CDS Central Counterparty Clearing Default Measures: Road to Recovery or Invitation to Predation?

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**Post-2008 Dodd-Frank legislation:**
Standardised CDS contracts & Mandated central clearing.

**Large, Opaque OTC market ($11.8 Trillion USD):**
CDS mostly bespoke & Largely uncleared.

**CCP → Global Systemically Important Institution (GSII)**
- Default fund cannot absorb default of more than 1 or 2 large members.
- CCP pays *Variation Margin* for life of CDS contract.

**Lehman Default on Derivative Contracts:**
CCPs left holding large positions
- CCP must unwind positions quickly (5 days) – common information.
- Offloaded positions to Barclays at fraction of value.
Motivation & Research Question

What if a large, global dealer bank failed today...

Could a CCP unwinding strategy trigger default contagion:
- If members (distressed) liquidate?
- If members (unconstrained) engage in predation?

Could this result in CCP failure?

Is there a CCP/Regulatory tool to prevent predation and aid CCP recovery?

Would it be incentive compatible for the CCP and Members?

- network problem (star)
- contagion (price-mediated) and amplification (predation)
- multi-agent, multi-asset, multi-period problem
I. Predation and Price Feedback Effects

- (Brunnermeier and Pedersen, 2005)
  Predation model for exchange-based trading (price-transparency).
  Predators sell in direction of distressed agents, buyback after liquidation (profit).
  - **Extension**: Model the opaque OTC market

II. Stability in Financial Networks

- (Cont and Wagalath, 2013)
  Model firesale and price-mediated contagion (indirect), increased covariance in hedge fund portfolios.
  - **Extension**: Explicitly model the covariance between different assets *inside* portfolio.

- (Amini et al., 2015)
  Examine alternative CCP Design, incentive compatible for banks.
  - **Extension**: Model on-going variation margin exchange, dynamic reaction of banks to defaults, disciplinary mechanism.
III. Determinants of Changes In CDS-Spreads

**Empirical Work:** Determine that variables thought to explain credit-spread changes, have only fraction of explanatory power.

- *(Collin-Dufresne and Martin, 2001)*
  
  Observe most of credit-spread change is driven by common, systematic component (difficult to explain).
  
  **Extension:** Theoretical CDS-spread model; permanent and time-dependant component.

- *(Tang and Yang, 2005)*
  
  Determine systematic component has time dimension. Explains the co-movements in credit default spreads.
  
  - Time component persists for max. 2 trading periods or becomes permanent.
  
  **Extension:** Model CDS-covariance and incorporate in the CDS-spread model.

- *(Tang and Yan, 2017)*
  
  Identify the fundamental determinants of CDS-spread and the effects of excess demand and supply (asymmetric).
  
  - Excess demand driven by info with fundamental content.
  
  - Excess supply liquidity-driven with little such information.
  
  **Extension:** CDS-spread model has transitory price impact from trading.
Credit Default Swaps

- **Insurance** on reference entity (used for Hedging/Speculating).

- Taken out on **Notional** amount (i.e. Value of bond position).

- Buyer pays **Premium** to seller for life of contract (5-yr Standard).

- Seller pays buyer if **reference entity** defaults (Cash or Physical delivery).

- **Standard CDS** premium is 100 or 500 bps (1 bps = 0.001%).

- Contract entered into a zero value - **Up-front Payment**.

- Market value expressed in **Credit Spread (bps)**, increases with default probability.

- Buyer and seller exchange **Variation Margin** = Credit Spread - Premium

- Feature: Buy/Sell both sides CDS contract multiple times → **Redundant Trades**
  - **Buy-side** (long CDS contract) & **Sell-side** (short CDS contract)
  - **Example 1:** Unwind 'sell' position by buying 'buy' position on asset k
  - **Example 2:** Sell 'sell' position on asset k to another party.
Dealer Banks & The Over-The-Counter CDS Market

- **Large market** (11.8 Trillion USD\(^1\)) with bespoke and standard CDS.
  
- **Over-the-counter trading** (search market).
  
- **No price transparency**, through dealer banks (bid-ask spread).
  
- Top 14 (Core) dealers own 85% (notional) of global CDS market.
  
- 75% trades are **Dealer-to-Dealer**.
  
- Top 14 dealers are members of all large **CCPs** (ICE, CME, LHC-Clearnet\(^2\))


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\(^1\)The CDS market size dropped from $61 trillion (end 2007) to $9.4 trillion (2017) due to central clearing.

