Central Counterparty Default Waterfalls and Systemic Loss

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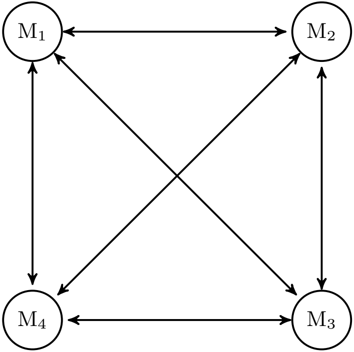
Overview

- Post-crisis reforms greatly increased the use of central clearing to reduce risks posed by large counterparty failures in OTC derivatives markets.
  - Pros: greater transparency, risk management, standardization.
  - Cons: concentrates risk in a single entity, imposes costs on members.

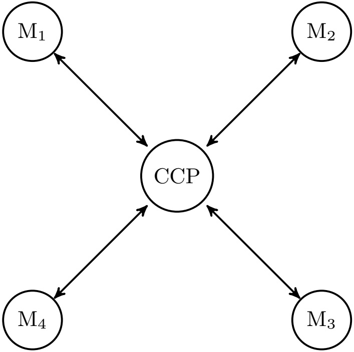
Central Clearing Example

- Pre-Central Clearing: variation margin payments are bilaterally exchanged.



Central Clearing Example

- Post-Central Clearing: variation margin payments are netted and cleared through the CCP



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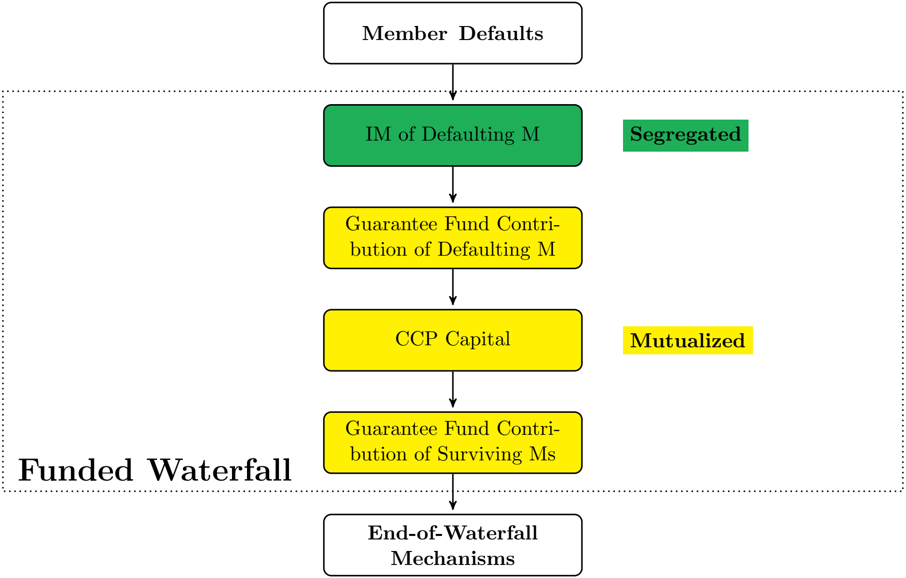
- Central counterparties (CCPs) maintain resources in their **default waterfalls**, which are meant to promote financial stability and ensure CCP continuity.
  - How resources are allocated in the default waterfall varies in practice. These variations affect both systemic resiliency and participant incentives.

CCP Default Waterfall



Funded Waterfall Resources

- CCPs collect the majority of their funded resources as **initial margin (IM)**, which are held in segregated accounts.
- However, the proportion of resources collected varies greatly depending on regulations, trust in CCP risk management, and membership agreements.

Table: Percent of Funded Resources By Region

	Africa	Asia	Australia	Europe	N. America	S. America
Number of CCPs	1	27	1	20	12	1
Funded Resources						
Initial Margin	98.8	69.2	92.8	74.0	85.2	99.6
Guarantee Fund	1.0	18.7	4.5	25.3	13.5	0.2
CCP Capital	0.2	12.2	2.7	0.7	1.3	0.2

Sources: CCPView Clarus Financial Technology; authors' analysis.

