Central Counterparty and the Design of Collateral Requirements

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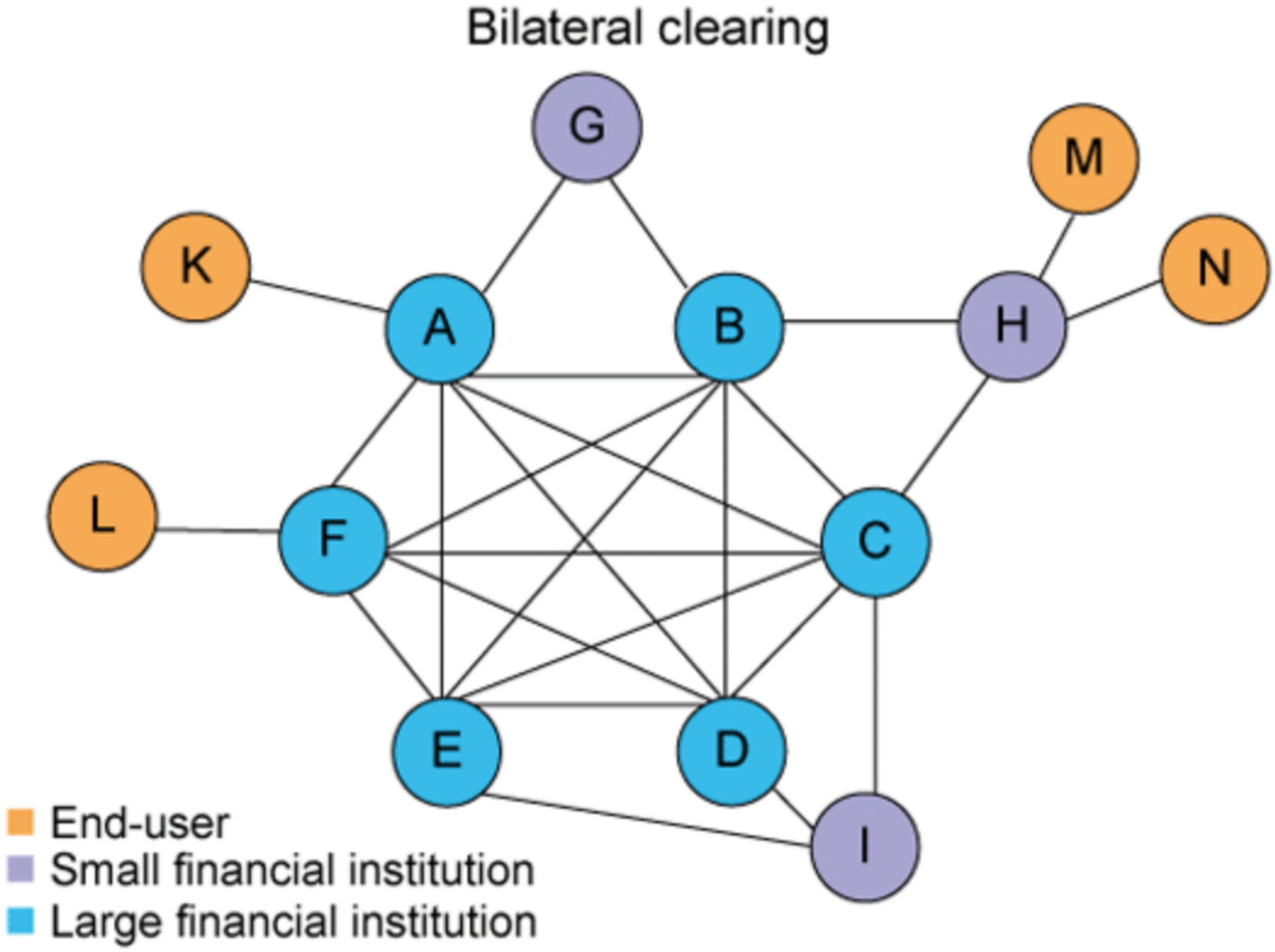
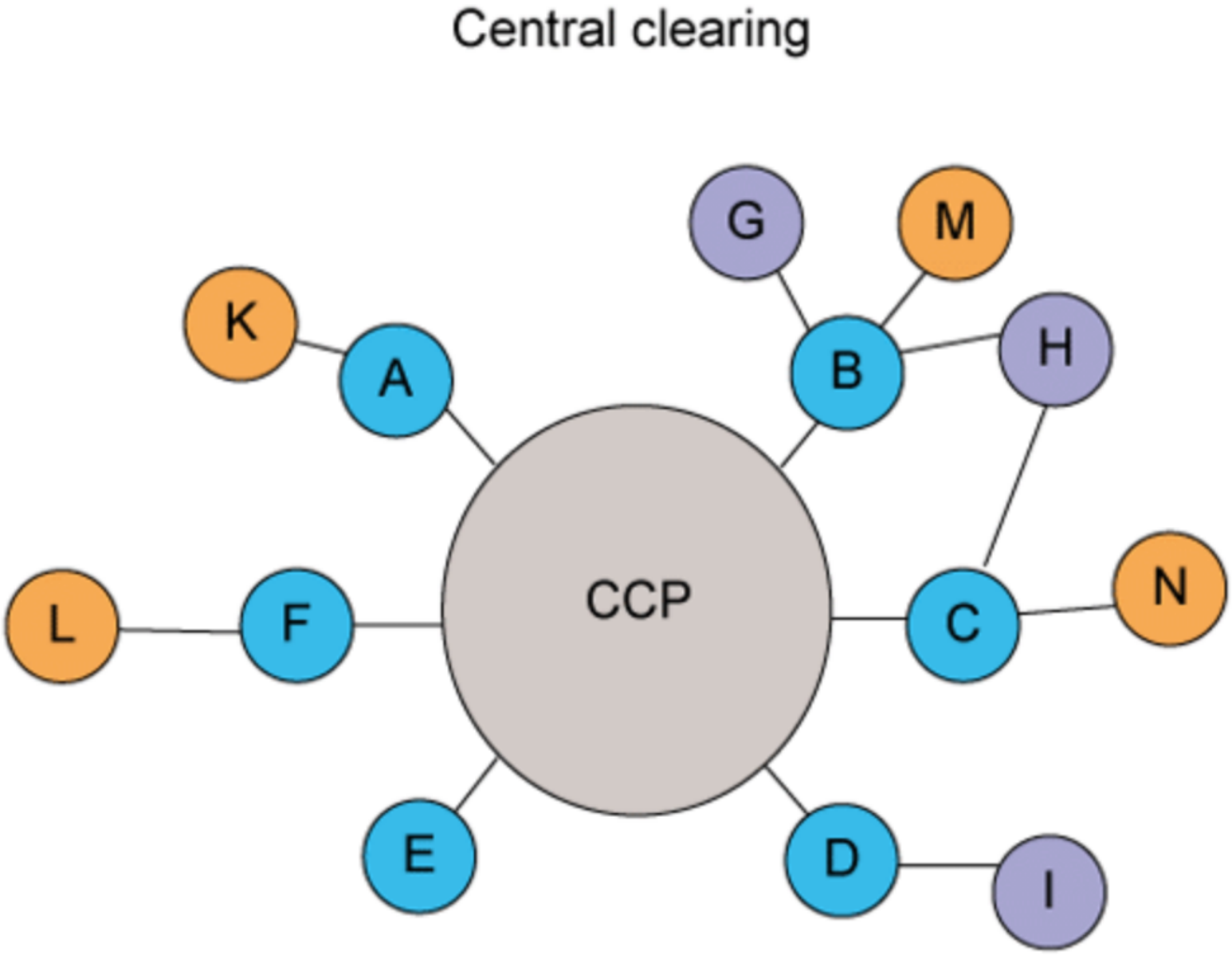
Mandatory Clearing of OTC Derivatives at CCPs

- 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.

