Central Counterparty and Collateral Requirements

Jessie Jiaxu Wang  Agostino Capponi  Hongzhong Zhang
Arizona State University  Columbia  Columbia

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Mandatory Clearing of OTC Derivatives at CCPs

- Counterparty failures in OTC derivatives market can cause contagion and systemic crisis, as seen in 2008.

- To manage counterparty risk, G20 leaders mandated the central clearing of standardized OTC derivatives—credit default swaps and interest rate swaps.
  - Dodd-Frank, European Market Infrastructure Regulation
  - Clearing rate is 45% for CDS and 62% for IRS (CFTC, 2018)

- CCPs act as the buyer to every seller and the seller to every buyer.

- CCPs guarantee terms of trades by pooling the counterparty risks.
Bilateral Trading Markets
Centrally Cleared Markets

Central clearing

CCP
Typical CCP Default Waterfall

1. Defaulting member’s Initial Margin
2. Default funds
3. Defaulting member’s Default Fund
4. CCP’s equity capital (tiny)
5. Surviving members’ Default Funds (loss mutualization)
6. End-of-Waterfall Resources (Assessments, IM Haircutting, VMGH)

Prefunded Collateral Resources: Prefunded and could be costly.
Lack of Global Standards for Collateral Requirements

- While CCPs are systemically important, the regulation of collateral is still debatable: lack of global standards (Cunliffe, 2018; Duffie, 2019)

- Initial margin is usually set at some Value-at-Risk level.

- Default fund is subject to “Cover 2”—total default funds should cover the shortfalls of the two largest clearing members (CPSS-IOSCO)
  - adopted by major CCPs: ICE Clear Credit, CME, and LCH

<table>
<thead>
<tr>
<th></th>
<th>Asia</th>
<th>Australia</th>
<th>Europe</th>
<th>North America</th>
<th>South America</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of CCPs</td>
<td>27</td>
<td>1</td>
<td>20</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td><strong>Funded resources %</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Initial margin</td>
<td>69.2</td>
<td>92.8</td>
<td>74.0</td>
<td>85.2</td>
<td>99.6</td>
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<tr>
<td>Default fund</td>
<td>18.7</td>
<td>4.5</td>
<td>25.3</td>
<td>13.5</td>
<td>0.2</td>
</tr>
<tr>
<td>CCP capital</td>
<td>12.2</td>
<td>2.7</td>
<td>0.7</td>
<td>1.3</td>
<td>0.2</td>
</tr>
</tbody>
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🔑 Q: How to regulate collateral requirements for central clearing?
This Paper

The first framework for determining optimal collateral requirements:

1. Highlight distinct role of default funds compared to initial margins
   - allows for loss-mutualization ⇒ valuable to CCP’s resilience
   - distorts members’ risk-taking incentive ex-ante
   - Initial margins are more cost-effective to align members’ incentives.

2. Determine a default fund rule to alleviate the inefficiency
   - likely more stringent than “Cover 2”
   - cover a fraction of members’ shortfalls ⇒ “Cover x%”

3. Optimal regulation of initial margins and default fund
   - if funding collateral is more costly ⇒ more initial margins
   - if recapitalizing the CCP is more costly ⇒ more default funds
Model
Bilateral Trading Market

- $N$ risk-neutral CDS dealers, a continuum of risk-averse CDS buyers

- $t = 0$: buyers and dealers trade CDS; buyers pay a unit price
  - dealers choose $a = \{\text{risky (r)}, \text{safe (s)}\}$, $a$ is unobservable
  - $1 - q_a \rightarrow R_a - p_c D$
    - investment
  - $q_a \rightarrow 0 \Rightarrow \text{default}$

  - $p_c$ is probability of credit event; $R_r > R_s > D$ but $q_r > q_s$

  - Assume safe project has higher expected return,

  → Safe project is socially optimal.

- $t = 1$: i.i.d. payoffs are realized, insurance payments $D$ are made.
Centrally Cleared Market: default waterfall

- CCP guarantees insurance payment $D$ to buyers with certainty.