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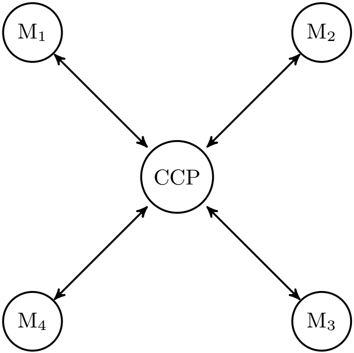
  - How resources are allocated in the default waterfall varies in practice. These variations affect both systemic resiliency and participant incentives.

- Ascertaining how variations in default waterfall resources influence resiliency, systemic losses, and participant incentives is difficult to determine.
  - Historical rarity of large counterparty defaults.
  - Network spillover effects due to centrally cleared and bilateral contracts.

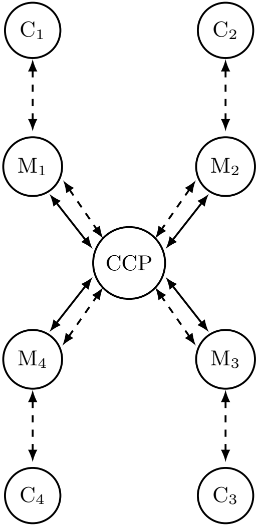
Network of Derivative Obligations

- Post-Central Clearing



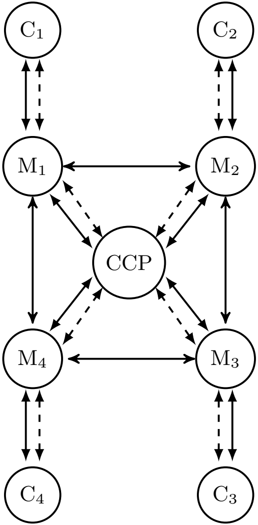
Network of Derivative Obligations

- Client Clearing

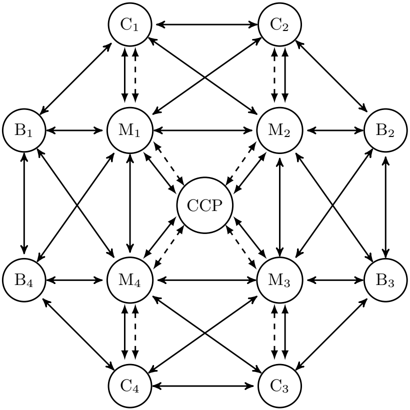


Network of Derivative Obligations

- Cleared and Uncleared Positions



Network of Derivative Obligations



- In total, four firm types operate in the swaps market: the CCP, members (M), clients (C), and purely bilateral firms (B).

This Paper

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2. Calibrates model and performs an empirical evaluation of the resiliency of a credit default swap market's CCP.
   - Uses supervisory data from the U.S. credit default swap market.

3. Analyzes the trade-off between resiliency and member incentives in the CCP's allocation of funded default waterfall resources.
   - Quantify resiliency, risk sharing, and member losses for different waterfall structures.

Data

Data

- Transaction- and position-level data provided by the Depository Trust & Clearing Corporation (DTCC). Features:
  - Data contains all transactions and positions wherein either counterparty and/or position is US-domiciled.
- Content used for this paper:
  - Position-level counterparty exposures, aggregated to the firm level.
  - Transaction-level: notional amounts, recovery, reference entity, maturity.
  - Credit spread term structure from Markit.

Table: Summary Statistics

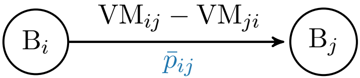
As-of-date	# Firms	# Positions	# Reference Entities
10/03/2014	959	6,389,129	3173

CCP Default Waterfall Model

Payments Model: Variation Margin

Building on the credit shock model of Paddrik, