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Central Clearing and Risk Transformation

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WORKING PAPER

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Central clearing and risk transformation

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ABSTRACT:

The clearing of over-the-counter transactions through central counterparties (CCPs), one of the pillars of financial reform following the crisis of 2007-2008, has promoted CCPs as key elements of the new global financial architecture. It is important to examine how these reforms have affected risks in the financial system and whether central clearing has attained the initial objective of the reform, which is to enhance financial stability and reduce systemic risk. We show that, rather than eliminating counterparty risk, central clearing transforms it into liquidity risk: margin calls transform accounting losses into realised losses which affect the liquidity buffers of clearing members. Accordingly, initial margin and default fund calculations should account for this liquidity risk in a realistic manner, especially for large positions. While recent discussions have centred on the solvency of CCPs, their capital and 'skin-in-the-game' and capital requirements for CCP exposures of banks, we argue that these issues are secondary and that the main focus of risk management and financial stability analysis should be on the liquidity of clearing members and the liquidity resources of CCPs. Clearing members should assess their exposure to CCPs in terms of liquidity, rather than counterparty risk. Stress tests involving CCPs should focus on liquidity stress testing and adequacy of liquidity resources.

Keywords: CCP, central clearing, central counterparty, systemic risk, liquidity risk, counterparty risk, default fund, OTC derivatives, collateral requirement, regulation, stress testing.

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One of the pillars of regulatory reform following the financial crisis of 2007-2008 has been the introduction of central clearing mandates for over-the-counter (OTC) derivative transactions. The clearing mandate for standardised OTC derivatives[2], together with collateral requirements and higher capital charges for non-cleared bilateral OTC transactions, as emphasised 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), have had a substantial impact on financial markets and institutions and transformed central counterparties (CCPs) into pillars of the new global financial architecture. At the same time, the cost of implementing the central clearing mandate has prompted legitimate questions on the real impact of these reforms. Has the implementation of these measures succeeded in reducing the risks that they were supposed to mitigate and made the financial system more stable?

This question has been primarily discussed through the angle of counterparty risk, which is the main reason central clearing was introduced in the first place. By replacing each bilateral transaction by a pair of symmetric trades with a *central counterparty* (CCP), which then becomes counterparty to both sides of the trade, and subjecting all counterparties to initial margin and variation margin requirements, central clearing can reduce counterparty exposures and isolate participating counterparties (clearing members) from each other's default.

Central clearing can reduce upfront counterparty exposures of clearing members through multilateral netting across counterparties (Duffie & Zhu 2011; Cont & Kokholm 2014), as illustrated in Chart 1. This large scale compression of exposures through multilateral netting was observed for example in the CDS market when bilateral trades in standardised CDS indices were gradually moved to central clearing in 2009 and 2010 (Cont & Kokholm 2014). Chart 1 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. Other benefits of central clearing include increased transparency in 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

[2] For a list of OTC derivatives subject to central clearing obligations see for example: https://www.esma.europa.eu/sites/default/files/library/public_register_for_the_clearing_obligation_under_emir.pdf

markets had implemented central clearing well before being mandated to do so by recent legislation.

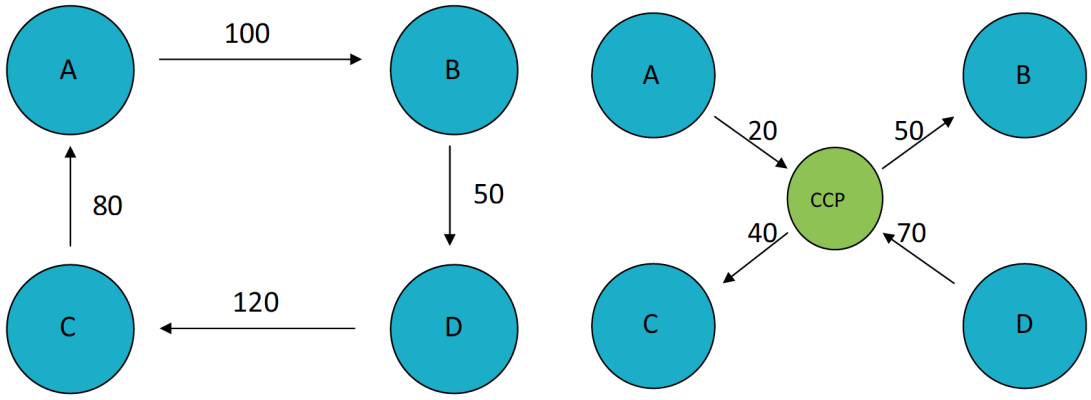

Chart 1: Bilateral vs multilateral netting. Central clearing can reduce exposures through netting across counterparties.