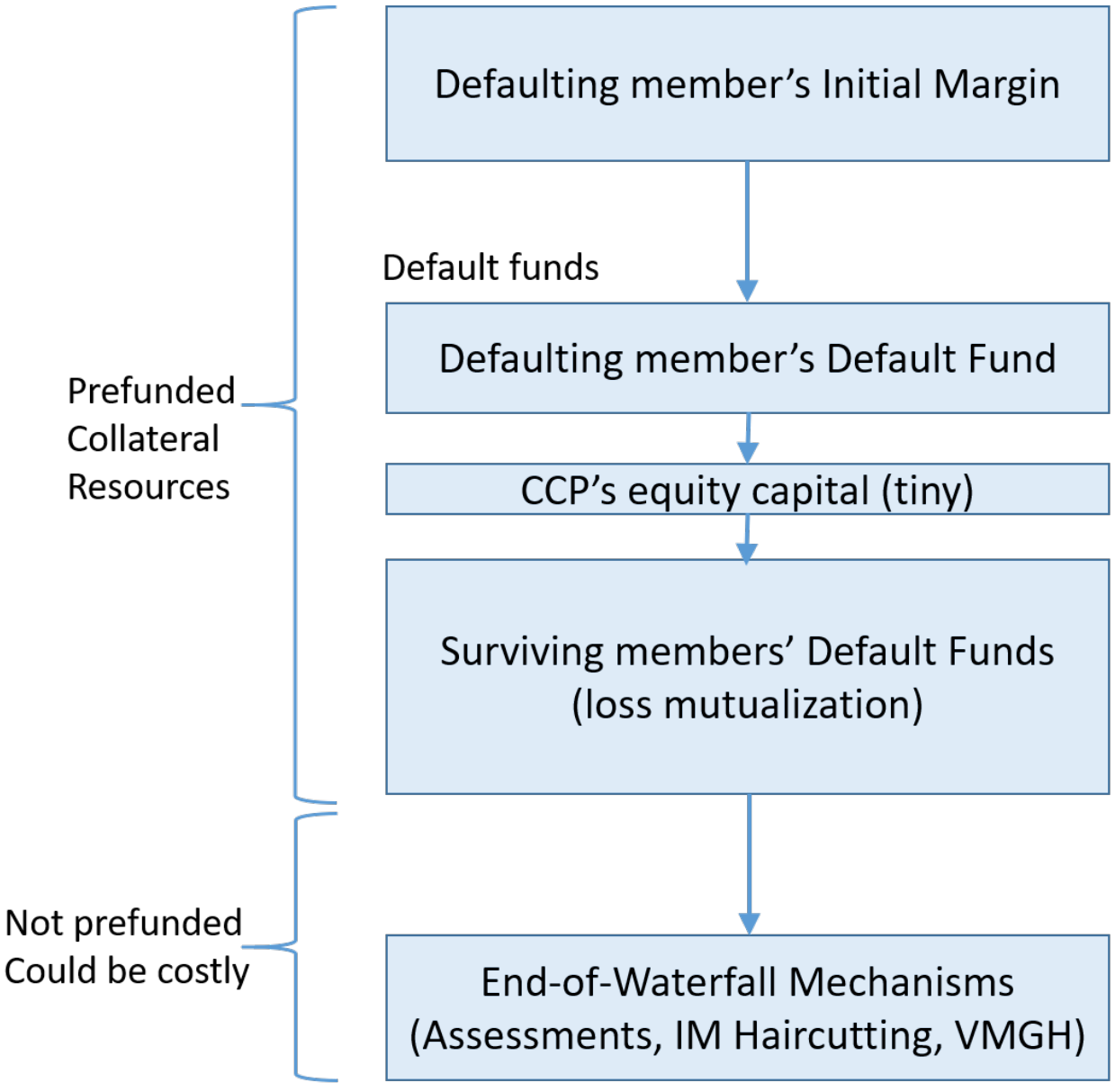
Bilateral Trading Markets



Centrally Cleared Markets



Typical CCP Default Waterfall



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

	Asia	Australia	Europe	North America	South America
Number of CCPs	27	1	20	12	1
Funded resources %					
Initial margin	69.2	92.8	74.0	85.2	99.6
Default fund	18.7	4.5	25.3	13.5	0.2
CCP capital	12.2	2.7	0.7	1.3	0.2

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☞ Q: How to regulate collateral requirements for central clearing?

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   - allows for loss-mutualization $\Rightarrow$ valuable to CCP's resilience
   - distorts members' risk-taking incentive ex-ante
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2. Determine a default fund rule to alleviate the inefficiency
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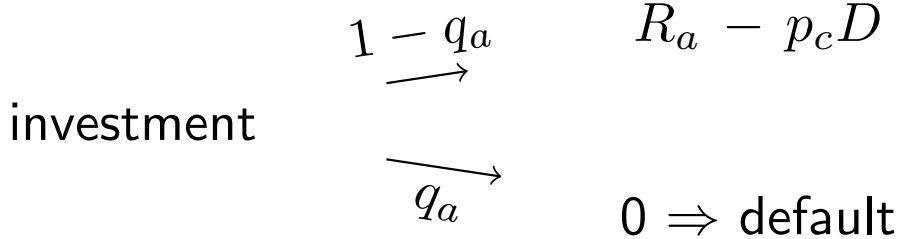
3. Optimal regulation of initial margins and default fund
   - if funding collateral is more costly $\Rightarrow$ more initial margin
   - if recapitalizing the CCP is more costly $\Rightarrow$ more default funds

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 $a = \{$risky (r), safe (s)$\}$, a is unobservable



