clearing Members) and equity is less than 0.25 % of assets! These ratios are quite different from those observed in financial institutions such as banks and seem alarming. Yet LCH, which cleared Lehman Brothers' \$ 60 billion swap positions, liquidated these positions without taking a single dollar of loss in 2008.

The reason why CCPs have been able to function with such a balance sheet structure is that losses due to the default of a Clearing Member affect a CCP's balance sheet only indirectly. Whereas mark-to-market losses on CCP assets directly affect the capital, default losses are first absorbed by the Clearing Member's margin and Default Fund contribution and then flow through the different steps in the loss waterfall. The CCP is affected by default losses insofar as it needs to make good on the payments to the counterparties of the defaulted member: thus, in principle, default losses pose a *liquidity risk* to the CCP, not an insolvency risk. Indeed, one *could* design a CCP waterfall in which all default losses are allocated to non-defaulting members through the Default Fund and other recovery mechanisms. These losses would then eventually pose a liquidity risk to the CCP, but would not necessarily impact its equity; if this liquidity risk arises, the CCP would then attempt to raise further liquidity from non-defaulting members and eventually rely on a lender of last resort to obtain further liquidity. We call such a CCP design the “liquidity pass-through model” since it allocates all default losses to non-defaulting members through the Default Fund. In this situation, the only insolvency risk for the CCP can arise from market losses in its investments, not from default losses. A CCP's revenue being proportional to the volume of assets cleared, such a CCP has no incentive to increase margin levels beyond the regulatory minimum since a higher margin rate is likely to reduce the volume.

In absence of regulatory constraints, there is no incentive for a profit-maximizing CCP to deviate from this “liquidity pass-through” model. This is a classical principal-agent problem:

in absence of regulation requiring the CCP to expose its own capital to default losses, there is no incentive for the CCP to include a capital contribution in the waterfall, unless its members are able to exert sufficient pressure for the CCP to do so.

For CCPs, a key issue in designing the capital structure is to provide incentives to the CCP's stakeholders to design a robust risk waterfall. The above observations show that an important variable for this purpose is the 'skin-in-the-game' of the CCP: the portion of its capital which is exposed to default losses in the loss waterfall. The issues are thus quite different from those pertaining to capital adequacy for banks, where the discussion has centered on the size of the capital buffer (see e.g. Admati & Hellwig 2013).

5.2. Skin-in-the-game

In order to align the risk management incentives of the CCP with those of its members, the CCP should be exposed to capital losses before the Default Fund contribution of non-defaulted members is used. This buffer should constitute a non-negligible fraction of the CCP's equity (current regulatory discussions place it around 20-25%) in order to provide a strong incentive for adequate risk management to the CCP. For example, EMIR (Reg. 153/2013 Article 35 §2) requires the CCP's contribution to be 25% of its capital. However, in absence of capital adequacy rules requiring the CCP's capital to be comparable in size to Clearing Member's Default Fund contributions, such a requirement might still lead to an insignificant contribution to the loss waterfall. Also, in order to align incentives of CCP management with Clearing Members, CCP management, and not just shareholders, should bear some consequences in the event that this capital buffer is used.

Some waterfall designs call for a second "skin-in-the-game" contribution after the Default Fund has been depleted but before any additional resources are deployed in the recovery phase (see Figure 3). This is a sound idea and provides incentives to the CCP to maintain an adequately sized Default Fund.

Such provisions are already in place at most CCPs, but the issue has been that given the low level of CCP equity, the size of the CCP's equity contribution is often negligible compared to the Default Fund. The reason is that the capital levels are often determined to cover in (non-default) risks faced by the CCP's treasury rather than as a provision for Clearing Member default losses, which were traditionally viewed as a liquidity requirement affecting the collateral pool. One would need to multiply the current levels of CCP capital by 10 in order for the 'skin-in-the-game' requirement to have any substantial loss-absorption role in the loss waterfall. The Basel Committee's more recent guidelines (BCBS 2013) try to address this by formulating capital adequacy criteria for CCPs which combine the non-default risk of the CCP's assets and the loss waterfall, albeit in a rather opaque way which is difficult to rationalize (Ghamami 2014).

Given the impossibility of estimating the probabilities of events -joint defaults of Clearing Members- that may affect the CCP's capital, it is difficult to adopt a quantitative, formula-based approach to CCP capital adequacy in terms of confidence levels, as done, for instance, for bank capital. If one keeps in mind that one purpose for maintaining CCP capital is "skin-in-the-game", this implies that CCP capital should be comparable in size to the Default Fund contributions of the Clearing Members, so that the CCP faces losses of the same order of magnitude in case the "skin-in-the-game" is breached. Requiring the "skin-in-the-game" of the CCP to match, say, the largest Default Fund contribution of any member will also deter the CCP from accumulating a large exposure to any single Clearing Member. Similar ideas may be found in recent proposals by market participants (JP Morgan 2014, BlackRock 2014).

The presence of "skin-in-the-game" provisions transforms what is initially a liquidity risk resulting from default losses (as in the "liquidity pass-through model" described in 5.1) into insolvency risk for the CCP, which clearly affects the shareholders of the CCP. A further problem which needs to be tackled is the possible misalignment of incentives between shareholders and management (the so-called 'principal-agent problem'). In order to align incentives of CCP management with shareholders and Clearing Members, CCP management should bear some consequences in the event that the CCP's capital buffer is used. This may involve retention of bonuses or removal of management.

6. Assessing the default resources of a CCP

6.1. Stress testing of default resources

A necessary step in the assessment of a CCP's default resources -margin requirements, default fund contribution and the CCP's "skin-in-the-game" contribution- is *stress-testing*.

Stress testing is sometimes interpreted to be synonymous with historical backtesting but based on a longer test period which includes periods of severe market turbulence: one compares, for every day in the sample, the possible losses (over the risk horizon) arising from the default of (one or two) Clearing Members with the CCP's default resources at the time of default. The goal is to assess whether the default resources of the CCP (margin requirements and Default Fund) would have been sufficient to absorb these losses.

A broader approach to stress-testing involves counterfactual scenarios, designed to represent extreme but plausible changes in the risk factors.

A common approach is to apply these stress tests to current Clearing Member portfolios; given the turnover in member portfolios, adequacy of default resources in such a stress test does not tell us whether other configurations of member portfolios will not fail the stress test.

A more comprehensive validation should involve not just current Clearing Member portfolios but also hypothetical 'test' portfolios which may represent possible positions that members may bring to the CCP. This allows to track potential weaknesses in the design of the loss waterfall and identify "worst-case portfolio configuration" which maximize the strain on the CCP's default resources.

6.2 Beyond single CCP stress tests: accounting for interconnectedness

Current CCP stress testing is limited to stress tests performed on a single CCP. However, since large financial institutions typically belong simultaneously to several CCPs and given the interoperating agreements between many CCPs, isolated stress tests of single CCPs may fail to provide an accurate picture of the levels of collateral and liquidity demand that clearing members may be subject to in the event of the default of one or more other clearing members.

Consider the case of several large dealer banks with positions in several classes of derivatives, each cleared in a different CCP. If one of these banks defaults on its margin calls in one of the CCPs, it will simultaneously default on its positions in all CCPs of which it is a member, leading to possible draws on the Default Fund of one or more CCPs. If this dealer bank happens to be the 'largest member' of one or more of the CCPs, its default may result

in simultaneous calls for liquidity on the surviving banks emanating from more than one CCP. This examples shows that the liquidity exposures of a Clearing Member to multiple CCPs, far from being independent, may turn out to be highly correlated to the same event, namely the default of another large Clearing Member.

Another example is the case of a large Clearing Member to which a CCP's exposure is largest. This exposure determines the size of the Default Fund under a 'cover one' rule. Now assume there existing a second, competing CCP clearing the same asset class. By dividing its positions across two CCPs, this member may avoid being identified as the CCP's largest exposure; this may lead to less Default Funds in total for the CCPs than if the large Clearing Member clears through a single CCP. Such a situation can only be acknowledged through regulatory supervision or information sharing between CCPs on common members.

A realistic assessment of the systemic risk associated with a CCP failure thus calls for stress tests which accounts for the interconnectedness of different CCPs, in particular through the presence of common Clearing Members. Such stress tests require data sharing between CCPs and monitoring of cross-membership and cross-margin agreements by supervisory authorities.

6.3 How risky are Default Fund assets?

An important issue regarding stress testing is how to make use of the results of a stress test. Beyond a simple assessment of failure or success, stress tests may be used as a method for assessing the risk of assets held in the Default Fund. These assets, which remain on the balance sheet of the Clearing Member, are subject to a capital charge and are affected a "risk weight" which, under the Basel III proposal, is 2% for "qualified CCPs". A more complex formulation has been proposed for risk weights attached to Default Fund exposures (Ghamami 2015). Default Funds of CCPs have been growing in size over the last few years and may constitute a substantial sum in the balance sheet of Clearing Members, so the issue of these risk weights and the associated capital charges is quite important.

It should be clear from the presentation of the CCP loss waterfall that the risk of assets held in the Default Fund depends on "what's underneath", i.e the level of margin requirements and 'skin-in-the-game', which varies across CCPs. In this respect, a risk weight attached to Default Fund exposures which does not take into account the quality of the risk management of the CCP would provide the wrong risk incentives and encourage a "race to the bottom".

To use a "CDO" analogy, each Clearing member is exposed to the first losses in its own portfolio ("equity tranche") up to the level given by its margin plus its Default Fund contribution; losses exceeding this level flow are first absorbed by a portion of the CCP's

capital (“mezzanine tranche”) and then absorbed by other members’ Default Fund contribution. Thus, each member holds the ‘senior tranche’ of other members losses; the risk of the assets held against the Default Fund therefore depends on the level of subordination of this “senior tranche”, which depends in turn on the level of margin and Default Fund requirements in the CCP. Accordingly, the risk weight assigned to Default Fund assets and the corresponding capital charge for Clearing Members should depend on the quality of the risk management of the CCP, as assessed for example through independent stress testing of its default resources.

A risk weight based on a stress test of the default resources of the CCP would provide Clearing Members with an incentive to clear with CCPs with better risk management standards, whereas a flat risk weight for Default Fund assets encourages a “race to the bottom” for a profit-maximizing CCP with the objective of maximizing clearing volume.

Using CCP stress tests for determining the risk of the Default Fund implies some degree of standardization in stress tests to ensure comparability of stress test results across CCPs clearing the same asset class. This calls for the supervisor, or an independent entity charges with stress testing, to design a series of stress scenarios for each asset class which can then be used to calibrate Default Fund levels and risk weights.

The comparability of results across CCPs, especially in the same asset class, is important: it provides an objective basis for assigning higher risk weights to assets held against Default Funds of CCPs deemed less resilient to stress. Differentiation of risk weights across CCPs is a natural way of preventing the ‘race to the bottom’ and giving incentives to market participants for clearing transaction through CCPs with better risk management standards.

6.4. How reliable are unfunded default resources ?

Currently, most CCP waterfalls include *unfunded default resources*, the most important of which is an assessment right for Default Fund contributions : in the event that the existing Default Fund is insufficient to cover losses, the CCP may request from all (non-defaulted) Clearing Members an additional contribution proportional to their previous contribution to the Default Fund. in order to replenish the Default Fund. In some CCPs, the contribution is uncapped. In other CCPs, this contribution is capped by the pre-default contribution of each member.

The presence of such assessment rights potentially gives the CCP access to a much larger pool of resources to cover losses in stress scenarios. Even in the case where the assessment right is capped by the pre-default contribution of clearing members, this leads to a pool which is double the size of the (funded portion of the) Default Fund. Some CCPs treat this unfunded portion as part of their default resources when performing stress tests.

However, if one considers that the depletion of the Default Fund will most probably occur in a stress scenario where two large Clearing Members have already defaulted, the risk that other non-defaulted members may fail to raise enough liquidity to make large payments to the Default Fund in such a stress scenario is non-negligible. This is due to the fact that some non-defaulted members may have been partially exposed to the same shocks or market losses which resulted in the failure of defaulted members.

This observation shows that the unfunded portion of the Default Fund should be considered as an uncertain cash flow and that the risk of its non-payment is correlated with the default events which trigger the assessment rights. In the terminology of credit risk, the unfunded portion of a CCP default fund is in general subject to « wrong-way risk ». To our knowledge, this aspect has not been taken into account when assessing default resources of CCPs and the unfunded portion is sometimes incorrectly considered on the same level as the funded component in stress tests. We also note that a quantitative assessment of this wrong way risk may be quite challenging, so a conservative baseline assumption in CCP stress tests would be to rely solely on funded resources.