Some of these functions, such as trade compression and multilateral netting, may also be achieved without a central counterparty, though post-trade portfolio reconciliation facilities such as TriOptima (Murphy 2013). The main difference between such facilities and a CCP is the systematic use of initial (and variation) margin requirements as well as other collateral requirements associated with the CCP default fund.

The introduction of initial and variation margins changes the nature of counterparty risk in the event of the default of a clearing member. In a bilateral transaction, default leads to a direct loss for the counterparty, in the form of a write-down on the value of assets held against the defaulted firm. As clearing members replace their bilateral exposures by exposures to the CCP, they are no longer directly exposed to other clearing members, so there is no write-down on asset values at the default of a clearing member. As long as the CCP continues to operate and is endowed with sufficient resources, it will continue to pay out the variation margins due to non-defaulted members. So, it seems that a CCP endowed with sufficient financial resources effectively isolates clearing members from the counterparty risk associated with each other's default: counterparty risk among clearing members seems to have magically disappeared! This picture also seems to identify the worst case scenario as the one in which the CCP fails to operate; much recent debate has centred on recovery and resolution measures for propping up faltering CCPs, as well as capital and "skin-in-the-game" requirements for CCPs supposed to make them less prone to failure.

Following the recent move to central clearing and bilateral margining, OTC exposures net of collateral between major banks have decreased to a small fraction of bank equity, showing that the counterparty risk stemming from OTC exposures alone is not likely to trigger insolvency or contagion in the banking system (Clerc et al, 2013). Thus, at first sight, one has the impression that CCPs have 'absorbed' the counterparty risk of the clearing members and isolated them from the failure of other members.

But this impression is incorrect and misses a crucial point: the distinction between "unrealised" or "accounting losses", which affect the firm's solvency but do not give rise to cash flows and "realised losses"-those which give rise to cash outflows and draw on a firm's liquidity resources.

Realised losses vs accounting losses

In the balance sheet of a firm, one traditionally distinguishes liquid assets – cash or securities readily convertible into cash- from other assets; similarly, one distinguishes short-term liabilities from other liabilities. A firm is said to be *solvent* if the total value of assets exceeds total liabilities: the difference is the firm's equity, or capital. A firm is said to be *liquid* if the liquid assets exceed the short term liabilities: this means that there are enough liquid assets to pay off liabilities due in the short term.

If asset values fall below liabilities, the firm becomes 'insolvent'. This may occur for instance following the failure of a large counterparty, if the resulting loss in asset value exceeds the capital of the firm. As long as the firm is liquid and can meet its short term payments this may or may not entail any immediate consequence. In the case of a regulated financial institution, solvency and capital ratios are monitored by regulators; if such a regulated firm becomes insolvent, the regulator may choose to intervene, take over the management or restructure the firm. 'Structural' models of credit risk and counterparty risk are in fact models of insolvency risk. Capital requirements, conceived as buffers against potential losses in asset value, address the issue of solvency.

Illiquidity, however, is a different story: if a firm, regulated or not, fails to meet a short-term payment obligation, such as a coupon or margin call, it is in *default*. In the case of margin calls, 'short-term' refers to one working day in most jurisdictions.

In theory, a firm may be (in)solvent without being (il)liquid or vice versa. In practice, many financial institutions manage their liquidity through short term repurchase agreements (repos) or by borrowing against their assets; this links

the amount of liquidity that they can access to the value of their assets, discounted by a 'haircut'. But, in the absence of full information on the assets of a financial institution, lenders can withdraw liquidity even from a solvent institution, resulting in an institutional 'bank run'. This seems to be in fact the typical failure scenario for large dealer banks or investment banks (Duffie 2010; Gorton 2012). Bear Stearns, Lehman Brothers and even AIG faced a shortage of liquid assets when faced with large margin calls. In a letter to the Basel Committee in 2008[3], SEC chairman Christopher Cox made the point that Bear Stearns was not insolvent at the time of its default; neither was AIG: both had excess capital. It is thus important to carefully distinguish between solvency and liquidity risk when devising measures to prevent similar events from reoccurring.