\(^2\)ICE Clear Credit clears the largest share of the single-name CDS market with approx. 77.1%, followed by 18.8% for ICE Europe, 3.69% for CME, 0.369% for LCH CDS Clear and 0.0369% for JSCC.
Facility **mediates** trades - Buyer to every seller, seller to every buyer.

Ensures adequate **collateral** and **compression** of trades (Min. Counterparty Risk).

Holds little equity, charges **volume-based fee**.

**Membership:** Up-front initial margin contribution (Guarantee Fund), smaller Default Fund contribution.

- Initial Margin is proprietary to dealer, Default Fund is risk-sharing fund.
- Default Fund is $\approx 10\%$ size of Guarantee Fund, deemed insufficient.

**Existing CCP Default Waterfall Procedure:** In default use...

1. Member Contribution
2. CCP Equity Tranche
3. Default Fund
4. Remaining CCP Equity
5. ... CCP Failure or Lender of Last Resort!
A Summary of Key Results:

- **Always lower CCP profits** with constrained unwinding (time/equity) → *Future research for unwinding strategies.*
- **Predation decreases profits** of all members & pushes all dealers toward default → *Institute hybrid fund to disincentivize predation.*
- **Risk-sharing guarantee fund** offers legal, enforceable disciplinary mechanism for predation → *Viable for CCP and regulatory intervention.*
- **Risk-sharing guarantee fund** increases protection for CCP equity for a large default → *CCP incentive-compatible and increases financial stability.*
- **Risk-sharing guarantee fund** increases effectiveness of bailout by Lender of Last Resort → *Margin refill reduces size of bail-out required.*
- **Lender of Last Resort** targeted liquidity injection at distressed dealers → *higher likelihood of success when very low/very high levels of distress only.*
Model Setup

- **Star-shaped Financial Network:** CCP connected to members through CDS. 
  - Network: CCP \((i = 0)\), Dealer Members \((i = \{1, \ldots, m\})\), 
    CDS Reference Entities \((k = \{1, \ldots, K\})\)
  - **Side** \((p)\) of CDS contract: Buy \((p=\text{B})\) or **Sell** side \((p=\text{S})\),
    \[ X^B = +X \quad \text{and} \quad X^S = -X \quad (1) \]

- **Variation Margin** \((VM_i)\) on the nominal value \((V_i)\) of dealer’s \(i\) CDS portfolio,
    \[ VM_i \approx [\triangle V_i]^+ = \sum_{k=1}^{K} X_i^k \triangle S^k(t_\ell) \geq 0 \quad (2) \]

- **Liability:** Dealer \(i\) **owes** to other dealers \(j\) in variation margin (on CDS \(k\)),
    \[ L_i^k = \sum_{j=1}^{m} L_{ij}^k = VM_i^k \quad (3) \]

- **Multi-lateral Netting:** Dealer \(i\)’s **net exposure** to counterparties \(j\),
    \[ \Lambda_i = \sum_{k=1}^{K} \left( \sum_{j=1}^{m} L_{ji}^k - \sum_{j=1}^{m} L_{ij}^k \right) \quad (4) \]
Covariance and Price impact

- CDS exhibit spread covariance - Model can assume a volatility-like structure,

\[ X_{ij}^{k,p} \sum_{ij} X_{ji}^{k,p} \]  

(5)

- Specialise to a linear price impact formulation,

\[ X_{ij}^{k,p} f(X_{ji}^{k,p}) \text{ with } f(X_{ji}^{k,p}) = S^k(t_\ell) \left( \frac{X_{ji}^{k,\pm p}}{D_k} \right) \]  

(6)

- \( D_k \): Vector of market depth for CDS assets of type \( k \).

- If \( S \) is CDS-spread then \( \triangle S \) is change in CDS-spread,

\[ \triangle S^k(t_\ell, t_{\ell-1}) = S^k(t_\ell) - S^k(t_{\ell-1}) \]  

(7)

- Price Impact: Trade (liquidation effect) on spread,

\[ S^k(t_\ell) = S^k(t_{\ell-1}) \left( 1 - \frac{1}{D_k} \sum_{j \in D} X_j^k(t_{\ell-1}, t_{\ell-2}) \right) \]  

(8)
Variation Margin & CDS-spread

- The change in the market value of dealer member $i$’s CDS holding is,

$$
\Delta V^k_i = X^k_i \Delta S^k(t_\ell, t_{\ell-1}) = X^k_i \Delta S^k(t_{\ell-1}, t_{\ell-2}) \left(1 - \frac{1}{D_k} \sum_{j \in D} X^k_j, t_{\ell_\ell}\right) \quad (9)
$$

- Permanent Price Impact: CDS-spread on $k$ moves due to changes in fundamentals\(^3\),

$$
\Delta S^k(t_{\ell-1}, t_{\ell-2}) \rightarrow \Delta F^k(t_{\ell-1}, t_{\ell-2}) \quad (10)
$$

- Temporary Price Impact: from trading/liquidation through $f(X^k_{j, t_{\Delta \ell}})$.