Even in the situation where the surviving members have the necessary resources for meeting the assessment payments for replenishing the Default Fund, they will have an incentive not to do so, by terminating their membership and either closing their positions or migrating to another CCP.

Some CCPs have clauses in their membership agreements which enforce the CCP's assessment rights by considering non-payment of the assessment as a default of the non-paying member ; this may reduce the risk of non-payment from the CCP's viewpoint, this

may have undesirable consequences from a financial stability perspective. Indeed, such a mechanism subjects surviving members to potentially large draws on their liquidity resources and may lead to their default. Bearing in mind that the initial purpose of central clearing is to mitigate the contagion arising from a member's default, enforcing a rule which would increase the likelihood of other members defaulting in such a scenario would be paradoxical.

In addition to being pro-cyclical, such assessments run the risk of not being provisioned when required due to members lacking the liquidity resources in a stress scenario. Thus, the unfunded portion of the Default Fund may not materialize as expected in a stress scenario and is subject to wrong-way risk. If the CCP retains assessment rights for the Default Fund, such assessment rights should be provisioned for in the liquidity reserve of Clearing Members in order to ensure payment. If the Clearing Member is a bank, such assessment rights should enter into the denominator of the member's Liquidity Coverage Ratio as a liquidity outflow in a stress scenario. The stress scenario should then correspond to the maximal assessment allowed under the CCP charter, which requires the assessment to be capped. Under the Basel III bank liquidity regulation framework, this forces the bank to provision for the unfunded portion of the Default Fund upfront, which makes it less of an advantage compared with the funded portion of the Default fund contribution.

In summary, we have argued that although there may be no downside for the CCP itself in including such unfunded components in the loss waterfall, the above arguments show that these unfunded contributions

- may fail to materialize when needed and they should be treated as subject to wrong way risk ; in particular the actual contribution of Default Fund assessment rights to the default resources of the CCP may in fact be much less than suggested by their notional size and difficult to assess in an objective manner;

- should be provisioned for in the liquidity reserves of Clearing Members which, if the members are banks, affects their Liquidity Coverage Ratio;

- in the event that their payment is enforced, they may lead to undue stress on liquidity resources of non-defaulted Clearing Members and act as a mechanism of contagion for liquidity shocks, which contradicts the very purpose of the CCP.

Prudential regulation of CCPs should therefore take into account the risky nature of unfunded resources and give priority to funded resources. A conservative approach would be to provision for absence of unfunded resources when assessing liquidity inflows and maximal assessment calls when provisioning for liquidity outflows. This is contrast to Basel III proposals (BCBS 2013) which do not distinguish funded and unfunded Default Fund contributions when determining the CCP's default resources or risk weights for default fund

exposures.

Some market participants (JP Morgan, 2014 ; BlackRock, 2014) have in fact argued against including any unfunded portion in a CCP's default resources. Whether or not one supports this view, which is not without merit, the above discussion pleads for relying primarily on funded resources when assessing the default resources of a CCP for stress testing purpose and recognizing the possibility of non-payment of any unfunded resources such as Default Fund assessment rights. From a financial stability perspective, such assessment rights should be capped and either provisioned for by Clearing Members in terms of liquidity reserves or removed from the table.

7. The end of the waterfall : recovery mechanisms for CCPs

In the situation where the losses exceed the total available Default Fund (including assessments) and the CCP's contribution from its own capital, one reaches the “end of the waterfall”. In such a scenario, most other financial institutions, such as banks, would enter a resolution procedure and restructuring or liquidation would then ensue. However, given the CCPs' systemically important role as a conduit for transactions of other large financial institutions, it may be desirable to use further resources to ensure the continuity of the CCP's clearing services to prevent further contagion from the triggering event of the CCP's losses. These operations, known as ‘recovery arrangements’, act as a temporary backstop and may, if successful deployed, delay further losses to the CCPs until the market situation is re-established and default resources may be replenished to pre-stress levels.

7.1 Variation Margin Haircuts (VMGH)

If a Clearing Member defaults primarily due to losses on its positions cleared within the CCP, then these losses materialize as large variation margin payments to other Clearing members. These variation margin payments are thus sufficient in principle to cover the (market) losses generated by the defaulting member's portfolio. Variation Margin Haircutting (VMGH) consists in using these variation margin payments as a source of funds for recovery of the CCP's default resources.

When haircutting variation margin, the CCP may reduce pro rata the amount it is due to pay participants with in-the-money positions, while continuing to collect in full from those participants with out-of-the-money positions. This procedure is meant to be a temporary means for recovery of the CCP's default resources. Clearing Members whose variation margin payments are withheld may receive notes which they may redeem once the CCP has recovered; alternatively they may receive shares of the CCP's equity.

The key attractive feature of VMGH is that it taps a resource which, by definition, is sufficient to absorb the market losses of the defaulting member's portfolio since this loss is mirrored in variation margins flowing to the counterparty. However, if loss of resources of the CCP is due to some other reason, such as a sudden loss in value of assets held in the Default Fund, VMGH may not be very helpful.

Another desirable feature of VMGH is that it allocates losses across surviving members similarly to what would occur in a resolution, while providing for continuity of clearing services and avoiding the irreversibility and costs associated with a full resolution.

In summary, VMGH can be an efficient recovery mechanism when losses arise from a large mark-to-market loss in instruments cleared by the CCP, but not when the loss originates from non-default losses of assets held in the CCP's treasury of Default Fund.

However, it should be kept in mind that VMGH restores the liquidity resources of the CCP at the expenses of Clearing Members. In a stress scenario where Clearing Members are otherwise subject to liquidity shocks, this may lead to further strain on the liquidity resources of Clearing Members. Thus, while it will be always in the interest of the CCP to use VMGH for its own recovery, the supervisor should assess the pros and cons of doing so and should have the option of discontinuing or limiting the use of VMGH by the CCP in the interest of preventing the default of systemically important clearing members.

7.2 Liquidity provision during the recovery process

The triggering of the recovery phase signals a shortage of liquidity for the CCP. CCPs identified as systemically important should therefore be granted access to central bank liquidity facilities in the event of a liquidity shortage.

Recovery mechanisms such as VMGH shift the demand for liquidity from the CCP to its surviving Clearing Members. The liquidity requirements in such scenarios should be transparent to the Clearing Members and provisioned for; for example, if Clearing Members are banks subject to a Liquidity Coverage Ratio, the liquidity demands resulting from CCP recovery scenarios should be included in the calculation of 'liquidity stress scenario' entering the Liquidity Coverage Ratio and provisioned for by the Clearing Member. The lender of last resort may choose to provide access to its liquidity facilities to Clearing Members subject to VMGH, supporting indirectly in this way the recovery of the CCP.

If the CCP and its members are registered in different jurisdictions, typically only the central bank of the jurisdiction where the CCP is registered may agree to provide direct liquidity to the CCP. It may then be in the interest of central banks of Clearing Members' jurisdictions

to contribute indirectly to the replenishment of the CCP's liquidity resources during the recovery phase by providing liquidity facilities to member institutions in their jurisdiction.

7.3. Contract tear-ups

If variation margin haircuts fail to provide enough relief to the CCP to continue its operations, the possibility for the CCP of closing certain unbalanced open positions provides a further backstop against continued losses. Such contract tear-ups may be partial or total and are usually restricted to the instrument(s) in which positions are unbalanced following a member's default.

The possibility of partial or total contract tear-up implies that the netting function of the CCP may fail in a default scenario, even before resolution is reached. In a recent position paper, ISDA (ISDA 2013) has argued that this is an undesirable feature since it contradicts the very purpose of a CCP.

The loss of a Clearing Member from the tear-up depends on the positions of the Defaulting Member and the choice of contracts subject to tear-up among these positions. None of these elements are known to non-defaulting Clearing Members beforehand, which results in an uncertainty which is difficult, if not impossible, to quantify: : being unable to anticipate which contracts may be subject to tear-up, Clearing Members cannot properly evaluate their exposure to such a scenario. Therefore, contract tear-up leads to a loss allocation across members which is not transparent ex-ante and increases uncertainty for Clearing Members without providing clear incentives.

In addition, the loss allocation resulting from contract tear-up may appear as unfair ex-post compared to a proper resolution procedure since, unless tear-up applied to all contracts, the allocation of losses will not be proportional to outstanding liabilities of the defaulted member.

7.4. Should 'initial margin' be used to fund a CCP's recovery?

Some recent discussions in regulatory circles have invoked the possible use of initial margin deposited by non-defaulted Clearing Members as a liquidity resource to enable the recovery of a failing CCP, and various versions of such 'initial margin haircuts' have been proposed.

In principle the initial margin requirements of a Clearing Member, though deposited with the CCP, can only be used to offset losses by the same Clearing Member. This is the main feature distinguishing the initial margin contributions from the Default Fund contributions, which are exposed to the losses of other members.

Since initial margin funds are deposited with the CCP, such ‘initial margin haircuts’ seem to be a way for the CCP to grab readily available liquidity resources to help its recovery. However, this proposal appears to have some major flaws.

Exposing initial margin contributions to default losses generated by other Clearing member through the possibility of ‘initial margin haircuts’ amounts to including a contingency clause which converts initial margin funds into Default Funds in the event the ‘recovery’ regime is triggered. In the end, it amounts to reallocating a (initially unknown) fraction of the initial margin to the Default Fund. This blurs the distinction between initial margin and Default Fund contributions and renders the risk analysis of the loss waterfall much more complex, especially for the Clearing Members, since they cannot correctly estimate the risk of such a scenario occurring without knowledge of other members positions. A simpler and more transparent design would be to size the Default Fund correctly in order to avoid such a scenario, instead of adding to it a random fraction of the initial margin pool, as this scheme implicitly does.

Initial margin haircuts may also lead to legal complications. The membership charter of most CCPs does not allow the use of initial margin funds of a Clearing Member for covering losses of other members, so such procedures may infringe upon property rights of Clearing Members and contractual agreements with the CCP.

Last but not least, the loss allocation resulting from ‘initial margin haircuts’ does not seem to provide the right incentives in terms of risk management. If initial margins haircuts are applied proportionally, the resulting allocation exposes most the members whose initial margin contribution is the largest, instead of penalizing those to which the CCP is most exposed. This would push towards a ‘race to the bottom’ and provide incentives to clear with CCPs whose margin levels are low, unless the Default Fund is deemed large enough to render the possibility of initial margin haircuts remote.

In summary, we find that ‘initial margin haircuts’ do not seem to be a good idea: they blur the distinction between margin requirements and Default Fund contributions, and distort Clearing Members’ risk incentives. If the Default Fund allocations, as suggested above, are proportional to the exposure of the CCP to each Clearing Member, then a better approach is simply to increase the global size of the Default Fund, instead of introducing ‘initial margin haircuts’.

8. When all else fails : resolution of a failed CCP

When recovery provisions fail to provide the CCP with enough resources to ensure the continuity of its clearing services, the CCP may either become insolvent, entering bankruptcy proceedings, or enter a failure resolution process. Regulators may also choose to trigger failure resolution before the recovery process ends, if they deem that the recovery provisions may hurt member firms in a way that is detrimental to financial stability. Various aspects of failure resolution of CCPs are extensively discussed by Duffie (2014).

The discussion on CCP recovery and resolution should be centered on avoiding financial instability and safeguarding the financial system, rather than maintaining a CCP's operations at all costs. In some scenarios, the regulator may assess that the resolution of a CCP, though not in the interest of the CCP or its clearing members, may be better for financial stability than the pursuit of the recovery plan. The resolution authority should then have the right to override contractual agreements and halt the recovery process. This decision should be based on an assessment of system-wide losses in different scenarios, including spillovers to non-member institutions via direct exposures (Cont & Minca 2014), common memberships across CCPs, inter-CCP cross-margin agreements or fire sales which can distort the value of collateral (Oehmke, 2014).

The decision to trigger failure resolution should also account for the fact that, even if the recovery process succeeds in maintaining a weakened CCP afloat, market participants may choose to walk away from the CCP either by reducing their open interest or by moving to another CCP, since a future failure will expose the members to further liquidity demands and losses. Thus, it is often a better option to spin off the CCP's sustainable activities as a separate entity which can continue to sustain its clearing functions while the failed portion is being liquidated. This process is greatly facilitated if the CCP maintains separate Default Funds for different asset classes it clears, preventing default losses in one asset class from contaminating the entire balance sheet.