- $t = 0$: CCP collects collateral from member: initial margins $I \in [0, D]$, default fund $F \in [0, D - I]$. Members incur a funding cost $\beta \times (I + F)$.

- **Cover 2**: default fund pool covers shortfalls of at least two members:

\[
NF \geq 2(D - I)
\]

- CCP uses end-of-waterfall resources when $N_d(D - I) > NF$ and incurs a linear cost $\alpha$.

- A technical assumption: $\beta \geq \alpha p_c \mathbb{P}(N_d > 2)$. 
Centrally Cleared Market: default waterfall

1. Defaulting member’s Initial Margin: $I \in [0, D]$
2. Default funds
3. Defaulting member’s Default Fund: $F \in [0, D - I]$
4. Surviving members’ Default Funds (loss mutualization):
   $$(N - N_d)F$$
5. Not prefunded, with cost $\alpha$
6. End-of-Waterfall Resources:
   $$\left((N_d(D - I) - NF)^+\right)$$
Loss Mutualization Mechanism

Conditioning on the credit event occurs, we analyze member \( i \)’s payoff:

- **Investment fails with probability** \( q_{a_i} \)
  - payoff is 0: \( i \)’s collateral covers partially obligation to buyer

- **Investment succeeds with probability** \( 1 - q_{a_i} \)
  - receives investment return, pays fully to buyer, recovers initial margins
  - its default fund is used to absorb shortfall of \( N_d \) defaulting members

- **Member \( i \) chooses** \( a \in \{r, s \} \) to maximize expected payoff

\[
\max_a (1-q_a) \left[ (1+f)R_{ai} - D + I + \mathbb{E} \left( F - \frac{N_d(D-I-F)}{N-N_d} \right)^+ \right] - (1+\beta)(I+F)
\]
The equilibrium consists of members’ risk choice and the collateral requirement:

- Given collateral and others’ risk choice, each member chooses riskiness to maximize profit.

- Given members’ risk choice, the regulator chooses collateral satisfying Cover 2 to maximize total value of all market participants.
Members’ Risk Choice

Proposition: The equilibrium risk profiles depend on collateral $I$ and $F$.

1. Excessive risk-taking can happen.
2. Given $I$, higher $F$ increases the recovery value in default fund account, making survival more attractive and discourages risk-taking.
3. $\hat{F}(I)$ is piecewise linear, strictly decreasing in $I$ with $\frac{\partial \hat{F}}{\partial I} < -1$.
   - when initial margin decreases by 1, default fund increases more than 1.
   - initial margin is more cost-effective in aligning members’ incentives.
Proposition: Given initial margin, the optimal default fund subject to “Cover 2” is

\[
F^e(I) = \begin{cases} 
\hat{F}(I) & W^s(\hat{F}(I)) \geq W^r \left( \frac{2(D-I)}{N} \right) \\
\frac{2(D-I)}{N} & \text{otherwise}
\end{cases}
\]

- Raise default fund from \(\frac{2(D-I)}{N}\) to \(\hat{F}\):
- members switch from risky to safe, so total value increases,
- but collateral cost also increases.
- Cover \(X > 2\) if funding cost is low.
A Generalized “Cover x%” Rule

“Cover x%” Rule: \( x(I; N) = \frac{F^e(I;N)}{D-I} \)

- Optimal cover number \( Nx(I; N) \) increases with \( N \); “Cover x%” has little variation with \( N \).

