Loss Sharing in Central Counterparties: Winners and Losers

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Derivatives markets and default losses

- OTC (over-the-counter) derivatives markets
  - large: $12 trillion gross market value (BIS 2019)
  - core (dealer) - periphery (end-user) structure: 16 dealers dominate the EU CDS, IRS, FX market (Abad et al. (2016))
  - *pre 2007*: largely unregulated
- Default losses: Lehman fails on derivative obligations
- Regulators: reduce spillover from default losses via central clearing of derivatives, *although* market participants (end-users!) reluctant to voluntarily clear ($< 40\%$ of CDS, IRD, FX transactions cleared pre-regulation)

This paper: central clearing $\Rightarrow$ default losses?
Main finding:
Central clearing no panacea: benefits for flat but not directional/peripheral entities.
Interaction: CCP rulebook $\leftrightarrow$ network structure $\leftrightarrow$ core vs. peripheral entities

Central clearing

Suppose *Deutsche Bank* buys credit protection (CDS) from *Lehman* sells it to *JPM*.
⇒ Default loss if Lehman fails on obligation to pay.

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

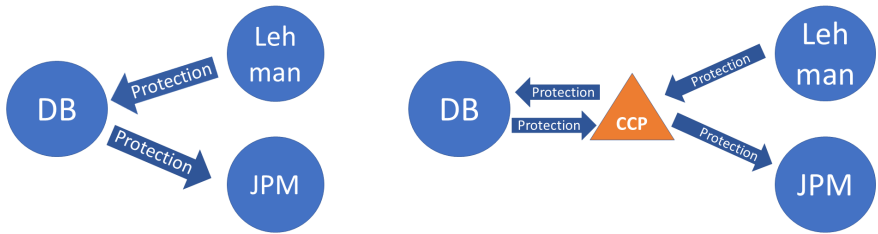


Figure: Uncleared market (left) and central clearing (right).

CCP waterfall

If a clearing member (CM) defaults on obligation to CCP, loss is covered by waterfall:

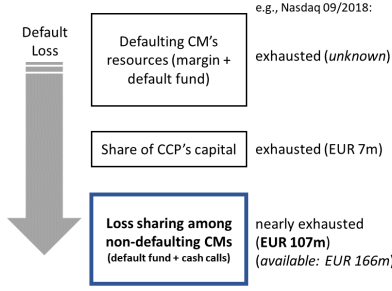


Figure: CCP waterfall and example from Nasdaq 09/2018.

$\Rightarrow$ Loss sharing contribution = exposure to CCP

Literature

Previous studies:

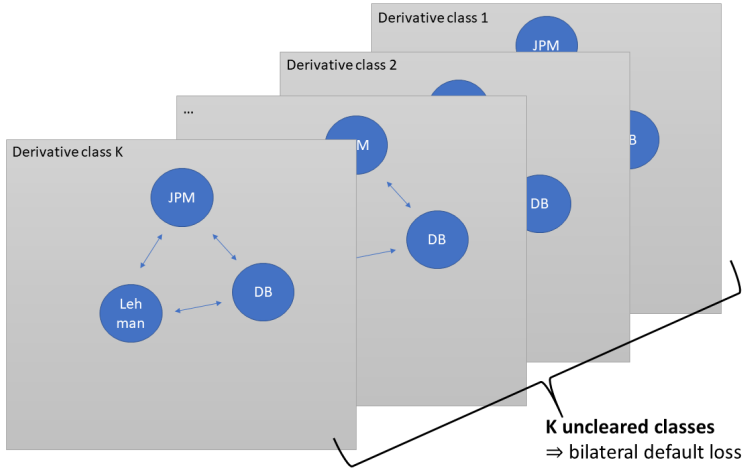
- Netting: offsetting gains & losses across contracts with originally different counterparties reduces overall default losses (Duffie and Zhu (2011), Cont and Kokholm (2014), Lewandowska (2015))
- Loss sharing: impact on a CCP's collateral and fee policy (Capponi et al. (2017), Capponi and Cheng (2018), Huang (2018)) and risk shifting (Biais et al. (2012, 2016), Capponi et al. (2019))