How margin requirements transform counterparty risk into liquidity risk

In the case of a bilateral OTC transaction with no margin payments, both sides mark-to-market their position daily but, outside coupon payments, there may actually be no exchange of cash flows: the resulting mark-to-market gains or losses are actually accounting losses which affect the asset values, hence the solvency risk, of the counterparties but may not affect their liquidity resources.

The same transaction, when subject to margin requirements, has a different impact on the balance sheet. First, a portion of the market risk –typically corresponding to a 99% Value at Risk or Expected Shortfall- is requested from each counterparty as an upfront *initial margin* payment. Second, all mark-to-market gains (resp. losses) result in positive (resp. negative) cash flows between the CCP and the clearing members, on a daily, or more frequent, basis: this corresponds to the *variation margin*. Finally, the CCP may require members to contribute to a Default Fund (or Guaranty Fund) to provision for losses in case of member defaults.

What is the impact of these operations on the balance sheet?

First, we note that the transfer of initial margin and variation margin are 'solvency-neutral': they do not alter the value of assets, the capital or the solvency of the firm. The clearing member retains ownership of the collateral posted as initial margin (and continues to receive interest on this collateral).

[3] https://www.sec.gov/news/press/2008/2008-48.htm

So, posting initial margin has little or no impact on its solvency since the collateral continues to remain on the clearing member's balance sheet. Similarly, Default Fund contributions are technically owned by the clearing member; here there is a small impact on the balance sheet since Default Fund contributions lead to a 2% capital charge (in the case of 'qualified' CCPs) for the clearing member. As for variation margin, any cash outflow in the form of variation margin corresponds to a mark-to-market loss which is already accounted for in the valuation of the clearing member assets. So, the payment of the variation margin corresponds to a transfer from the firm's liquid assets to its non-liquid assets, to compensate for a loss in the latter, the total asset value remaining the same.

However, the impact of these collateral requirements on liquidity resources can be substantial. Both initial margin and variation margin are deposited in the form of liquid assets. Most CCPs adopt a narrow definition of 'liquid assets' and require initial and variation margin payment to be made in cash and in some cases G8 sovereign debt instruments, with a haircut for all non-cash or foreign currency collateral. Thus, unlike accounting losses and 'write-downs', initial margin and variation margin directly impact the liquidity reserves of the clearing member.

Thus the overall effect of central clearing on the clearing member's balance sheet is the net transfer of value from liquid to non-liquid assets, the total asset value remaining unchanged. This operation does not affect the equity of the firm, nor does it impact its solvency risk. We therefore observe that the net impact of the systematic application of initial margin and variation margin requirements is to replace counterparty risk resulting from exposures to clearing members -and the associated solvency risk- by liquidity risk.

According to data disclosures by major CCPs, members maintained an average of more than USD 400 billion of liquid assets as collateral with these CCPs in 2016. This amount is comparable to the total amount of liquid assets available on the balance sheets of major dealer banks which are members of these CCPs as revealed by LCR disclosures by banks. By comparison, SEC FOCUS filings in 2015 of US broker-dealers show around 25 Billion USD in cash reserves across the 4 largest broker-dealers. Thus, although clearing members exposure to CCPs may not be large compared to their capital cushion, CCP collateral requirements and margin calls do represent a substantial proportion of members' available liquidity resources. If there is any potential for instability in such a system, it will manifest itself as a liquidity issue rather than a solvency issue.

CCPs as liquidity intermediaries

The balance sheet structure of CCPs reflects their role as pure liquidity intermediaries. In the absence of member defaults, a CCP collects margin and Default Fund contributions from its members, in the form of cash or other liquid assets, and passes on any variation margin collected from members with negative balances to those with positive balances. These margin and default fund contributions are the bulk of the balance sheet and are held in the form of liquid assets. The assets on the balance sheet of the CCP are subject to market fluctuations and this leads to a prudential capital requirement to prevent insolvency due to market losses. But, as the bulk of these assets are in the form of low risk, highly liquid assets, the level of capital needed for this type of insolvency risk is tiny.

Chart 2 displays the balance sheet of LCH Group Ltd, one of the world's largest group of CCPs, in 2015. The liability side of the balance sheet is dominated by liabilities to clearing members stemming from margin balances and, to a lesser extent, Default Fund contributions. More than 99 % of the assets in the balance sheet are liquid assets, 99 % of liabilities are short-term liabilities (mostly to clearing members). The CCPs' equity only represents 0.21 % of assets! As seen from this example, the capital is in fact so small that it would constitute an insignificant contribution to the absorption of default losses.

Regulatory discussions often refer to the 'financial resources' that a CCP can use to 'absorb losses'. In the bank regulation terminology, 'loss absorption' refers to the capital of a financial institution and its role as a buffer against insolvency. This vague terminology fails to distinguish liquidity risk from solvency risk, a distinction which is important for our discussion. As long as members have not defaulted, variation margin payments sum to zero: a CCP is affected by market risk of member portfolios only in scenarios where one or more clearing members default. Even then, losses due to the default of a clearing member affect a CCP's balance sheet only indirectly, insofar as it needs to make good on the payments to the counterparties of the defaulted member. Since these payments need to be made in cash or liquid assets, default losses pose a *liquidity risk* to the CCP, not an insolvency risk.
The size of this liquid reserve is the only relevant 'loss absorption' capacity as far as default losses are concerned. Discussions regarding 'skin-in-the-game' for CCPs which focus on CCP capital appear to neglect this point.

The risk analysis and stress testing of CCPs and their clearing members, insofar as it concerns cleared products and products subject to initial and

variation margin requirements, should thus be focused on liquidity risk, not just solvency risk or capital requirements. Yet supervisory stress tests of CCPs have mainly focused on counterparty credit risk and solvency: the CFTC's report supervisory stress test for CCPs states: "The exercise addressed credit risk; it did not address liquidity, operational, or cyber security risks," (CFTC 2016) while ESMA's 2015 EU-wide CCP stress test report states "it was decided to focus on the counterparty credit risk aspect of the CCPs and leave the additional risk dimensions for future exercises" (ESMA 2015). In the light of the above discussion, the current emphasis of current CCP stress tests on credit risk, CCP solvency and CCP capital seems misguided.

The relevant notion of stress test here is a liquidity stress test, in which losses of clearing members are compared to their liquidity buffers, not to their capital (Cont & Minca 2016; Paddrik et al 2016).

ASSETS : **424 198 M€**	**LIABILITIES** **423272 M€**
Non-liquid assets 325 M€	Long-term Liabilities 207 M€
Current assets: -margin balance with CMs 366 206 M€ (86% of assets) -cash and receivables 40 000 M€ (9.43% of assets)	Short-term liabilities: -margin balance withCMs 415 254 M€ (98% of liabilities) CCP default Fund: 7561 M€
	CCP Equity: 926 M€ (0.21 % of total assets)

Chart 2: Balance sheet of LCH Group Ltd (December 2015).
Source: LCH Group Ltd Consolidated Annual Statement 2015.

Provisioning for default losses: the CCP loss waterfall

The liquidity resources available to a CCP are used to absorb potential losses arising from the default of clearing members according to the 'loss waterfall', in the following order:

1. **Initial margin**: The first layer of protection against losses is provided by the margin requirements. Each clearing member posts an initial margin requirement with the CCP, which corresponds to a measure of the risk of the member's portfolio over a standard risk horizon which depends on the asset class being cleared. 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 CCP losses.

2. **Default fund contribution of defaulting member**: If the loss exceeds the initial margin contribution, the failing member's Default Fund contribution is used to offset the additional losses.

3. **Mutualisation of large losses**: If the loss exceeds the sum of the defaulting member's margin and Default Fund contribution:

    a. first the CCP makes a limited (capped) contribution to offset the remaining loss: this contribution is sometimes referred to as "skin-in-the-game";
    b. if the CCP's contribution is insufficient, the Default Fund contributions of other members are used to absorb remaining losses.

4. **Recovery**: If losses exceed the size of the Default Fund, the CCPs may have recourse to:
    a. an additional contribution to the Default Fund by non-defaulting clearing members: this "assessment" is often capped by the initial contribution of the members;
    b. other measures to replenish the CCP's liquidity resources. One oft-discussed proposal is 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 (CPSS-IOSCO 2014). Other mechanisms considered include partial tear-up of contracts (Duffie 2015).

5. **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 may enter failure resolution.

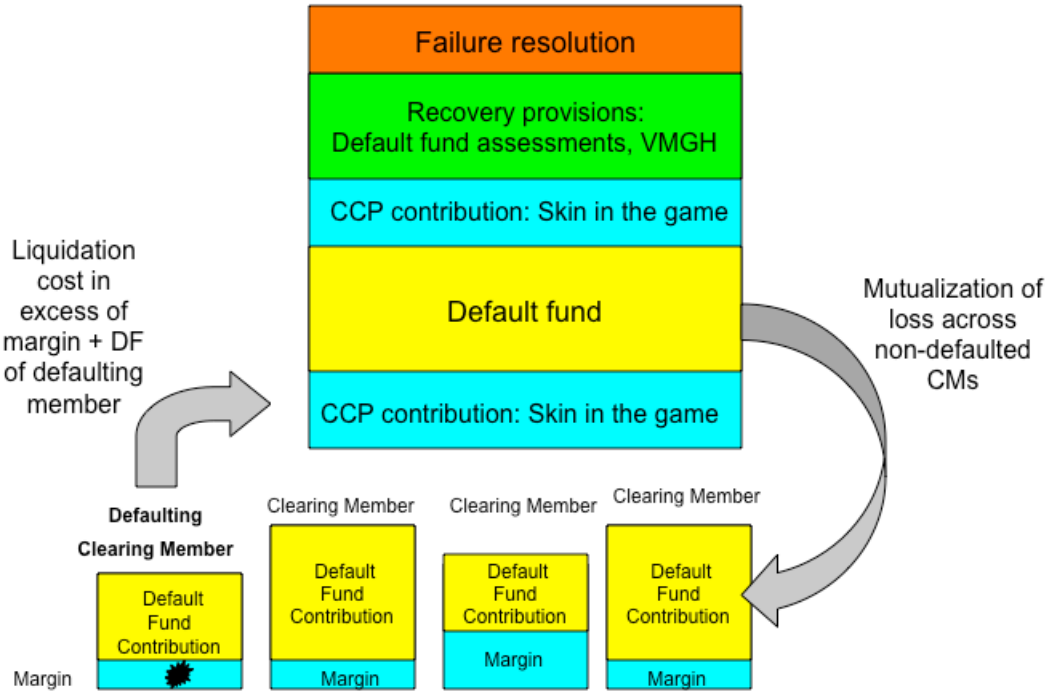

Chart 3: Loss waterfall: allocation of losses in the event of a clearing member default.

Margin requirements should address liquidation costs

Initial margin requirements for clearing members, which are the first layer of protection in the loss waterfall, are typically computed based on a measure of **market risk** –typically Value at Risk (VaR) or Expected Shortfall (ES)- for the clearing member's positions over a risk horizon. 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, a scenario based approach such as CME's "Standard Portfolio Analysis approach" (SPAN), or using a model-based simulation involving statistical assumptions on the risk factors affecting the clearing member's portfolios. The risk horizon, in current practice, depends on the asset class being cleared and ranges from one to several days but does not depend on the characteristics of the portfolio or position. The rationale

usually offered is that the risk horizon represents the time necessary for the CCP to liquidate a defaulting member's positions. Validation of margin requirements is typically done using historical back testing: comparing margin requirements to realised losses for a set of test portfolios over a historical period.

However, 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 or auctions the defaulting member's positions. Since the clearing member has paid variation margin up to the time of default, the only exposure of the CCP is to the portfolio loss between the default time and the liquidation, that is, the *liquidation cost*.

Commonly used market risk measures such as VaR or Expected shortfall do not yield a proper evaluation of liquidation costs: they do not account for differences in liquidity, market depth or bid ask spreads across instruments.
Also, while market risk depends on the net position (for a long-short portfolio), the liquidation cost is proportional to the gross notional size (Avellaneda & Cont, 2012). Consider for example a portfolio combining a 1 billion $ long position in on-the-run bonds with a 1 billion $ short position in a corresponding off-the-run bond. Such on-the-run/ off-the-run spread positions are often observed in fixed income trading books. Market risk measures for this portfolio are based on the net P&L, which is proportional to the volatility of the spread between the two bonds, typically of the order of a few basis points. However when unwinding the two legs of the spread one pays a transaction cost proportional to the gross notional size of each leg, which may be sizable for the off-the-run position which is less liquid and can be easily 10 times the spread volatility. The JP Morgan "London Whale" losses in 2012 involved the unwinding of such long-short positions across CDS indices, leading to liquidation losses which exceeded several multiples of the Value-at-Risk (Cont & Wagalath 2016).