  - 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

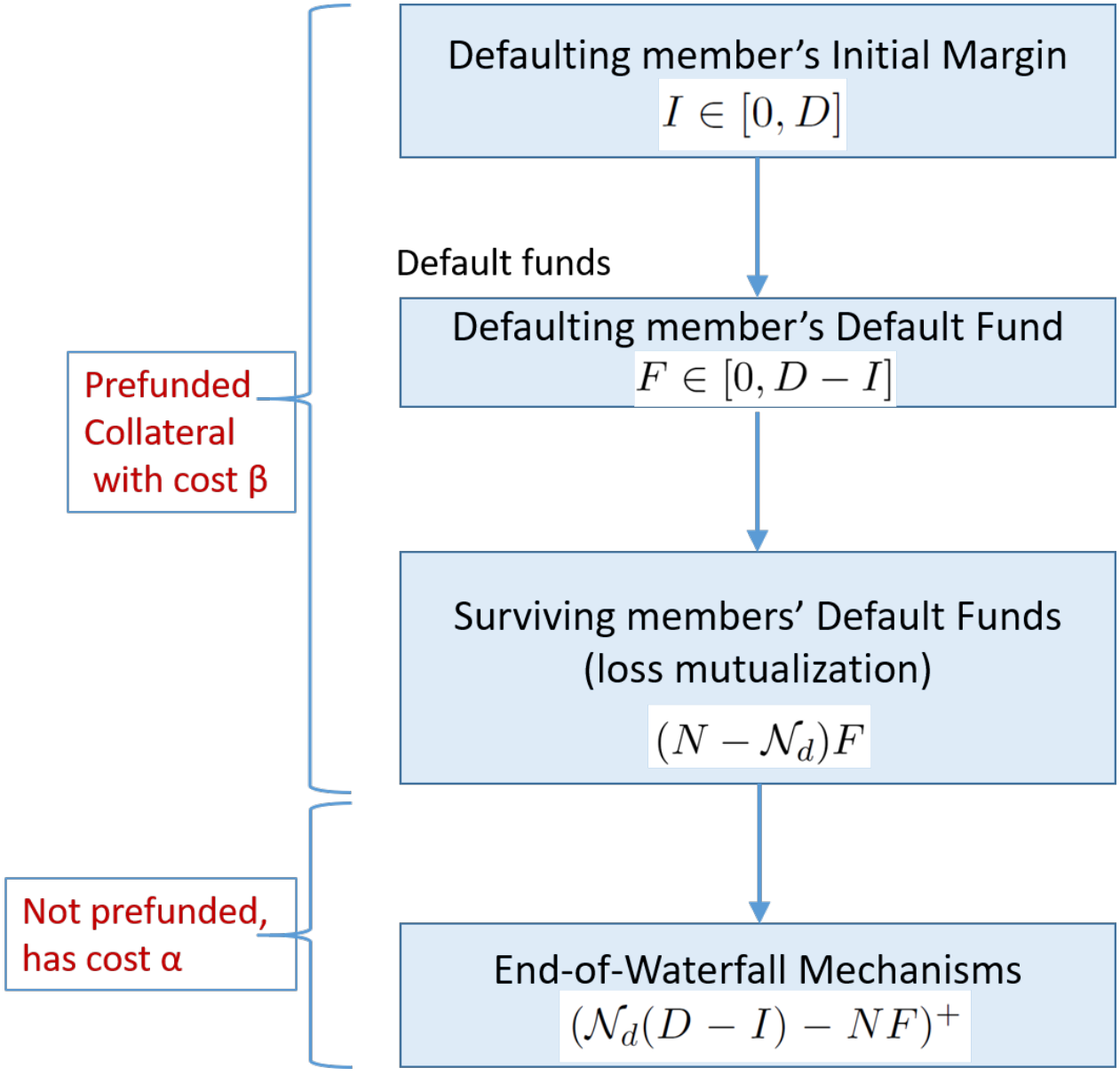
Centrally Cleared Market: default waterfall

- CCP guarantees insurance payment D to buyers with certainty.
- $t = 0$: CCP collects collateral from member: initial margin $I \in [0, D]$, 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 $\mathcal{N}_d(D - I) > NF$ and incurs a linear cost α.
- A technical assumption: $\beta \geq \alpha p_c \mathbb{P}^r(\mathcal{N}_d > 2)$.

Centrally Cleared Market: default waterfall



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 margin
  - its default fund is used to absorb shortfall of $\mathcal{N}_d$ defaulting members
- Member i chooses $a \in \{r, s\}$ to maximize expected payoff

$$\max_a (1-q_a) \left[(1+f)R_{a_i} - D + I + \mathbb{E}\left(F - \underbrace{\frac{\mathcal{N}_d(D-I-F)}{N-\mathcal{N}_d}}_{\text{remaining default fund}} \right)^+ \right] - (1+\beta)(I+F)$$

Equilibrium

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.

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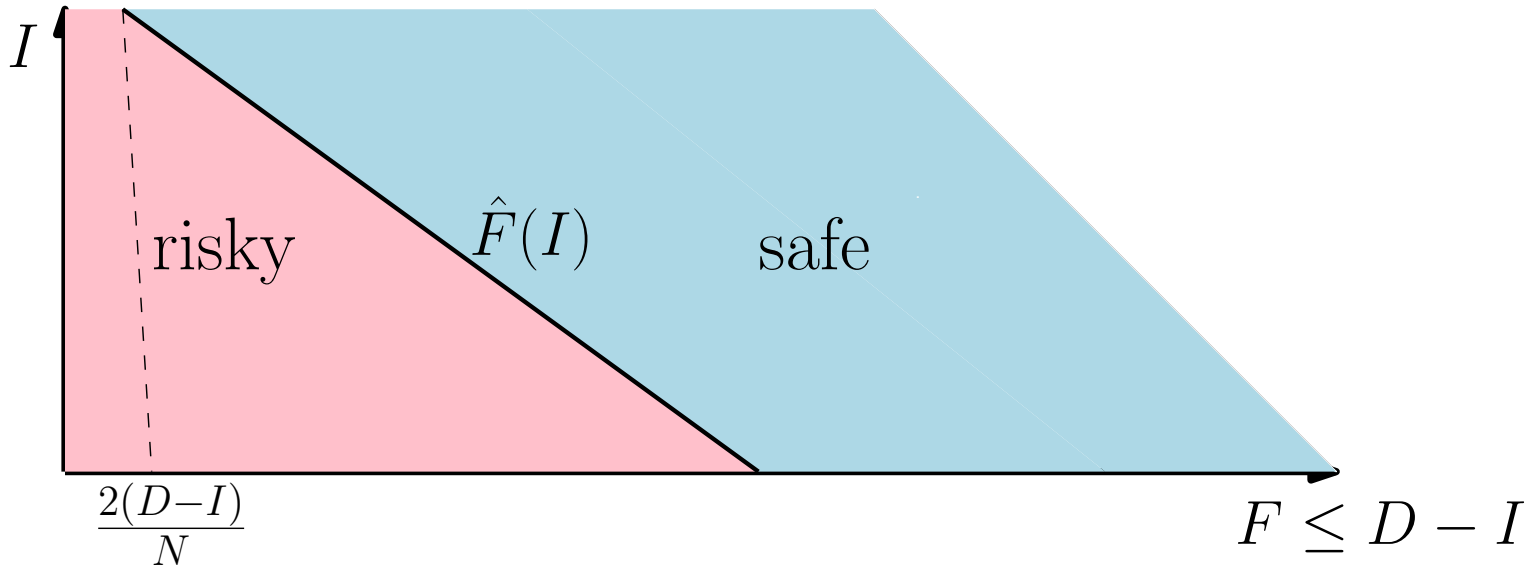