Our contribution:

- Default losses: central clearing vs uncleared market
- Main ingredients:
  1. network structure
  2. loss sharing rules
  3. correlation of derivatives prices (systematic risk)

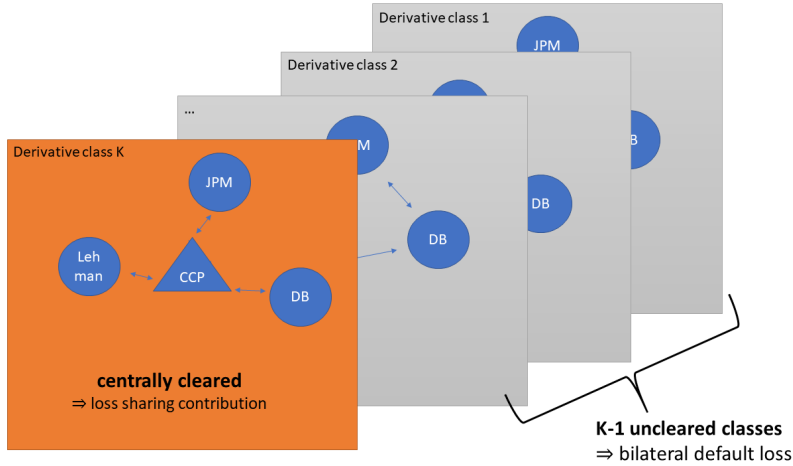
Model

K derivative classes, γ market participants



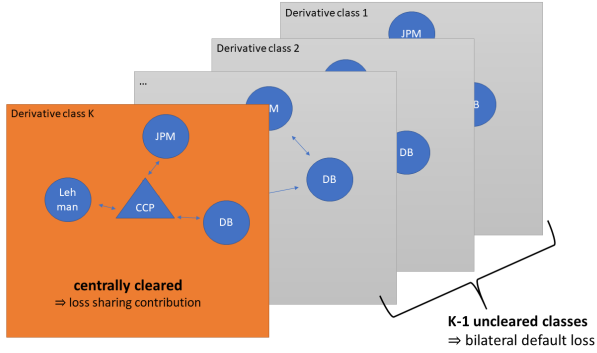
Model

class-K centrally cleared:



Model

class-K centrally cleared:



Relative effect of loss sharing: $\Delta E = \dfrac{\mathbb{E}[LSC^{CCP} + DL^{uncleared,K-1}]}{\mathbb{E}[DL^{uncleared,K}]} - 1$

$\Rightarrow$ If $\Delta E < 0$, loss sharing *reduces* expected default loss.

Networks of derivative positions

(1) Flat only & complete

$$\begin{pmatrix} & 1 & -1 & 1 & -1 & \text{(flat)} \\ -1 & & 1 & -1 & 1 & \text{(flat)} \\ 1 & -1 & & 1 & -1 & \text{(flat)} \\ -1 & 1 & -1 & & 1 & \text{(flat)} \\ 1 & -1 & 1 & -1 & & \text{(flat)} \end{pmatrix}$$

(2) Heterogeneous & complete

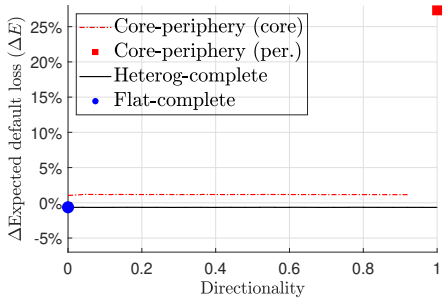
$$\begin{pmatrix} & 1 & 1 & 1 & 1 & \text{(directional)} \\ -1 & & 1 & 1 & 1 & \\ -1 & -1 & & 1 & 1 & \text{(flat)} \\ -1 & -1 & -1 & & 1 & \\ -1 & -1 & -1 & -1 & & \text{(directional)} \end{pmatrix}$$

