Pitfalls of central clearing in the presence of systematic risk

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AFA meeting
Derivative market and counterparty risk

- **OTC derivative market**
  - not exchange-traded
  - large: $12 trillion gross market value (BIS 2019)
  - core (dealer) - periphery (end-user) structure
  - *pre 2007*: largely unregulated

- **Counterparty risk**: Lehman fails on derivative payments.

- Regulators: reduce counterparty risk via **central clearing of derivatives**, 
  *though* market participants, particularly end-users, are reluctant to centrally clear voluntarily (< 40% of CDS, IRD, FX transactions cleared pre-regulation)

*This paper: central clearing ⇒ reduces counterparty risk?*

**Main finding:**
Central clearing is no panacea: substantially benefits dealers but not end-users.
⇒ One possible explanation for reluctance to clear.
Central clearing

Suppose *Deutsche Bank* buys credit protection (CDS) from *Lehman* sells it to *JPM*. 
⇒ Counterparty risk

Clearing: CCP (Central CounterParty) steps in-between every trade
⇒ *Deutsche Bank* exposed to CCP instead of Lehman and JPM.

*Figure:* Bilateral netting (left) and central clearing (right).
Central clearing mechanisms

(1) Multilateral netting (MN)
   ▶ Offsetting gains and losses across (original) counterparties

(2) Loss sharing
   ▶ Default losses are shared among surviving clearing members
Literature

Previous studies:

- Netting: sufficient *uncorrelated* multilateral netting opportunities $\rightarrow$ multilateral netting reduces counterparty risk exposure (Duffie and Zhu (2011), Cont and Kokholm (2014), Lewandowska (2015))

- Loss sharing: impact on a CCP’s collateral and fee policy (Capponi et al. (2017), Capponi and Cheng (2018), Huang (2018)) and risk shifting (Biais et al. (2012, 2016), Capponi et al. (2019))

Our contribution:

- Counterparty risk: central clearing vs bilateral netting

- 2 components:
  1. single-factor that drives correlation of derivatives prices (**systematic risk**)
  2. portfolio directionality (dealer (flat) vs end-user (directional))

- 2 mechanisms:
  1. multilateral netting
  2. loss sharing
Overview

Central Clearing

Netting

Loss sharing
Bilateral netting

Net with each counterparty $j$ across derivative classes $k$ (e.g., CDS, IRS, FX,...)
Multilateral netting

Clearing class-$K$: multilateral pool with CCP across (original) counterparties $j$

Additional netting pool $\Rightarrow$ Reduction of exposure?
Model (1)

- \(X_j^k\) = profit with \(j\) in class \(k\). Counterparty risk exposure = LGD = \(\max(X_j^k, 0)\)
- Single-factor model: Profit \(X_j^k = \beta M + \varepsilon_j^k \sim\) Normal with \(E[X_j^k] = E[M] = 0\)
- **Bilateral netting** (BN) across \(K\) classes:
  
  \[
  \text{total counterparty risk exposure} = E[E^{BN,K}] = \sum_{j=1}^{\gamma} E \left[ \max \left( \sum_{k=1}^{K} X_j^k, 0 \right) \right]
  \]

  Exposure to \(j\)

- **Multilateral netting** (MN) of class-\(K\): \(E[E^{MN}] = E \left[ \max \left( \sum_{j=1}^{\gamma} X_j^K, 0 \right) \right]\)
  
  \[
  \text{total counterparty risk exposure} = E[E^{BN+MN}] = E[E^{MN}] + E[E^{BN,K-1}]
  \]
Model (2)

**Measure:**

$$\Delta E = \frac{\mathbb{E}[E^{BN+MN} - E^{BN,K}]}{\mathbb{E}[E^{BN,K}]} = \text{effect of MN on counterparty risk exposure}$$

⇒ If $\Delta E < 0$, MN *reduces* counterparty risk exposure.

**Calibration:** index CDS and S&P 500 ($\text{cor}(X^k_j, M) = \rho_{X,M} = 43\%$)
No systematic risk: Bilateral vs multilateral netting

*Tradeoff*: excluding class-$K$ from BN $\Rightarrow$ exposure↑ vs. MN $\Rightarrow$ exposure↓

**Figure**: Multilateral vs bilateral netting (no systematic risk: $\rho_{X,M} = 0$).

Sufficient counterparties & no systematic risk $\Rightarrow$ MN beneficial (Duffie and Zhu (2011))
Central Clearing Netting Loss sharing References

Systematic risk

- End-user: MN benefit ↓
- Dealer: MN less affected than BN ⇒ MN benefit ↑

⇒ MN favors dealers vs end-users.

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Extreme events: Effect of netting conditional on $\text{VaR}^M(q)$

Wedge amplified: End-users **never** benefit & dealers **always** benefit.

*Intuition*: large $M$ dominates netting opportunities $\Rightarrow$ MN benefit ↓
Dealer: offset systematic risk exposure with MN $\Rightarrow$ MN benefit ↑

**Figure**: Effect of netting conditional on event $M = \text{VaR}^M(q)$.
Overview

Central Clearing

Netting

Loss sharing
Loss sharing

Upon default losses, CCPs allocate losses to remaining clearing members

- **Loss allocation** proportional to margins (≈ Nasdaq,..): Small margin ⇒ small contribution
  ⇒ Counterparty risk with central clearing is

\[
\mathbb{E}[E_{cleared}] = \sum_j P(\text{default}_j)\mathbb{E}[\text{bilateral exposure}_{j}^{K-1}] + \mathbb{E}[\text{contribution to CCP}^K]\text{(margin)}
\]

- **Netting** ⇒ margin(dealer) < margin(end-user)
  ⇒ Dealers contribute less to loss sharing than end-users
  ⇒ Larger reduction in counterparty risk \(\Delta E = \frac{\mathbb{E}[E_{cleared}^\text{dealers}] - PD \cdot \mathbb{E}[E_{BN}^K]}{PD \cdot \mathbb{E}[E_{BN}^K]}\) for dealers
Loss sharing and systematic risk

Figure: Effect of central clearing with loss sharing.