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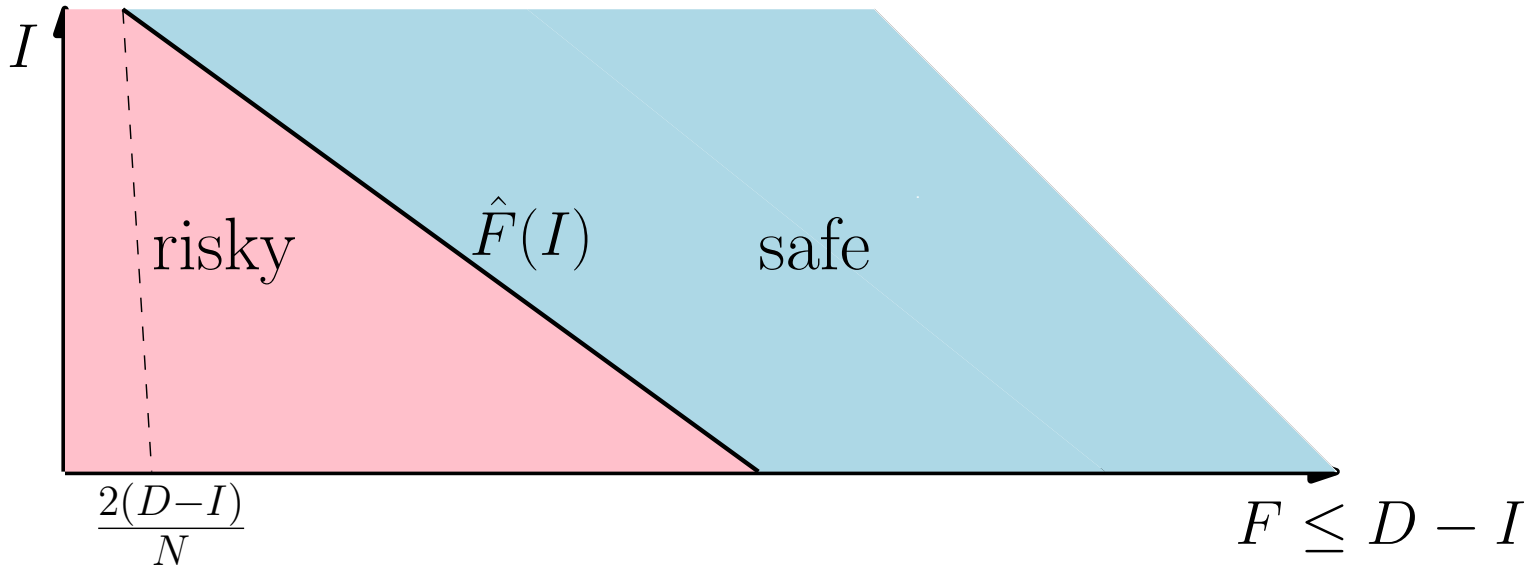

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$\rightarrow$ makes survival more attractive and discourages risk-taking.

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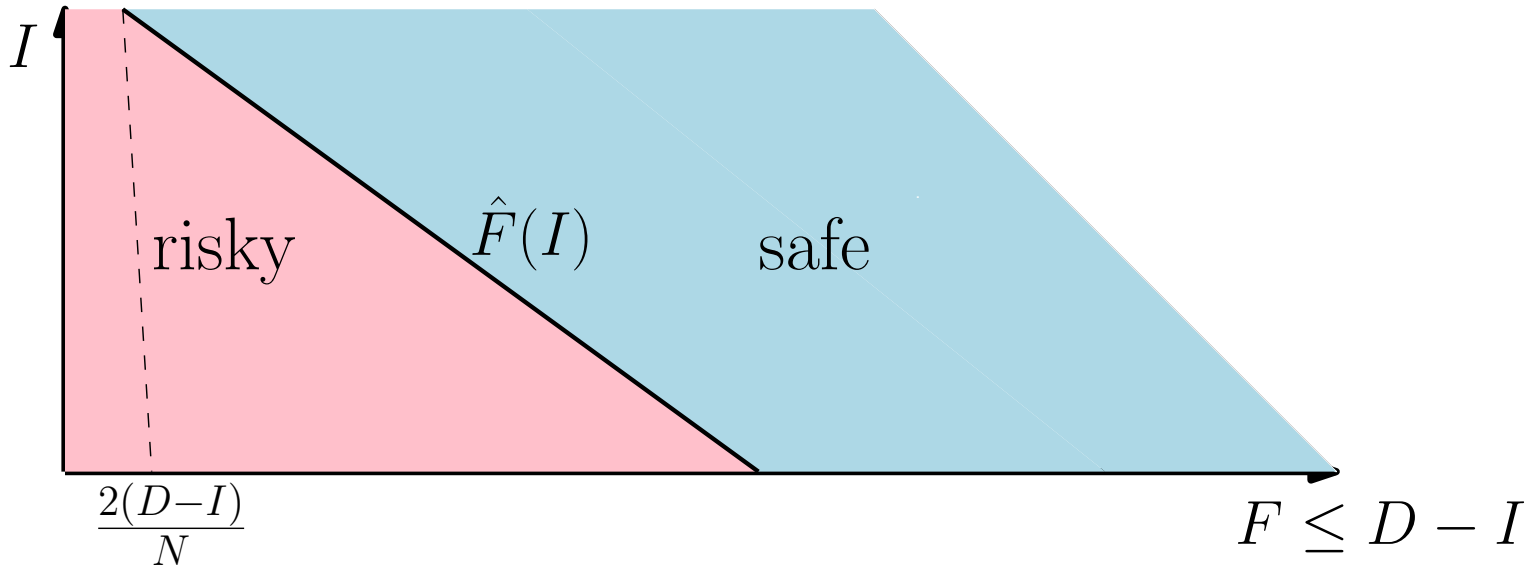

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3. $\hat{F}(I)$ is piecewise linear, strictly decreasing in I with $\partial\hat{F}/\partial I < -1$.