(3) Heterogeneous & core-periphery

Peripheral entities only trade with one core-entity:

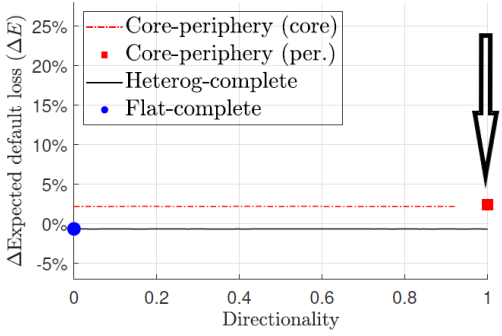
$$\begin{pmatrix} & & & & 1 & & & & \text{(per.)} \\ & & & 1 & & & & & \text{(per.)} \\ & & 1 & & & & & & \text{(per.)} \\ & -1 & & 1 & 1 & 1 & 1 & & \text{(direct.)} \\ & -1 & -1 & & 1 & 1 & 1 & & \\ -1 & & -1 & -1 & & 1 & 1 & 1 & \text{(flat)} \\ & & -1 & -1 & -1 & & 1 & & \\ & & -1 & -1 & -1 & -1 & & 1 & \text{(direct.)} \\ & & & & & & -1 & & \text{(per.)} \\ & & & & & -1 & & & \text{(per.)} \\ & & & & -1 & & & & \text{(per.)} \end{pmatrix}$$

Effect of loss sharing across entities *w/o systematic risk*



- Directionality in portfolios does not matter
  Why? No correlation.
- Peripheral entities' loss sharing contribution >> core entities' LSC
  Why? No netting opportunities ⇒ large relative share in loss sharing.

Importance of loss sharing rule *w/o systematic risk*



Proportional to gross notional $\Rightarrow$ same benefit across entities.

Systematic risk

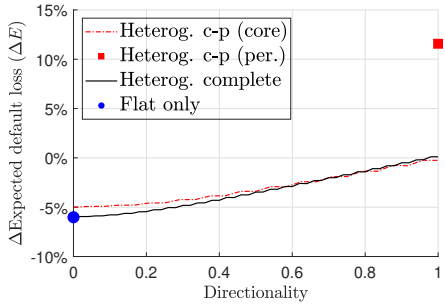
Central clearing matters most when there are correlated shocks (crises)!

Model: systematic risk factor that affects all derivatives prices (e.g., macroeconomic conditions, liquidity, etc.):

$$X_j^k = \beta M + \varepsilon_j^k \sim \text{ Normal with } \mathbb{E}[X_j^k] \equiv \mathbb{E}[M] = 0$$

Calibration: cor(Index CDS, S&P500) $= \text{cor}(X_j^k, M) = 43\%$

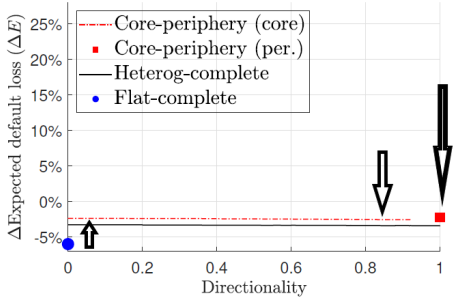
Effect of loss sharing across entities **with systematic risk**



Directionality matters:

- More directional → loss sharing less beneficial
  Why? Directionality + systematic risk ⇒ small netting opportunities
  ⇒ large portfolio risk ⇒ large relative loss sharing contribution