Liquidation costs are especially relevant for portfolios with large or concentrated 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 $4\sqrt{4}=8$.

To account for these effects, margin requirements need to include a *liquidity charge* corresponding to the potential additional cost incurred by the CCP for liquidating the member's portfolio in an extreme but plausible market scenario. A properly calculated liquidity charge should be

- higher for portfolios with positions whose sizes are large relative to market depth, and
- higher for portfolios with positions in less liquid instruments.

As the list of centrally cleared OTC derivatives is steadily expanding to include less and less liquid instruments, the incorporation of a liquidity charge in margin requirements is an essential step towards a sound risk management of CCPs clearing such instruments. A properly calibrated liquidity charge can deter members from accumulating concentrated exposures and illiquid positions, and provides incentives to the clearing members for managing their exposure to liquidity risk.

By adjusting its initial margin requirements to reflect a realistic assessment of liquidation costs for CM portfolio, a CCP can provision for the liquidity risk associated with its exposures. This upfront liquidity charges also provides the the correct incentive to clearing members: rather than drawing on their liquidity resources during a stress scenarios, clearing members have the choice of either provisioning for the liquidation costs or reducing the position, rather than maintaining a large liquidity exposure which may then materialize as a loss in a liquidation scenario.

This point is illustrated by the JP Morgan "London Whale" portfolio, which involved large long and short positions in OTC credit default swap (CDS)

indices. The liquidation costs of this portfolio, which was entirely composed of standardised instruments subject to central clearing, greatly exceeded both its initial margin as computed by the CCP and its Value-at-Risk as computed by the bank itself. As shown in (Cont & Wagalath 2016), had this portfolio been subjected to a correctly calibrated liquidity charge the upfront margin requirement would have provided a strong incentive to the trader and the bank to reduce the size of these large positions.

The evaluation of liquidation costs can be a challenging task for complex, multi-asset portfolios. An integrated approach to the evaluation of margin requirements, which simultaneously addresses market risk and liquidation cost, is the CloseOut Risk Evaluation (CORE) method (Avellaneda & Cont, 2012), versions of which have been implemented in several major CCPs.

Liquidation costs should also be accounted for in the sizing of the CCP Default Fund, which is based on the exposure of the CCP to large clearing members. These members are typically large broker-dealer banks with multiple long and short positions which can be costly to liquidate and whose default is very likely to be associated with a high level of market volatility and/or widened bid-ask spreads. The calculation of CCP exposures to the default of such clearing members should therefore go beyond a standard market risk calculation for the portfolio and account for widening of bid-ask spreads and liquidation costs (Cont & Wagalath 2013, 2016). Given that the liquidation costs are proportional to the gross, rather than net, positions a realistic assessment of liquidation costs for large members can result in a dramatic impact on the Default Fund size.

Liquidity at the end of the waterfall: recovery mechanisms for CCPs

In the situation where the losses exceed the total available Default Fund, one reaches the "end of the waterfall". In the absence of other resources, restructuring or liquidation would then ensue. However, given the CCPs' systemically important role as a conduit for transactions of other large financial institutions, it has been proposed to use further resources to ensure the continuity of the CCP's clearing services to prevent further contagion (CPSS-IOSCO 2014; Cont 2014; Singh 2015). Such 'recovery arrangements' act as a temporary backstop and may, if successfully deployed, delay further losses to the CCPs until liquidity resources are replenished to pre-stress levels.

Default fund assessments

The first recourse of a CCP once the Default fund is depleted is an assessment right for Default Fund contributions: 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 it. In most 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 larger pool of liquidity resources to cover losses in stress scenarios.

Yet, if one considers that the depletion of the Default Fund will occur in a stress scenario where one or two large clearing members have already defaulted, the risk that other non-defaulted members may fail to have enough liquidity to meet the assessment is non-negligible. This is due to the fact that some non-defaulted members may have been exposed to the same shocks or market losses which resulted in the failure of defaulted members. Even in the situation where the surviving members have the necessary resources to meet the assessment payments for replenishing the Default Fund, they will have an incentive not to do so, or close their remaining positions.