- Absent trading, only change in fundamental CDS-spread alters VM,

$$
VM^{k,p}_i(t_\ell) = \left[ X^{k,p}_{ij}(t_{\ell-1}) (\Delta F^k(t_{\ell-1}, t_{\ell-2}) \right]^+ \quad (11)
$$

- With trading, primary and temporary impact on CDS-spread alters VM,

$$
VM^{k,p}_{i,t_\ell} = \left[X^{k,p}_{ij}(t_{\ell-1}) (\Delta F^k(t_{\ell-1}, t_{\ell-2}) - \Delta S^k(t_{\ell-1}, t_{\ell-2}) \frac{1}{D_k} \sum_{j \in D} X^k_j, t_{\ell_\ell}\right]^+ \quad (12)
$$

\(^3\)Where $F$ is a strictly positive, continuous, non-linear function (e.g. polynomial, trigonometric function bounded from the bottom by zero.)
Figure: Covariance relationships Covariance relationships between CDS and counterparties in financial network - defined by the distance of dealers’ CDS (colour) positions from a defaulter’s CDS positions which are undergoing close-out by CCP.
The Mathematical Structure I: Symbolic Form

- If no trading before $S^k(t_\ell) = F^k(t_{\ell-2}) - f(X_j^k, t_{\triangle \ell})$ then $S^k(t_{\ell-1}) = F^k(t_{\ell-2})$

- The cumulative effect of the price impact can be seen by looking at the change in spread over the next time increment, in terms of the fundamentals (proof in appendix),

\[
\triangle S^k(t_{\ell+1}, t_\ell) = \left[ F^k(t_\ell) - \frac{S^k(t_\ell)}{D^k(t_\ell)} \sum_{j \in D} X^k_{j, (t_\ell)} \right]
\]

\[= F^k_{t_\ell} - F^k_{t_{\ell-1}} - \frac{S^k(t_{\ell-1})}{D^k(t_{\ell-1})} \sum_{j \in D} X^k_{j, (t_{\ell-1})} \]

\[= F^k_{t_\ell} - f_{t_\ell} (F^k_{t_{\ell-1}}) + f_{t_{\ell-1}} (F^k_{t_{\ell-2}}) + f_{t_{\ell-1}} (F^k_{t_{\ell-2}})
\]

- Where $X^k_{j, t_{\triangle \ell}}$ is the trading rate $A^k_{j, t_{\triangle \ell}}$ at $\tau = t_{\triangle \ell}$
If $X^k_{j,t_\triangle}$ is the trading rate $A^k_{j,t_\triangle} = \sum_j a^k_{j,t_\triangle}$ per $\tau = t_\triangle$.

And dealers trade due to other dealers’ optimal trading, the cds-spread from motivated trading is,

$$\sum_k \Delta S^k(t_{\ell+2}, t_{\ell+1}) = \sum_k \left[ F^k(t_{\ell+1}) - F^k(t_{\ell}) - F^k(t_{\ell}) \frac{\sum_{i \in D} A^k_{j_i(t_{\ell+1})}}{D^k_{(t_{\ell+1})}} \tau \right]$$

$CCP$ leads primary trading

$$+ F^k(t_{\ell-1}) \frac{\sum_i A^k_{i,(t_{\ell+1})}}{D^k_{(t_{\ell+1})}} \tau \frac{\sum_i A^k_{i,(t_{\ell})}}{D^k_{(t_{\ell})}} \tau$$

$Primary$ distressed quick reaction

$$- F^k(t_{\ell-2}) \frac{\sum_j A^k_{j,(t_{\ell})}}{D^k_{(t_{\ell})}} \tau \frac{\sum_i A^k_{i,(t_{\ell-1})}}{D^k_{(t_{\ell-1})}} \tau$$

$Secondary$ distressed delay

$$+ F^k(t_{\ell-2}) \frac{\sum_{j''} A^k_{j'',(t_{\ell+1})}}{D^k_{(t_{\ell+1})}} \tau \frac{\sum_j A^k_{j,(t_{\ell})}}{D^k_{(t_{\ell})}} \tau \frac{\sum_i A^k_{i,(t_{\ell-1})}}{D^k_{(t_{\ell-1})}} \tau$$

$Tertiary$ downstream response
The Mathematical Structure IIb: Full Form

- **OTC market price intransparency** permits only a partial view of market prices and trading rates - dealers can only trade the visible market price not the fundamental price!