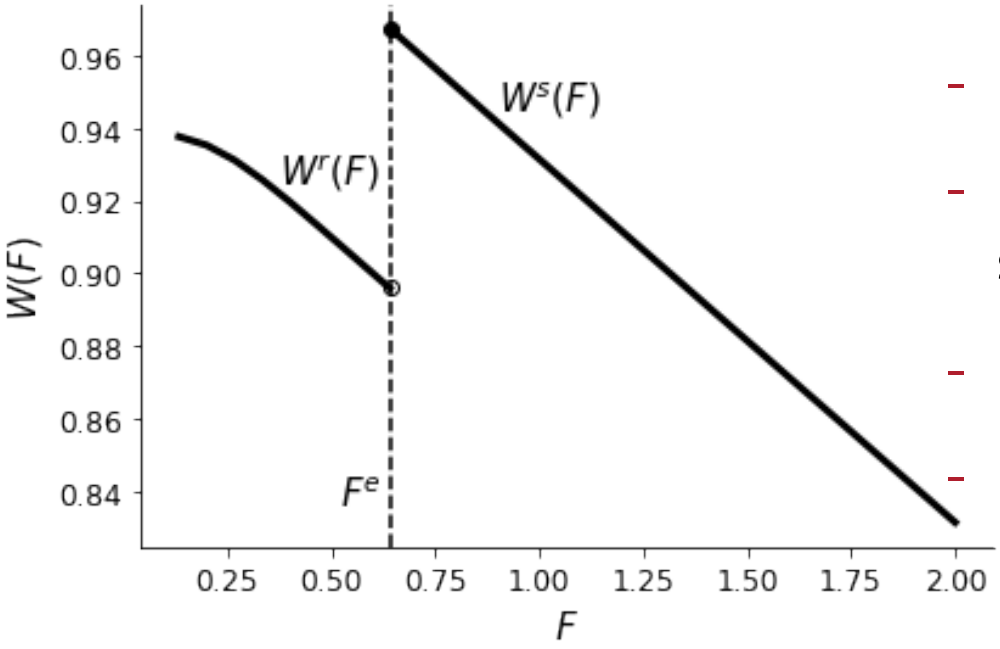
→ when initial margin decreases by 1, default fund increases more than 1.

→ initial margin is more cost-effective in aligning members' incentives.

Optimal Cover Rule for Default Fund

Proposition: Given initial margin, the optimal default fund subject to "Cover 2" is

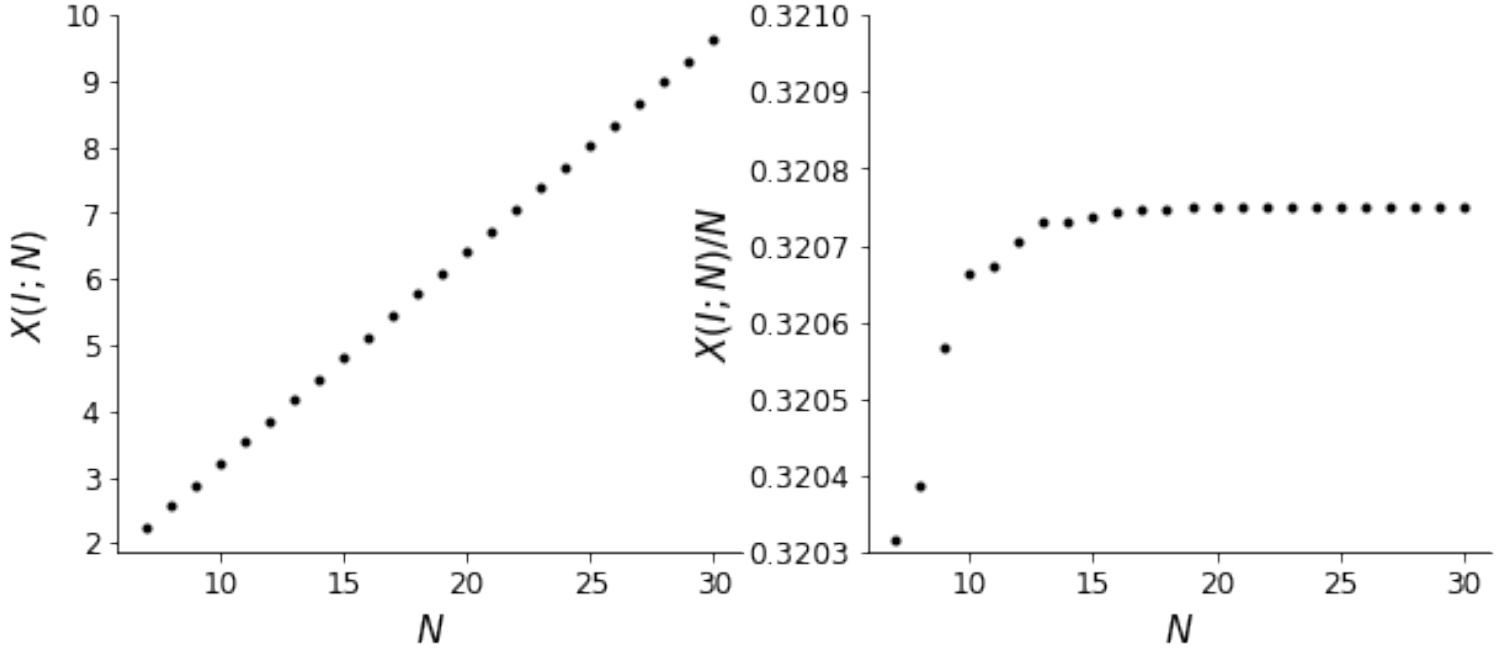
$$F^e(I) = \begin{cases} \hat{F}(I) & W^s(\hat{F}(I)) \geq W^r(\frac{2(D-I)}{N}) \\ \frac{2(D-I)}{N} & \text{otherwise} \end{cases}$$



- 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: $X(I;N) = \frac{NF^e(I;N)}{D-I}$