This observation shows that the unfunded portion of the Default Fund is subject to « wrong-way risk »: the risk of its non-payment is correlated with the default events which trigger the assessment rights. 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. If the clearing member is a bank, such assessment rights should be in principle provisioned for in the Liquidity Coverage Ratio as a liquidity outflow in the LCR stress scenario. Under the Basel III bank liquidity regulation framework, this would force a clearing member 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.

Variation Margin Haircuts (VMGH)

If a clearing member defaults primarily due to losses on its positions cleared within the CCP, then these losses materialise 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: the CCP reduces pro rata the amount due to clearing members, while continuing to collect in full from those participants with out-of-the-money positions. This procedure 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. It 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.

Like Default Fund assessments, 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.

In summary, although there may be no downside for the CCP itself in including assessments and recovery provisions in the loss waterfall, these mechanisms subject surviving members to potentially destabilising draws on their liquidity resources during a stress scenario, similar to the large margin calls which brought down Bear Stearns, Lehman and AIG, and may act as a channel of contagion for liquidity shocks, which contradicts the very purpose of central clearing. Some market participants (JP Morgan, 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 benefit of such recovery provisions needs to be examined in a liquidity stress testing framework, not just from the viewpoint of the CCP but from a financial stability perspective.

Summary: follow the liquidity

The introduction of central clearing in OTC markets has been effective in reducing counterparty exposures across clearing members. But, rather than removing counterparty risk, central clearing -together with initial and variation margin requirements for non-cleared transactions- transforms it into *liquidity risk*. In a financial system where more and more transactions are subject to initial and variation margin requirements, accounting losses materialise - via margin calls- as (negative) cash flows which draw on liquidity resources of market participants, shifting the focus from solvency risk to liquidity risk.

This has several important implications for risk management of CCPs, clearing members as well as for financial stability.

First, it shows that the primary focus of financial stability analysis of central clearing and margin requirements should be on the adequacy of liquidity resources of clearing members, especially dealer banks, rather than solvency and capital requirements. Stress tests of CCPs and their clearing member should focus on liquidity stress testing: the focus should be on comparing the size of the potential liquidity shocks to clearing members with their liquidity buffers, rather than their equity. In the event of a default, the main impact on surviving clearing members will be through margin calls and default fund assessments, which should be provisioned for in the liquidity reserves of clearing members and not, as is done in current regulation, through capital requirements against Default fund contributions. Provisions such as "skin-in-the-game" requirements for CCPs, rather than focusing on CCP capital, should address the amount of liquid assets that the CCP can contribute in the loss waterfall to offset losses in a stress scenario. Likewise, clearing members should assess their exposure to CCPs in terms of liquidity, rather than counterparty risk.

Margin requirements for CCP members should not be solely based on an evaluation of the market risk of their portfolio but also include a component related to the liquidity risk of their position. This 'liquidity margin' should correspond to a realistic assessment of its liquidation cost in extreme but plausible market scenarios. A properly calibrated liquidity charge can deter members from accumulating concentrated exposures and provide incentives to members for managing their liquidity risk.

Recovery provisions for failing CCPs have been primarily discussed as measures which would allow the CCP to continue operating through a stress period. Most recovery tools –such as Default Fund assessments and variation margin haircutting – are inherently procyclical and tap into the liquidity resources of clearing members in order to replenish the liquidity pool of the CCP. But draining the liquidity pool of clearing members in a market stress scenario may have a destabilizing effect on large clearing members. CCP stress tests should attempt to assess how these potential draws on clearing member liquidity compare with the members' liquidity buffers, and whether such recovery measures and assessment rights are not detrimental to financial stability, which, let us not forget, is the reason for central clearing mandates in the first place. Access of (large) clearing members to central bank liquidity during such episodes can provide relief and prevent failure of solvent but

illiquid clearing members. CCP recovery mechanisms should be centered not on maintaining a CCP's operations at any cost but on avoiding financial instability and safeguarding the financial system. Design of recovery and resolution mechanisms should be based on an assessment of system-wide losses in different scenarios, including spillovers to non-member institutions via margin calls, inter-CCP cross-margin agreements or the risk of fire sales.

Bear Stearns, Lehman and AIG failed following large margin calls that they were unable to meet. Much of the reforms related to central clearing and margin requirements for non-cleared derivatives have been motivated by the desire to avoid a repeat of these spectacular failures. Remedies need to focus on the actual causes of failure. L*iquidity risk* seems to be the key to understanding these examples and improving risk management practices for preventing similar events in the future.

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