⇒ Dealer benefits more from central clearing than end-user.
Conclusion

In terms of counterparty risk,…

- multilateral netting favors dealers over end-users,
- loss sharing favors dealers over end-users since proportional to margins,
- during extreme events (e.g., crises), wedge between dealers and end-users amplifies.

⇒ Small/no incentive to centrally clear for end-users.
⇒ Consistent with reluctance to voluntarily clear in practice, particularly by end-users.
Thank you for your attention.


Backup
## Baseline Calibration

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exposure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\sigma_X$</td>
<td>0.01</td>
<td>Total contract volatility</td>
</tr>
<tr>
<td>$\rho_{X,M}$</td>
<td>0.43</td>
<td>Correlation between contract value and systematic risk factor $M$</td>
</tr>
<tr>
<td>$\sigma_M$</td>
<td>0.03</td>
<td>Systematic volatility</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.1433</td>
<td>Implied beta-factor contracts</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>0.009</td>
<td>Implied idiosyncratic contract volatility</td>
</tr>
<tr>
<td>$\nu$</td>
<td>1</td>
<td>Initial market value</td>
</tr>
<tr>
<td>$\text{cor} \left( r_{ij}^k, r_{hl}^m \right)$</td>
<td>0.185</td>
<td>Implied pair-wise correlation of contracts</td>
</tr>
<tr>
<td>$\alpha_{BN}$</td>
<td>0.99</td>
<td>Bilateral margin level</td>
</tr>
<tr>
<td>$\alpha_{MN}$</td>
<td>0.99</td>
<td>Multilateral (CCP) margin level</td>
</tr>
<tr>
<td><strong>Default model</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$pd$</td>
<td>0.05</td>
<td>Individual probability of default</td>
</tr>
<tr>
<td>$\rho_{A,A}$</td>
<td>0.05</td>
<td>Correlation of log assets conditional on $M$</td>
</tr>
<tr>
<td>$\bar{\sigma}_A$</td>
<td>1</td>
<td>Total log asset volatility</td>
</tr>
<tr>
<td>$\rho_{A,M}$</td>
<td>0.1</td>
<td>Correlation between log asset and systematic risk factor $M$</td>
</tr>
<tr>
<td>$\beta_A$</td>
<td>3.33</td>
<td>Implied beta-factor of log assets</td>
</tr>
<tr>
<td>$\sigma_A$</td>
<td>0.2</td>
<td>Implied idiosyncratic log asset volatility</td>
</tr>
</tbody>
</table>

**Table:** Baseline calibration (estimated for North American CDS indices from CDX series). We assume the same calibration for each entity.
Exposure and systematic risk

Systematic risk reduces multilateral netting efficiency

⇒ Increases lower limit to average exposure per counterparty: \( \frac{E_{MN}}{\gamma - 1} \geq |\rho_{X,M}| \sigma_X \varphi(0) \)

**Figure:** Reduction in average bilateral exposure, \( BN^K - BN^{K-1} \), and increase in multilateral exposure upon multilaterally netting contract class \( K \) (scaled by \( 10^4 \)) per counterparty.
Loss sharing and distribution of counterparty risk

(a) Dealers.

(b) End-users.

Figure: Effect of central clearing conditional on event $VaR^M(q)$.

$\Rightarrow$ Redistribution of risk from profitable to unprofitable states $M$.

$\Rightarrow$ Central clearing harmful in most states ($> 80\%$).

Intuition: Lower total margin with CCP $\Rightarrow$ exposure $\uparrow$

$\Rightarrow$ Extreme wedge: no state with a benefit for everyone.
Role of margins

![Graphs](image)

(a) With margin.

(b) Margin ≈ 0.

**Figure:** Effect of central clearing conditional on event $\text{VaR}^M(q)$ for end-users.

Smaller margin $\Rightarrow$ larger exposure
$\Rightarrow$ If BN margin/exposure large (moderate $M$) and MN reduces margin, clearing increases risk.
$\Rightarrow$ Margins shift clearing benefits to distribution’s tails.
Loss sharing vs no loss sharing

Figure: Loss sharing vs no loss sharing conditional on $M = \sigma_M \Phi^{-1}(q)$.

Loss sharing $\approx$ catastrophe insurance: only insures end-users’ tail risk
$\Rightarrow$ “insurance premium” eliminates multilateral netting benefits in less extreme states

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Margin requirements

Derivative transactions typically include margins (i.e., collateral).

Current margin requirements: Clearing margin level $\alpha_{MN} <$ Bilateral margin level $\alpha_{BN}$

* CCPs have incentives to set low margins to attract investors (e.g., Capponi and Cheng (2018)).
Uncollateralized exposure

If $\alpha_{MN} << \alpha_{BN}$, then multilateral netting does not reduce exposures - regardless of netting.  
$\Rightarrow$ Under current margin requirements, multilateral netting likely increases counterparty risk.

Figure: Change in exposures for fixed bilateral margin level $\alpha_{BN} = 0.99$.

Intuition: Small margins raise exposure, dominating diversification.