Importance of loss sharing rules **with systematic risk**



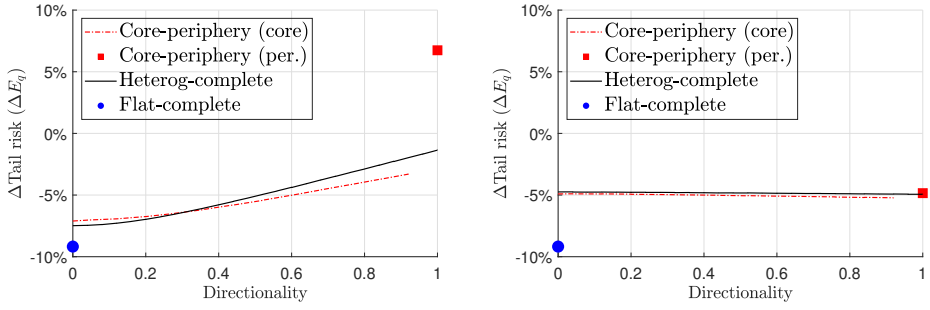
Proportional to gross notional ⇒ same benefit across entities.

Overview

Tail risk

Financial stability perspective: central clearing matters most in crises, when there are correlated shocks!

Similar effect as on average:



(a) $\propto$ margin (b) $\propto$ gross

Figure: Relative change in tail risk($\hat{q} = 0.05$) due to central clearing.

Conclusion

- Loss sharing in practice is based on net risk
  - favors interconnected+flat entities (core) over end-users (periphery+directional)

$\Rightarrow$ Consistent with reluctance of end-users to voluntarily clear in practice.

- Loss sharing rule crucial:
  - $\propto$ gross notional: homogeneous effect of loss sharing,
    but smaller benefit for interconnected entities compared to $\propto$ net

$\Rightarrow$ Interaction with CCP profit maximization (favor those with large portfolio)?

$\Rightarrow$ Trade-off important for systemic risk. Need to regulate loss sharing rules?

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 risk factor volatility
β	0.1433	Implied beta-factor contracts
σ	0.009	Implied idiosyncratic contract volatility
v	1	Initial market value
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
σ_A	0.2	Implied idiosyncratic log asset volatility

Table: Baseline calibration (estimated for North American CDS indices from CDX series 2006-2010). We assume the same calibration for each entity.

Loss sharing

In practice, if the CCP default loss exceeds defaulters resources, exploit

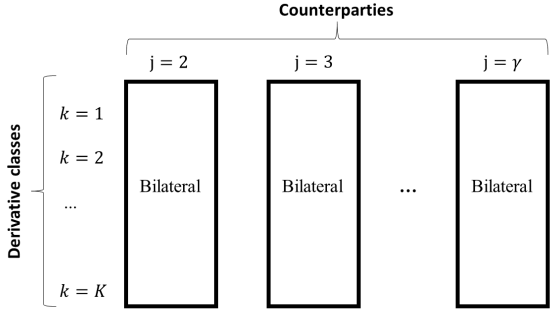
(1) non-defaulters' **default fund** (DF) contributions
- CM's pre-funded contribution proportional to CCP exposure to CM
- losses allocated proportionally to contributions (not specified in regulation!)
- replenished regularly (typically: each month)

(2) **cash calls** to non-defaulters (unfunded contributions)
- proportional to DF contributions

In our model:
default fund contributions $\approx$ unfunded contributions
$\Rightarrow$ sufficient to calculate CM's loss sharing contribution

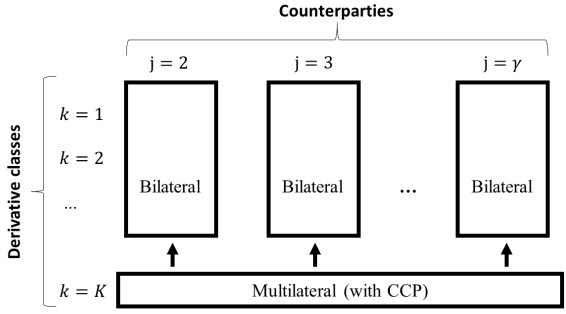
Trade portfolio: uncleared market

Default loss with counterparty j: net loss across derivative classes k (e.g., CDS, IRS, FX,...)