- Each dealer chooses optimal trading rate by approximating average market trading rate (of other traders).

- This shifts the price and permits the exchange (proof appendix) to the tradeable price $S_{t_{\ell}}^k$ such that,

$$F_{t_{\ell-1}}^k \frac{A_i^k}{D_k} \tau \rightarrow S_{t_{\ell}}^k \frac{A_i^k}{D_k} \tau$$

(14)

- The change in spread then incorporates a shift from the fundamental value,

$$S_{t_{\ell+1}}^k - S_{t_{\ell}}^k = - S_{t_{\ell}}^k \frac{A_j^k}{D_k(t_{\ell})} \tau(t_{\ell+1}, t_{\ell}) = \Delta S_{(t_{\ell+1}, t_{\ell})}^k$$

(15)

- Dealers mis-estimation of trading rates and subsequent shift in spread from fundamentals *observes the price impact of dealers’ own trading*...

Thus, predators become prey to own predatory behavior!
Proposition 1: A dealer's variation margin, given by the changing value of its portfolio, is determined by the type and size of CDS positions \( X_i^k = \sum_j X_{ij}^k \), as well as, the changing CDS-spread \( \Delta S^k \). The spread captures the magnitude of price impact exerted on the value of a dealer’s CDS portfolio from market trading of a defaulter’s CDS portfolio – based on the degrees of counterparty covariance between the particular CDS comprising those portfolios.

\[
\sum_{k}^{K} X_i^k \Delta S_{t_{\ell+2},t_{\ell+1}}^k = \sum_{k}^{K} X_i^k \left[ \frac{\Delta F_{(t_{\ell+1},t_{\ell})}^k}{\text{fundamental spread}} - \frac{\sum_{j}^{m} a_{0j}^k \tau_{(t_{\ell+2},t_{\ell+1})}}{S_{t_{\ell+1}}^k} \frac{D_{t_{\ell+1}}^k}{D_{t_{\ell}}^k} \right] + \left[ -\left( \frac{\sum_{i,j}^{m} a_{ij}^k \tau_{(t_{\ell+1},t_{\ell})}}{S_{t_{\ell}}^k} \frac{D_{t_{\ell+1}}^k}{D_{t_{\ell}}^k} + \frac{\sum_{i,j}^{m} a_{ij}^k \tau_{(t_{\ell+1},t_{\ell})}}{S_{t_{\ell}}^k} \frac{D_{t_{\ell+1}}^k}{D_{t_{\ell}}^k} \right) \right] \\
+ \left[ \frac{\sum_{i,j}^{m} a_{ij}^k \tau_{(t_{\ell+1},t_{\ell})}}{S_{t_{\ell}}^k} \frac{D_{t_{\ell+1}}^k}{D_{t_{\ell}}^k} - \left( \frac{\sum_{i,j}^{m} a_{ij}^k \tau_{(t_{\ell+2},t_{\ell+1})}}{S_{t_{\ell+1}}^k} \frac{D_{t_{\ell+1}}^k}{D_{t_{\ell}}^k} \right) \right] \right]
\]
Pure Fund vs. Hybrid Fund

Using CCP Design Framework of (Amini et al., 2015):

- **Dealer**: Has **Cash** ($\gamma_i$), **Initial Margin** ($g_i$), **External Asset** ($Q_i$).
- **Shortfall**: Liquidate fraction $Z_i$ of external asset $Q_i$, for **recovery value** $R_i$.

- **Guarantee Fund**: Sum of the members’ initial margin contributions ($G_i = \sum_{i=1}^{m} g_i$)
  - **Pure Fund** (Current): Proprietary initial margin contribution.
  - **Hybrid Fund** (Proposed): Risk-sharing initial margin contribution (like Default Fund $D_i$)

- If **Net-Exposure** of dealer ($i$) to CCP is negative ($\Lambda_i^- = \sum_{j=1}^{m} L_{ij} \leq 0$)
  - **Pure Fund**: Initial margin used only after cash and external asset depleted
  - **Hybrid Fund**: Initial margin used before cash or external asset (lower liquidation loss)