A key issue is to avoid moral hazard and especially costs to taxpayers in the event of a CCP failure. Though the function of the CCP as a utility in the interest of financial stability can be considered a 'public good' to some extent, this does not entail that private, third-party funds cannot be mobilized to fund the resolution of a failed CCP. Such third-party funds may be used for emergency liquidity provision and/or recapitalization of a failed CCP.

An interesting proposal, recently put forth by JP Morgan, is for CCPs to set up a « trust fund » to which clearing members and external participants can contribute and which will be used in the event of the CCP's failure to set up a recapitalized « bridge CCP » which then inherits the positions of the clearing members from the failed CCP (JP Morgan 2014). The

possibility of external participants (non-members) participating in this trust fund is particularly attractive as it opens the possibility of funding by investors not directly exposed to the risks faced by the CCP. Unlike clearing members, who will be subject to losses during the recovery process, such external participants will be more likely to have the resources for supporting the resolution process.

Many major international CCPs have cross-border features, through their membership structure, the assets they clear or interoperability agreements with other CCPs. Transparent rules for resolution of such complex entities should be established in advance through international guidelines and agreements among regulators to avoid an international tug-of-war during the resolution process.

CCP supervision and resolution often involves multiple authorities, through a complex multi-step decision process. In the same way that some CCPs periodically organize 'default management drills' to simulate the procedures to be followed in case a Clearing Member defaults, it would be highly instructive for authorities involved in CCP failure resolution to organize a simulation of the failure resolution procedure for systemically important CCPs, involving the major actors who would intervene in such a process. Such an exercise would reveal possible operational risk and help identify some thorny issues that may arise during the resolution process.

9 . Conclusion : Lessons for CCP waterfall design

We summarize below the main points of our analysis.

1. *The importance of incentives* : When designing loss allocation and recovery mechanisms for a CCP, one must bear in mind not only their effectiveness for absorbing losses in a stress scenario but also the risk management incentives they provide to the CCP and its clearing members in advance of such stress scenarios.

2. *Liquidity charges*: margin requirements for CCP members should not be solely based on an evaluation of the market risk of their portfolio but also include a liquidity charge which corresponds to the potential additional cost incurred by the CCP for liquidating the member's portfolio in an extreme but plausible market scenario. A properly calibrated liquidity charge will deter members from accumulating concentrated exposures and provide incentives to members for managing their liquidity risk.

3. *Size of CCP Default Funds*: in determining the size of the Default Fund to cover losses in case of a given number of Clearing Member defaults, a CCP should not rely on (unverifiable) assumptions on the default probabilities or default correlations of Clearing Members but consider the worst-case scenario loss for the CCP across all possible defaults. The size of the Default Fund depends on the configuration of Clearing Member portfolios and should be updated as frequently as required by the turnover of member portfolios.

4. *Allocation of Default Fund contributions across Clearing Members*: the contribution of a Clearing Member to the Default Fund should be based on the exposure of the CCP to the default of this Clearing Member. Other allocation schemes, proportional to initial margin, open interest or trading volume, may provide distorted risk incentives to Clearing Members.

5. *Skin in the game*: A CCP's capital should be exposed to default losses before the Default Fund contribution of non-defaulted members is used and once the Default Fund is depleted. The magnitude of these exposures should be comparable in size to the Default Fund contributions of Clearing Members and should constitute a non-negligible fraction of the CCP's equity in order to provide a strong incentive for adequate risk management to the CCP. Without such 'skin-in-the-game', default of Clearing Members would pose little or no insolvency risk to the CCP. In order to align incentives of CCP management with Clearing Members, CCP management should bear some consequences in the event that this capital buffer is used.

6. *Stress testing of CCP default resources*: The adequacy of default resources of a CCP should be subject to independent stress testing using a transparent methodology comparable across CCPs clearing the same instruments. Stress testing should not be limited to historical scenarios but should also include counterfactual but plausible risk scenarios relevant for the

asset class being cleared. Such stress tests can provide an objective basis for determining capital charges against assets held in the Default Fund.

7. *Risk weights attached to CCP Default Funds:* Assets held in the CCP Default Fund have the risk profile of the senior tranche of the CCP's exposure to member defaults. Accordingly, the risk weight attached to a CCP Default Fund should depend on the subordination of this tranche, which in turn depends on the margin pool and the CCP's "skin-in-the-game". Capital charges for CCP default funds based on an independent and objective assessment of the risk of the default fund will provide an incentive for clearing with CCPs with better risk management standards.

