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 $\Rightarrow$ reduces counterparty risk?

Main finding:
Central clearing is no panacea: substantially benefits dealers but not end-users.
$\Rightarrow$ 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.

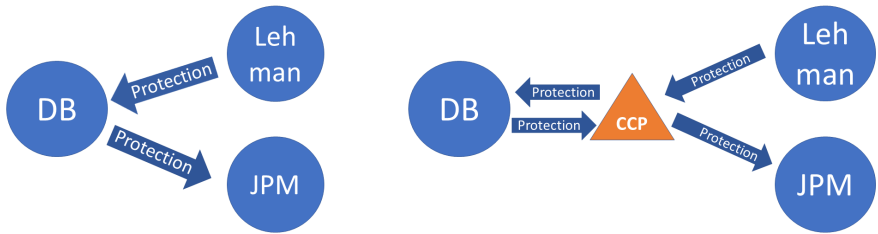


Figure: Bilateral netting (left) and central clearing (right).

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 → 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))

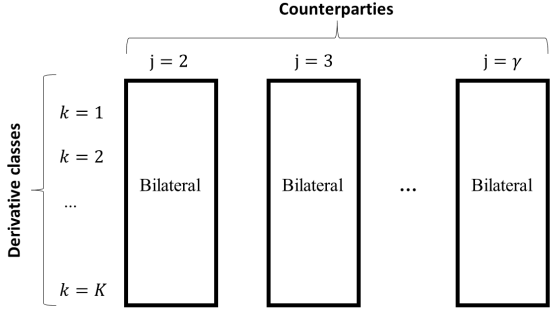
Our contribution:

- 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

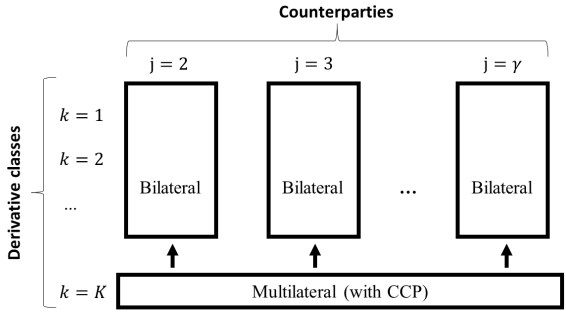
Bilateral netting

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 $\mathbb{E}[X_j^k] \equiv \mathbb{E}[M] = 0$
- **Bilateral netting** (BN) across K classes:

$$\textit{total counterparty risk exposure} = \mathbb{E}[E^{BN,K}] = \sum_{j=1}^{\gamma} \underbrace{\mathbb{E}\left[\max\left(\sum_{\mathbf{k=1}}^{\mathbf{K}} \mathbf{X_j^k}, 0\right)\right]}_{\text{Exposure to } j}$$

- **Multilateral netting** (MN) of class-K: $\mathbb{E}[E^{MN}] = \mathbb{E}\left[\max\left(\sum_{\mathbf{j=1}}^{\gamma} \mathbf{X_j^K}, 0\right)\right]$

$$\textit{total counterparty risk exposure} = \mathbb{E}[E^{BN+MN}] = \mathbb{E}[E^{MN}] + \mathbb{E}[E^{BN,K-1}]$$

Model (2)

Measure:

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

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

Calibration: index CDS and S&P 500 ($cor(X_j^k, M) = \rho_{X,M} = 43\%$)

No systematic risk: Bilateral vs multilateral netting

Tradeoff: excluding class-K from BN $\Rightarrow$ exposure$\uparrow$ vs. MN $\Rightarrow$ exposure$\downarrow$

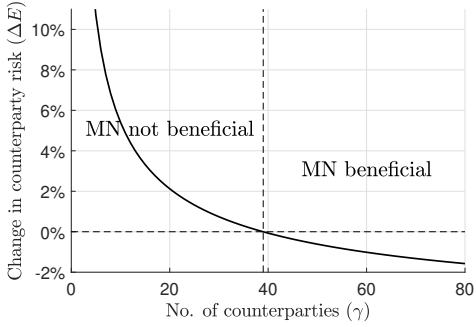
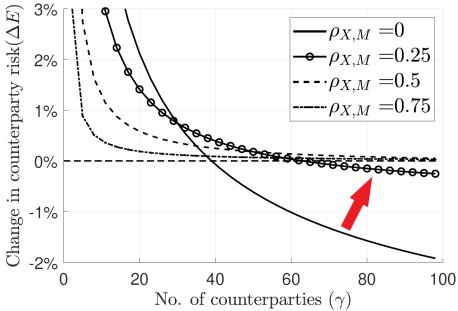


Figure: Multilateral vs bilateral netting (no systematic risk: $\rho_{X,M} = 0$).