- **Incentive Compatibility**;
  - **Pure Fund**: CCP has larger guarantee fund ($\tilde{G}_i$), with CCP surplus ($\tilde{C}_0$)
  - **Hybrid Fund**: CCP has smaller guarantee fund ($\hat{G}_i$) to meet all shortfalls ($\hat{C}_i^-$), but larger aggregate member surplus ($\sum_{i=1}^{m} \hat{C}_i$),
Periods: Liquidation, Buyback, Recovery

Each period \((t = 1, 2, 3)\) has \(\ell\) trading time-steps \((\tau = 1 \text{ day})\) \(\Rightarrow t\ell\tau\ldots\)

1. **Period I - Closeout**
   - CCP 5-day unwinding window \(\propto\) est. initial margin coverage
   - CCP trades at average market rate until \(X_{ij}^k \in D = 0\) \(\rightarrow a_0^k = \frac{\sum_{i,j=1}^m a_{ij}^k}{m}\)
   - Distressed dealers *choose to* liquidate with CCP
   - Predators will liquidate as *fast* as possible without impact
     - **Single/Colluding Predators**: liquidate until CCP is finished.
     - **Competing Predators**: finish liquidating before CCP.

2. **Period II - Buyback**
   - Predatory dealers buyback assets.
     - **Single/Colluding Predators**: obtain maximum profit.
     - **Competing Predators**: reap diminished profit due to early buyback.

3. **Period III - Resolution/Recovery**
   - CCP evaluation of remaining guarantee fund.
     - **Pure Fund**: Initial margin contribution returned (If positive).
     - **Hybrid Fund**: Predators *must* replenish initial margin depleted by dealer distress/default (Initial margin membership criteria!).
Theoretical Results I

★ Prop 2: Price impact on CDS-spread removes decreases info about fundamental value.
- Trading dynamics (demand/supply) invisible in opaque OTC market.

\[
\Delta S^k(t_{\ell\tau}) = \frac{v}{P_0} - \frac{1}{D_k}(S^k(t_{(\ell-1)\tau}) - \sum_i X_i^k(t_{(\ell-1)\tau}))
\]

\[P_1, \ P, \ P_2, \ P_3\]

★ Prop 3: If one predator predates, then all predators are better off predating:
- Better off holding smaller position in same side of CDS if decreasing in value.

\[X_{ij}^k(t_{(\ell-1)\tau}) \Delta S(t_{(\ell-1)\tau}) \geq [X_{ij}^k(t_{\ell\tau}) \Delta S(t_{\ell\tau}) \text{ if } |\Delta S(t_{(\ell-1)\tau})| \geq |\Delta S(t_{\ell\tau})| \text{, } X_{ij}^k(t_{(\ell-1)\tau}) = X_{ij}^k(t_{\ell\tau})]
\]

★ Prop 4: The price impact of liquidation and predation is cumulative:
- For Members: Amplifies unfavourable CDS-spread movements, dampens positive movements
- For CCP: given by lemma 1

\[
P_1(3\tau, X_i^k, S(3\tau, a_{ji}^k, \pm(2\ell)), \Delta S^k, S(3\tau, X_i^k, S(2\tau), \Delta S^k, S(2\tau)), P_1(2\tau), P(2\tau), P_2(1\tau), P_3(1\tau), a_{ji}^k, \pm(2\ell))
\]
**Theoretical & Simulation**

Theoretical Results II

★ **Lem 1: Unwinding, CCP feels price/predation impact on income (↓), variation margin (↑):**

- Defaulters’ shortfalls carried through periods and met by proceeds from closeouts.

\[
L_0(t + s) = L_0(t) + L_0^{D,-}(t + s) \quad \text{where } X_{t+s} \leq X_t
\]

\[
L_{ij}^{D,-}(t+s) = X_{t+s} (\Delta S_t + \sum_{s=1}^{T} \Delta S_{t+s})
\]

★ **Prop 5: In hybrid guarantee fund structure, natural predation disincentive tool:**

- CCP makes margin call on each profitable banks to replenish own initial margin contribution.

\[
\hat{G}_i^{\text{gr}}(t_{T_T} = 3) = (g_i - \hat{G}_i^*)
\]

★ **Prop 6: Hybrid fund incentive compatible for CCP if shortfall \(\geq\) Guarantee Fund + Tranche:**

- CCP expects to be better off using the hybrid approach and protecting its own equity.