8. *Accounting for interconnectedness in risk assessment:* Due to cross-membership of large financial across multiple CCPs and interoperating agreements between CCPs, isolated stress tests of single CCPs do not provide an accurate picture of losses in the event of the default of one or more clearing members. A realistic assessment of the systemic risk associated with the failure of a clearing member calls for a stress test which accounts for the interconnectedness of different CCPs and their clearing members. Such stress tests, which may call for data sharing across CCPs or the participation of regulators, should form the basis for identifying systemically important CCPs.

9. *Recovery provisions* such as Default Fund assessments, Variation Margin haircuts (VMGH) and the possibility of contract tear-ups may provide temporary relief to the CCP in a stress scenario and avoid a costly and irreversible resolution procedure. Exposures resulting from recovery provisions need to be transparent for clearing members and capped in their magnitude. Transparency provides clearing members a clear view of their exposures in a stress scenario and incentives to manage these exposures. A key question is whether recovery provisions, which tend to shift the liquidity demand in a stress scenario from the CCP to the members, will not increase the likelihood of further Clearing Member failures.

10. *Unfunded default resources :* Current CCP waterfall designs allow for an assessment on Default Fund contributions, which is either uncapped or can go up to the existing Default Fund contribution of each member. Such assessments run the risk of not being provisioned when required, due to members lacking the liquidity resources in a stress scenario. Thus, the unfunded portion of the Default Fund may not materialize as expected in a stress scenario and is subject to wrong-way risk. A conservative stress test should therefore refrain from assuming the availability of unfunded default resources, and priority should be given to funded resources. If the Default Fund does allow for assessment rights, these should be capped and provisioned for in the liquidity reserves of Clearing Members.

11. *Variation Margin haircuts (VMGH)* allocate losses similarly to what would occur in a resolution, while providing for continuity of clearing services and avoiding the irreversibility

and costs associated with a full resolution. VMGH can be efficient when losses arise from a large mark-to-market loss in instruments cleared by a CCP, but not when a member defaults due to losses in assets not cleared by the CCP.

12. *Access to central bank liquidity:* The triggering of the recovery phase signals a shortage of liquidity for the CCP. CCPs identified as systemically important should be granted access to central bank liquidity facilities in the event of a liquidity shortage. If the CCP and its members are registered in different jurisdictions, it may be in the interest of central banks of Clearing Members' jurisdictions to contribute indirectly to the replenishment of the CCP's liquidity resources during the recovery phase by providing liquidity facilities to Clearing members registered in their jurisdiction.

13. *Contract tear-ups:* The possibility for the CCP of closing certain unbalanced open positions provides a further backstop against continued losses. However, contract tear-up results in a loss allocation across members which is not transparent ex-ante and thus does not provide clear incentives to Clearing Members, and may appear as unfair ex-post compared to a proper resolution procedure.

14. *Initial margin haircuts:* It has been proposed to use the initial margin of non-defaulted members as a source of funds for the CCP during recovery. Such 'initial margin haircuts' blur the distinction between margin requirements and Default Fund contributions, reduce transparency of risk exposures for Clearing Members and distort Clearing Members' risk incentives. If the Default Fund contributions are proportional to the exposure of the CCP to Clearing Members, then a better idea is simply to increase the size of the Default Fund.

15. *Financial stability, not survival at all costs:* The discussion on CCP recovery and resolution should be centered not on maintaining a CCP's operations at any cost but on avoiding financial instability and safeguarding the financial system. In some scenarios, failure resolution of a CCP, though not in the interest of the CCP or its clearing members, may be better for financial stability than the pursuit of a recovery plan. The resolution authority should then have the right to override contractual agreements and halt the recovery process. This decision should be based on an assessment of system-wide losses in different scenarios, including spillovers to non-member institutions via direct exposures, common memberships across CCPs, inter-CCP cross-margin agreements or the risk of fire sales.

16. *Need for international guidelines on cross-border resolution:* Many CCPs have cross-border features, through their membership structure, the assets they clear or interoperability agreements with other CCPs. Transparent rules for resolution of such complex entities and liquidity provision during resolution should be established in advance through international guidelines and agreements among regulators to avoid an international tug-of-war during the resolution process.

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