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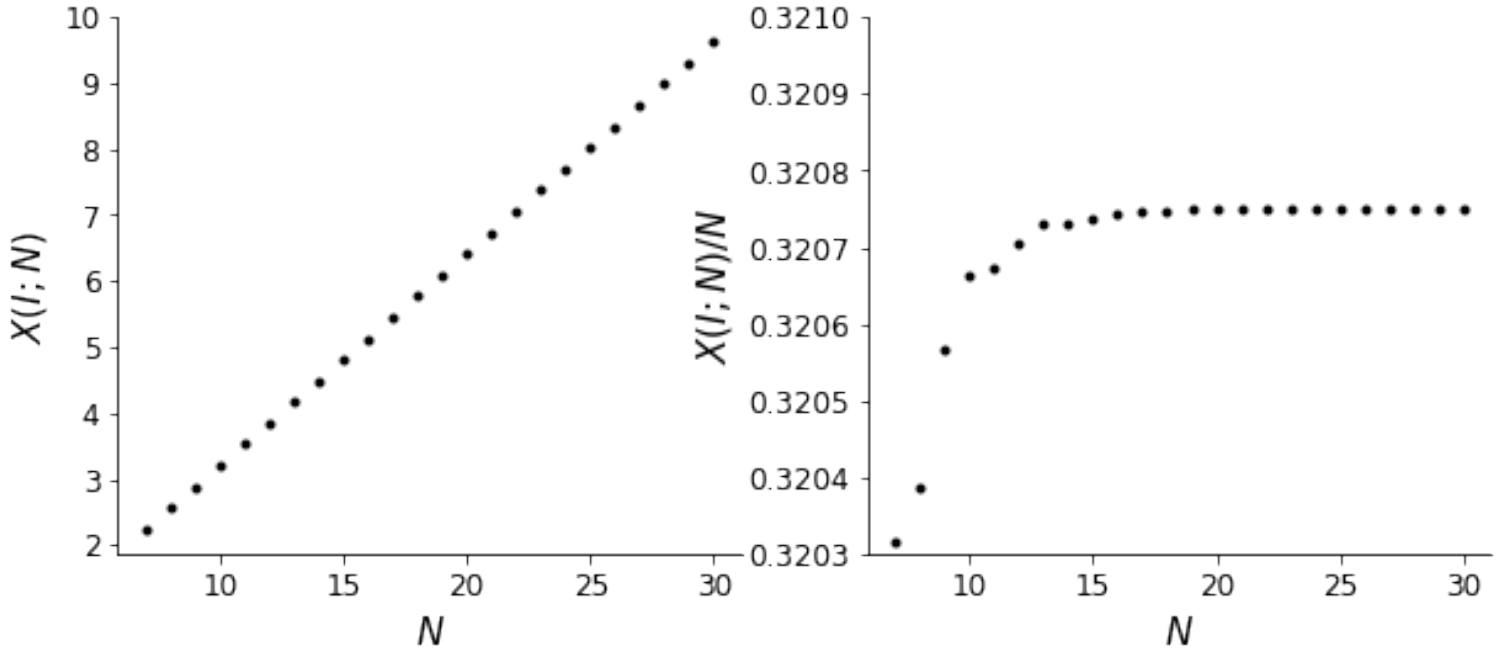
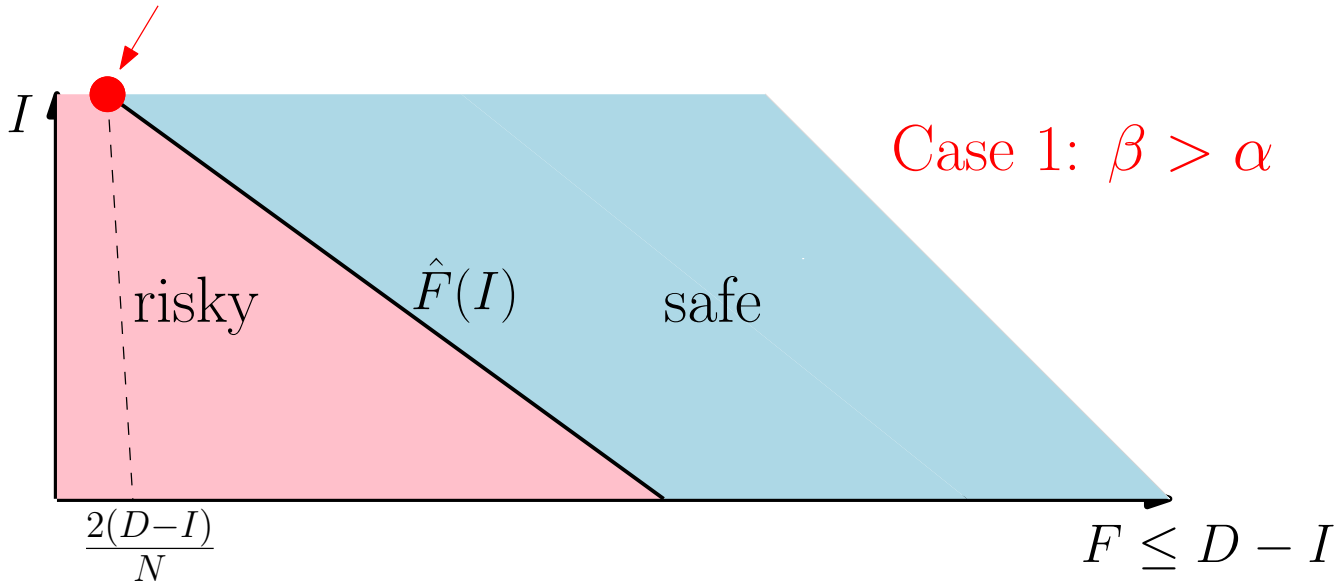


- Cover X rule increases with N; Cover ratio $X(I;N)/N$ has little variation with N.
- Implications: cover a fixed fraction rather than a fixed number.
  - The rule should account for the number of clearing members.
  - ICE and LCH have more than 20 members, with entries and exits.

Optimal Collateral Requirements

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

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



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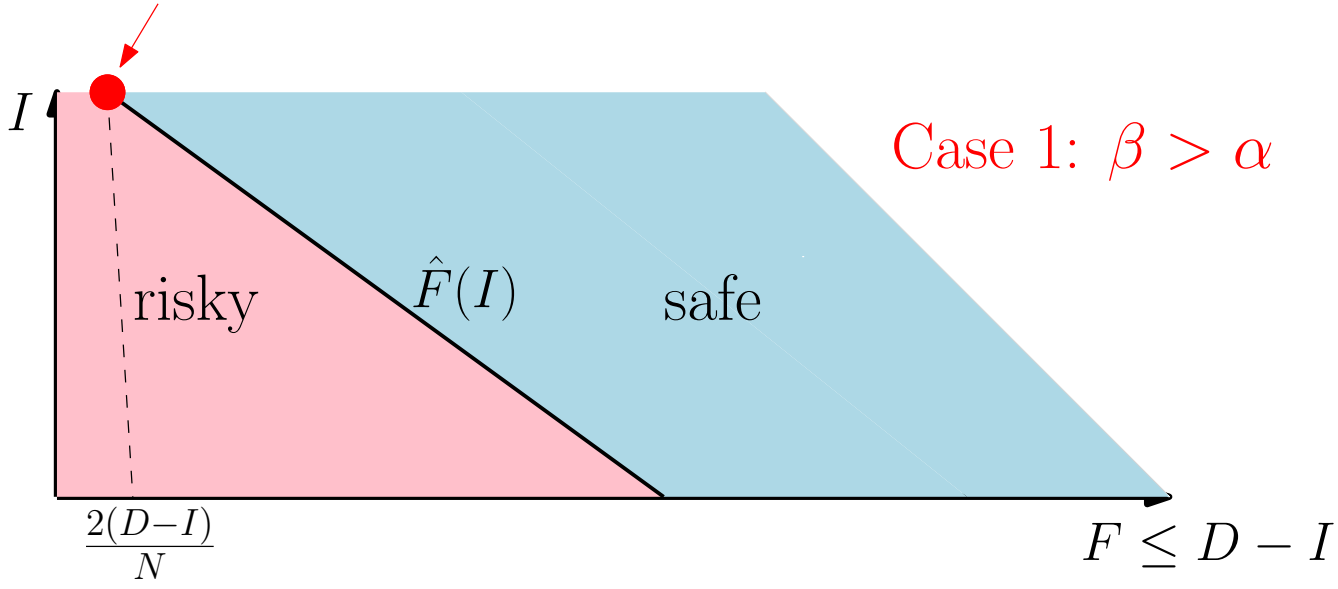