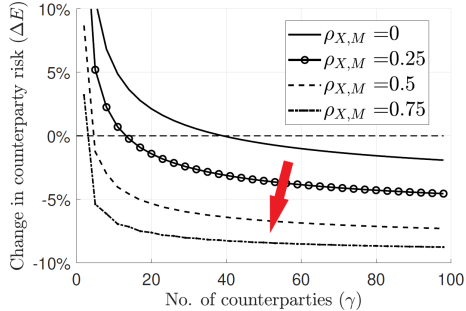
Sufficient counterparties & no systematic risk $\Rightarrow$ MN beneficial (Duffie and Zhu (2011))

Systematic risk

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



(a) End-user.

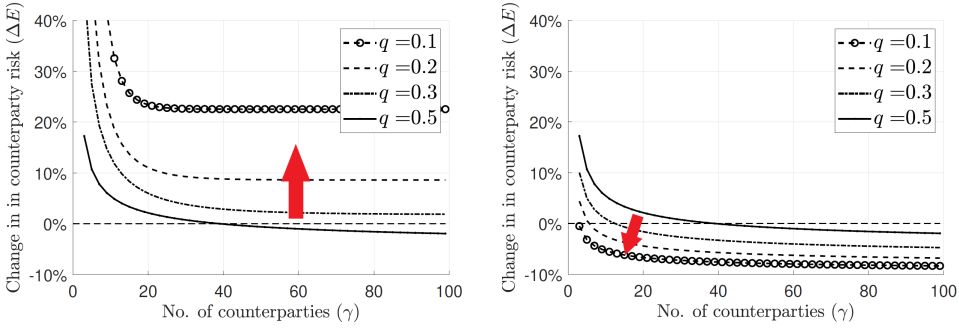


(b) Dealer.

⇒ MN favors dealers vs end-users.

Extreme events: Effect of netting conditional on $VaR^M(q)$

Wedge amplified: End-users **never** benefit & dealers **always** benefit.
Intuition: large M dominates netting opportunities $\Rightarrow$ MN benefit $\downarrow$
Dealer: offset systematic risk exposure with MN $\Rightarrow$ MN benefit $\uparrow$



(a) End-user. (b) Dealer.

Figure: Effect of netting conditional on event $M = VaR^M(q)$.

Overview

Loss sharing

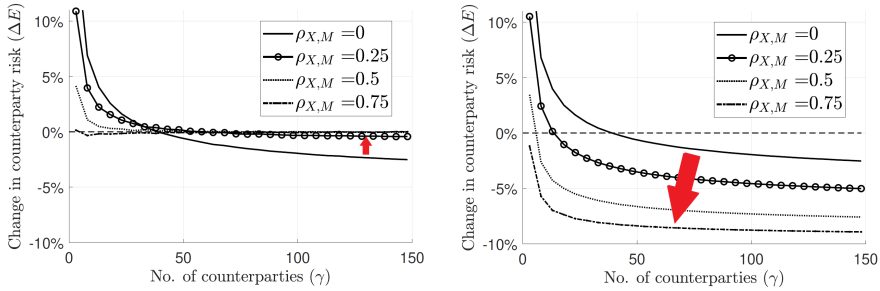
Upon default losses, CCPs allocate losses to remaining clearing members

- Loss allocation proportional to margins ($\approx$ Nasdaq,..): Small margin $\Rightarrow$ small contribution
  $\Rightarrow$ Counterparty risk with central clearing is

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

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

Loss sharing and systematic risk



(a) End-user. (b) Dealer.

Figure: Effect of central clearing with loss sharing.

$\Rightarrow$ 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.

$\Rightarrow$ Small/no incentive to centrally clear for end-users.

$\Rightarrow$ Consistent with reluctance to voluntarily clear in practice, particularly by end-users.

Thank you for your attention.

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Backup

Baseline Calibration

Variable	Value	Description
Exposure		
σ_X	0.01	Total contract volatility
$\rho_{X,M}$	0.43	Correlation between contract value and systematic risk factor M
σ_M	0.03	Systematic volatility
β	0.1433	Implied beta-factor contracts
σ	0.009	Implied idiosyncratic contract volatility
v	1	Initial market value
$\text{cor}\left(r_{ij}^k, r_{hl}^m\right)$	0.185	Implied pair-wise correlation of contracts
α_{BN}	0.99	Bilateral margin level
α_{MN}	0.99	Multilateral (CCP) margin level
Default model		
pd	0.05	Individual probability of default
$\rho_{A,A}$	0.05	Correlation of log assets conditional on M
$\bar{\sigma}_A$	1	Total log asset volatility
$\rho_{A,M}$	0.1	Correlation between log asset and systematic risk factor M
β_A	3.33	Implied beta-factor of log assets
σ_A	0.2	Implied idiosyncratic log asset volatility