\[
D^*_\text{tot} + (1 - \epsilon)(\gamma_0 + f \sum_{i=1}^{m} \Lambda_i^+) < \epsilon(\gamma_0 + f \sum_{i=1}^{m} \Lambda_i^+) + G^*_\text{tot} \leq \mathbb{E} [C_0^-(t_{T_T} = 3)]
\]

\[
\mathbb{E} [\hat{C}_0(t_{T_T} = 3)] \geq \mathbb{E} [\bar{C}_0(t_{T_T} = 3)]
\]
Simulation: Description

- **Network (nodes)** & agent-based model (14 dealers + CCP) of discrete event (exogenous default).
- **Dealer behaviour** given by regulation/trading rules (exchange of variation margin)
- Previous empirical work provides OTC data [Oehmke and Zawadowski 2017, Darrell Duffie and Vuillemey 2015, Amini et al. 2015b] for market size, CCP size, dealer holdings, turnover per trading day.
- Notional position size in each CDS, fundamental CDS-spread changes determined with distribution created from data parameters.
- **Exogenous default perturbs network producing knock-on effects:**
  - Exogenous default,
  - CCP unwinding, member trading → change in CDS-spread (price impact),
  - Realise variation margin payments, net-exposure, pay CCP/CCP pays, determine defaults,
  - Defaulters’ positions moved to CCP account
  - CCP starts unwinding...

**Goal:** Visualise CCP-specific default dynamics, pin-point underlying drivers.
Simulation Results Ia: Default Distribution based on Market Depth

Figure: Under Normal Market Liquidity (left) & Decreasing Market Liquidity (right): Shows decreasing dealer distress and increasing predatory banks. Defaults increase rapidly with decreasing liquidity.
Simulation Results Ib: Default Distribution based on Market Depth

Figure: Under Normal Market Liquidity (left) & Decreasing Market Liquidity (right): Low levels of predatory banks does not decrease defaults. Defaults highly driven by level of distressed dealers.
Simulation Results II: Final CCP Loss based on Market Depth

Figure: Under Normal Market Liquidity (left) & Financial Crisis Market Liquidity (right):
Low distressed/predatory dealer levels (yellow/green bars) and level of predator competition (blue and aqua bars). Dealer distress (shortfall) creates larger than predatory profits (refill margin).
Simulation Results III: Final CCP Loss based for Decreasing Market Depth

Figure: Decreasing Market Liquidity - Left: Predatory competition (x-axis, red bars) decreases profits and increases CCP losses (y-axis). Right: Effect of Low, stable level of predation (red) or distress effect (blue) on CCP losses. The x-axis provides the number of increasing predatory/distressed dealers. Low levels of distressed banks (blue) lowers CCP losses.
Simulation Results IVa: Predation Profits & Margin Refill

Figure: Under Decreasing Market Liquidity - Realised avg profit loss to margin refill for all members (aqua) vs. profitable predators (red) (after call). Profit loss to margin refill as % of buyback income (y-axis). **Left:** Predation profits outweigh margin refill payment for avg. distress levels (conflict of high profits, but high margin refill from distress vs. loss of predator competition). **Middle:** Low margin refill with low distress (prey). **Right:** Low losses from predatory competition vs. Strong profit decrease from margin refill (high distress).
Simulation Results IVb: Predation Profits & Margin Refill

**Figure: Under Decreasing Market Liquidity - Left:** Avg predation earnings/loss (y-axis) in various trading scenarios (colours). Effect of distress level (high prey) and competition (early buyback) on predators’ profit/loss in buyback of original positions. **Right:** Avg margin refill (y-axis) by predators alone. Effect of increasing margin demand with decreasing distressed dealers to prey upon (red/blue).
Simulation Results V: Pure vs. Hybrid Wealth for Decreasing Market Depth

**Figure: CCP & Aggregate Member Hybrid Fund Incentive Compatibility** -

*Left:* Equal/larger loss from CCP unwinding (y-axis) with pure vs. hybrid fund.

*Right:* Higher member surplus (y-axis) for liquidation (blue)/buyback (red) hybrid vs. pure fund. [R1: Increasing predatory competition (x-axis)/decreasing distress. R2: Low level (two) distressed dealers with increasing predation (x-axis). R3: Increasing distress (x-axis) and low level (two) of predators.]
Simulation Limitations and Possible Extensions:

- Allow formation of new trading contracts (existing change from default/liquidation)
- Obtain (if possible) further data for CDS or for internal CCP procedures (proprietary)
- Introduce covariance/correlation data explicitly (tractability)
- Introduce an empirically estimated size for each price impact effect.

Thank You For Your Time & Your Attention!