1. collateral is more costly $\Rightarrow$ More initial margin

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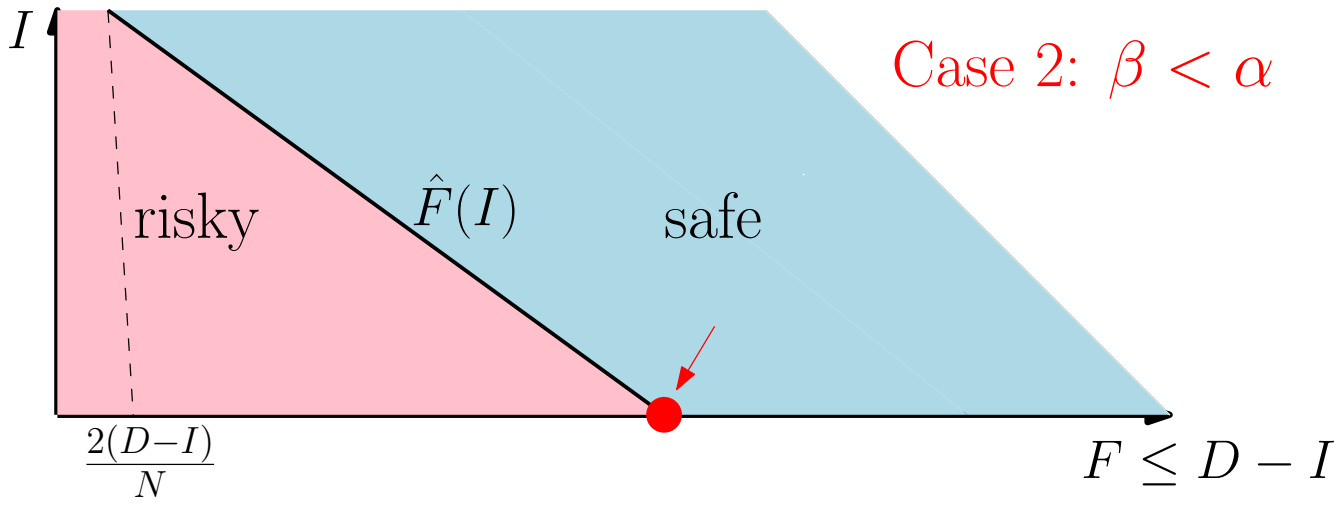

2. end-of-waterfall is more costly $\Rightarrow$ More default fund

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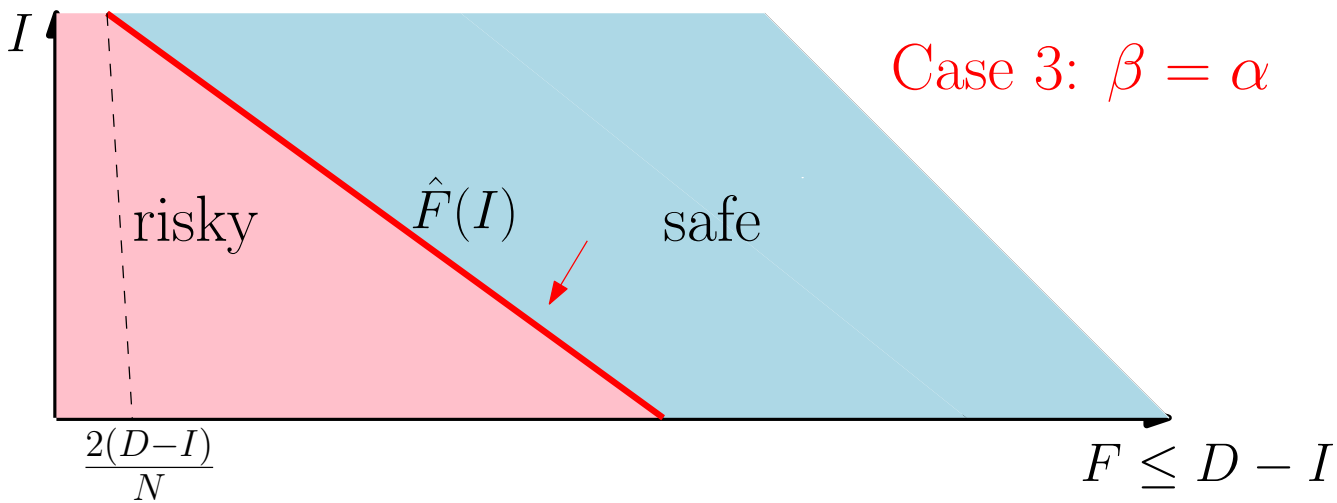


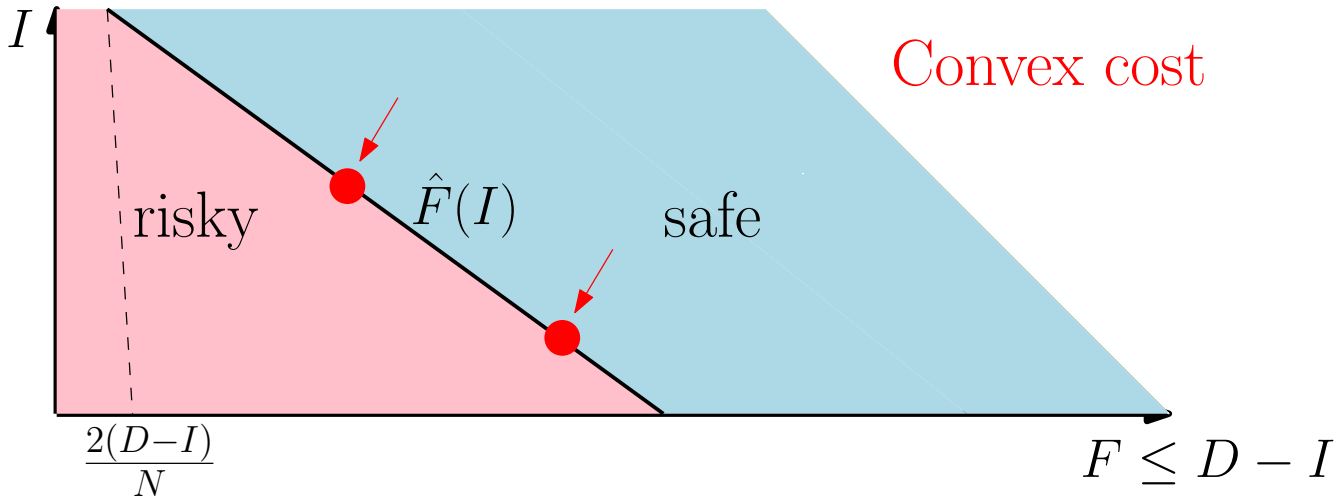
3. costs are the same $\Rightarrow$ Indifferent