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**

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

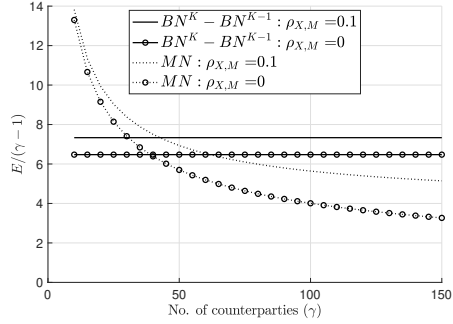
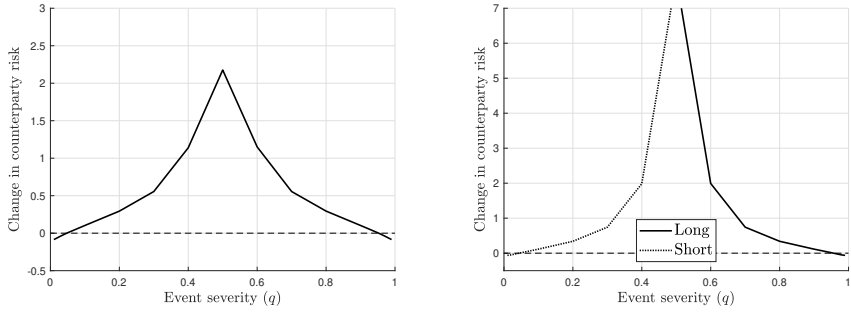


Figure: Reduction in average bilateral exposure, $BN^K - BN^{K-1}$, and increase in multilateral exposure upon multilaterally netting contract class K (scaled by 10^4) per counterparty.

Loss sharing and distribution of counterparty risk



(a) Dealers. (b) End-users.

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

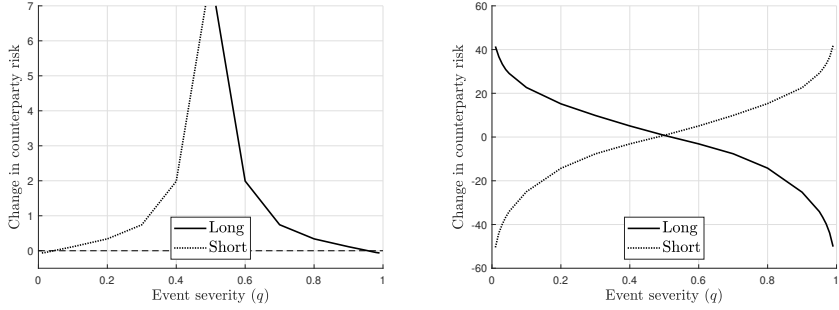
$\Rightarrow$ Redistribution of risk from profitable to unprofitable states M.

$\Rightarrow$ 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



(a) With margin.

(b) Margin ≈ 0.

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

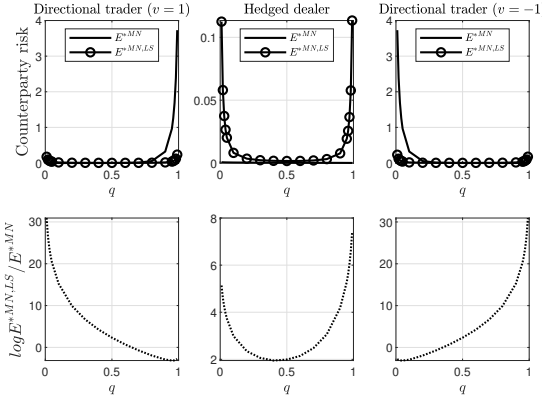


Figure: Loss sharing vs no loss sharing conditional on $M = \sigma_M \Phi^{-1}(q)$.

Loss sharing $\approx$ catastrophe insurance: only insures end-users' tail risk

$\Rightarrow$ "insurance premium" eliminates multilateral netting benefits in less extreme states

Margin requirements

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

Current margin requirements: Clearing margin level α_{MN} < Bilateral margin level α_{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.

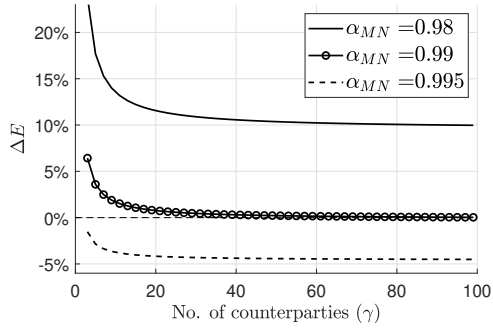


Figure: Change in exposures for fixed bilateral margin level $\alpha_{BN} = 0.99$.

Intuition: Small margins raise exposure, dominating diversification.