Trade portfolio: with central clearing

Central clearing of class-K: default loss with CCP depends on multilateral pool across (original) counterparties j



Model (1)

- i trades with $\gamma - 1$ counterparties in K different contract classes (CDS, IRS, ...)
- X_{ij}^k =profit for i in class k if j defaults, default loss for $i = \max(X_{ij}^k, 0)$
  Independently distributed $X_{ij}^k \sim$ Normal with $\mathbb{E}[X_{ij}^k] \equiv 0$
- $D_j = \{j \text{ defaults}\}$ with $\mathbb{P}(D_j = 1) = \pi \in (0, 1)$
- C_{ij}^K = Value-at-Risk bilateral collateral posted by j to i,
  C_j^{CCP} = Value-at-Risk CCP collateral
- **Uncleared market** across K classes:

$$\textit{total expected default loss} = \mathbb{E}[DL_i^{uncleared,K}] = \sum_{j=1}^{\gamma} \underbrace{\mathbb{E}\left[D_j \max\left(\sum_{\mathbf{k=1}}^{\mathbf{K}} \mathbf{X_j^k} - \mathbf{C_{ij}^K}, 0\right)\right]}_{\text{loss if } j \text{ defaults}}$$

Model (2)

- Due to symmetry: portfolio-VaR = CCP initial margin $C_i^{CCP} \propto$ CCP exposure to CM
  $\Rightarrow$ CCP losses allocated prop. to C_i^{CCP}
- **Central clearing** of class-K implies expected loss sharing contribution

$$\mathbb{E}[LSC_i^{CCP}] = \mathbb{E}\Bigg[\underbrace{\frac{(1-D_i)C_i^{CCP}}{\sum_{g=1}^{\gamma}(1-D_g)C_g^{CCP}}}_{\text{share allocated to } i} \times \underbrace{\sum_{j=1}^{\gamma} D_j \max\left(\sum_g X_{gj}^K - C_j^{CCP}, 0\right)}_{\text{CCP's loss}} \mid \sum_{g=1}^{\gamma}(1-D_g) > 0 \Bigg]$$

  and total default loss $= \mathbb{E}[DL_i^{uncleared,K-1}] + \mathbb{E}[LSC_i^{CCP}]$

  $\Rightarrow$ loss sharing contribution depends on (1) relative loss sharing and (2) CCP's loss

- **Relative effect of loss sharing** measured by

$$\Delta E = \frac{\mathbb{E}[DL_i^{uncleared,K-1}] + \mathbb{E}[LSC_i^{CCP}] - \mathbb{E}[DL_i^{uncleared,K}]}{\mathbb{E}[DL_i^{uncleared,K}]}$$

  $\Rightarrow$ If $\Delta E < 0$, central clearing *reduces* expected default losses.

- **Calibration**: 50 CMs (LCH interest rates: 64 general CMs, LCH OTC FX: 14, ICE US: 34,...), 90% VaR

CCP's loss and netting **with systematic risk**

With systematic risk, directionality matters:

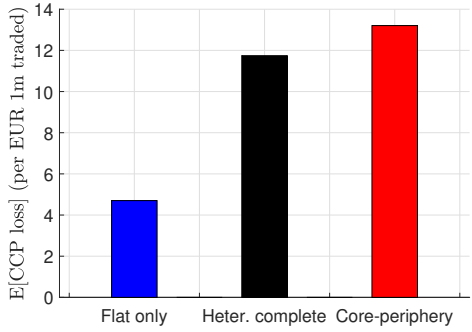


Figure: Expected CCP's default loss across networks.

Directional positions ⇒ less netting opportunities ⇒ larger CCP default loss per trade volume