- Implications: cover a fixed fraction rather than a fixed number.
  - The rule should account for the number of clearing members.
  - ICE and LCH have more than 20 members, with entries and exits.
Optimal Collateral Requirements

Proposition: The regulator's equilibrium choice of the collateral requirements \((I^e, F^e)\) is

\[
(I^e, F^e) = \begin{cases} 
\left( I^*, \hat{F}(I^*) \right) & \text{if } W^s(I^*; \hat{F}(I^*)) \geq W^r(0; \frac{2D}{N}) \\
\left( 0, \frac{2D}{N} \right) & \text{otherwise}
\end{cases}
\]

- Case 1: \(\beta > p_c \alpha\)
  
  \(\Rightarrow\) collateral is more costly \(\Rightarrow\) More initial margins
Optimal Collateral Requirements

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\end{cases}
\]

- Case 2: \(\beta < p_c \alpha\)
  \(\Rightarrow\) end-of-waterfall is more costly \(\Rightarrow\) More default fund
**Proposition:** The regulator’s equilibrium choice of the collateral requirements \((I^e, F^e)\) is

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(I^e, F^e) = \begin{cases} 
  \left( I^*, \hat{F}(I^*) \right) & \text{if } W^s(I^*; \hat{F}(I^*)) \geq W^r(0; \frac{2D}{N}) \\
  \left( 0, \frac{2D}{N} \right) & \text{otherwise}
\end{cases}
\]

- **Case 3:** \( \beta = p_c \alpha \)

  \[
  \Rightarrow \text{costs are the same} \Rightarrow \text{Indifferent}
  \]
Robustness 1: convex end-of-waterfall cost

In systemic events when multiple members default, the CCP faces increasing marginal costs to raise end-of-waterfall resources:

\[
\alpha \left( (N_d(D - I) - NF)^+ \right)^2
\]

- The trade-off between initial margins and default fund is robust.
- Nonlinearity allows to pin down interior levels of collateral.
CCPs’ exposures tend to concentrate in a few large clearing members. Suppose $i$ is $K$ times ($K > 1$) the size of others: $KD, K(1 + f)R$

- The trade-off between initial margins and default fund is robust.
- Required collateral normalized by size is lower for a big member.
- Big member finds it easier to internalize externalities.

\[ F \leq D - I \]
Policy Implications: framework for collateral requirements

• The lack of global standards calls for a framework for regulating collateral.

• Optimal collateral is the cost-effective combination of $I$ and $F$ that ensures CCP’s resilience and aligns members’ risk-taking incentives.

• Current low-interest-rate environment and the inverted yield curve $\Rightarrow$ more default funds

• Results challenge existing practices, e.g., initial margins should be lower when it is more expensive to fund collateral.
Policy Implications: irreplaceable role of default fund

Can default fund be replaced entirely by initial margins?

\[ F \leq D - I \]

\[ \hat{F}(I) \]

I=D, F=0

risky

safe

\[ 2(D - I) \]

\[ \frac{2(D - I)}{N} \]

\[ F \leq D - I \]
Can default fund be replaced entirely by initial margins?

**Proposition:** No. Posting 100% collateral as margin gives a lower total value and a lower member profit than the optimal collateral \((I^*, \hat{F}(I^*))\).

- Loss-mutualization mechanism is cheaper.
- A fully collateralized position in a bilateral trading market also eliminates counterparty risk \(\Rightarrow\) members prefer CCP than OTC.
- Central clearing generates positive social surplus under optimal regulated collateral.
Collateral tends to be depleted during market stress when recapitalization cost is high $\Rightarrow$ CCP’s recapitalization relates to systemic risk.

Our proposed optimal collateral rule minimize the probability of CCP recapitalization, and thus systemic risk.

**Proposition:** In the limiting case of a large CCP network, the expected losses at the CCP under the optimal collateral requirements $(I^*, \hat{F}(I^*))$ converges to 0.
Conclusions

• This paper develops the first framework for collateral in central clearing.
  • Default fund allows for members’ risk-sharing ex-post, but distorts risk-taking incentives ex-ante.
  • Initial margin is more cost-effective to align incentives, but less valuable for CCP resilience.

• We propose optimal collateral requirements.
  • Cover 2 is suboptimal, especially in low funding cost environments
  • Load more on default fund when CCP recapitalization is costly.
  • Load more on initial margins when collateral is costly.