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:

$$\alpha \left((\mathcal{N}_d(D-I) - NF)^+ \right)^2$$

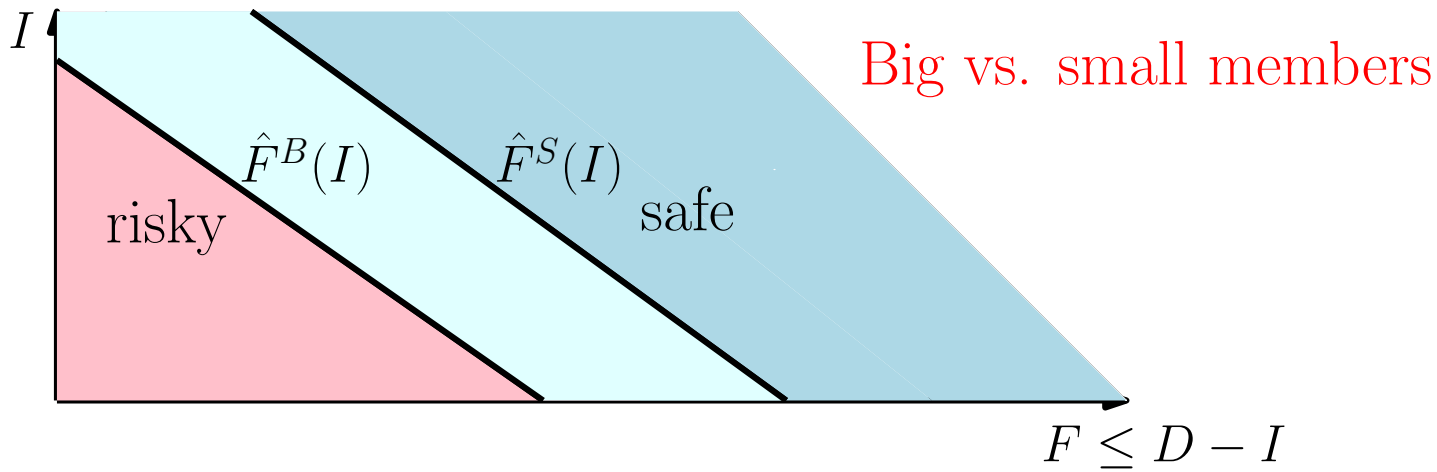
- The trade-off between initial margin and default fund is robust.
- Nonlinearity allows to pin down interior levels of collateral.



Robustness 2: heterogeneity in size

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 margin and default fund is robust.
- Required collateral normalized by size is lower for a big member.
- Big member finds it easier to internalize externalities.



Policy Implications: framework for collateral requirements

- 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
- Opposite to the conventional view that initial margins increase with volatility and decrease with funding cost

Policy Implications: irreplaceable role of default fund

Can default fund be replaced entirely by initial margin?

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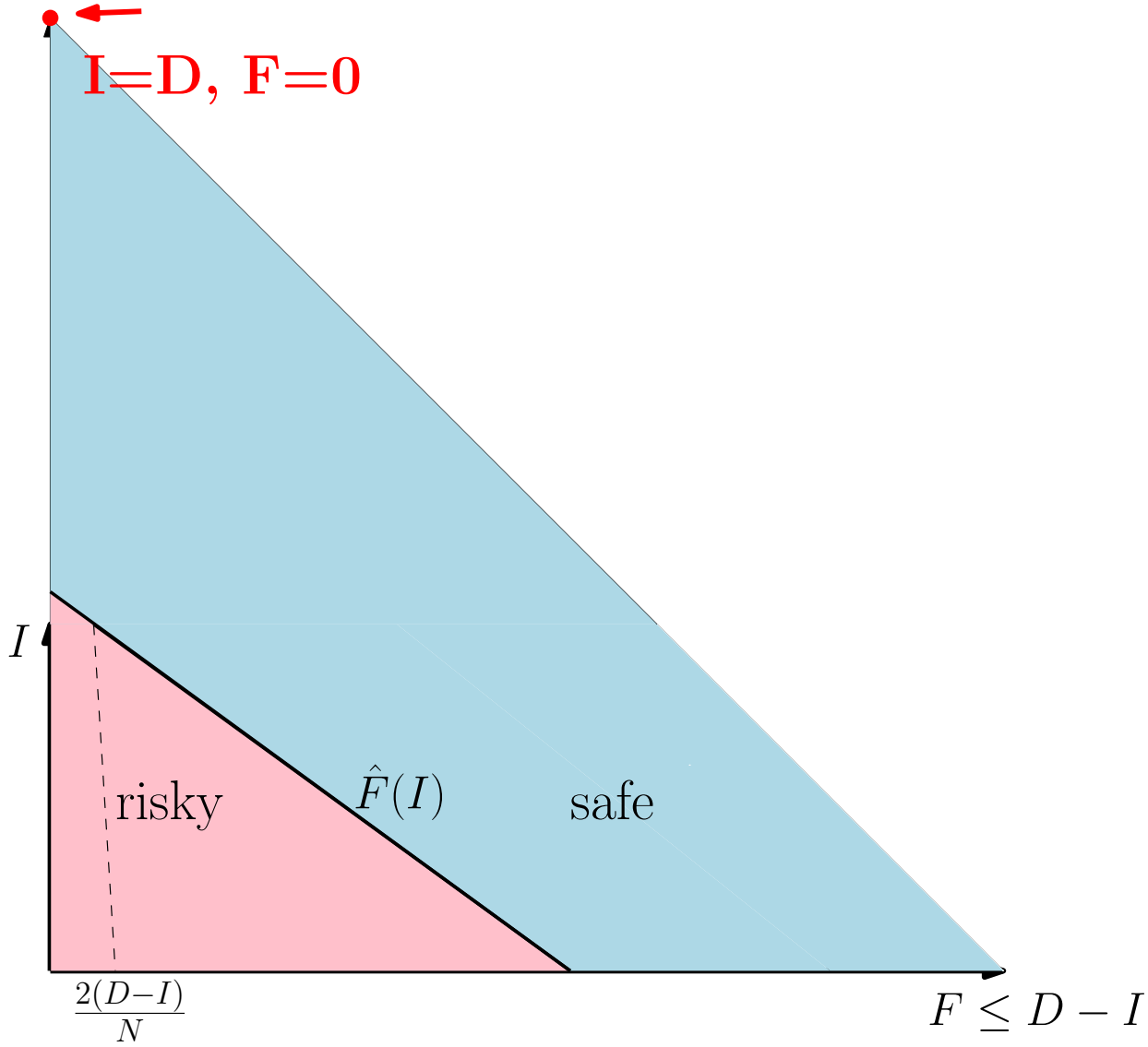

Policy Implications: irreplaceable role of default fund

Can default fund be replaced entirely by initial margin?

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.

Policy Implications: CCP resilience and systemic risk

- 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 margin when collateral is costly.

Centrally Cleared Markets

Product	Centrally cleared		Total
	Amount (USD bn)	Percentage	(USD bn)
Interest rate derivatives			
Fixed-Float	84,610	69%	122,727
Forward Rate Agreement	34,884	87%	39,990
Overnight Indexed Swap	29,459	82%	36,139
Other	17,680	26%	69,222
Total	166,633	62%	268,078
Credit derivatives			
Index Tranche and Index	1,871	55%	3,424
Asia	13	13%	99
Europe	1,208	68%	1,782
North America	592	42%	1,395
Other regions	57	39%	148
Other	0.53	0%	765
Total	1,871	45%	4,189

Source: data reported to the CFTC in May 2018

Centrally cleared and uncleared notionals outstanding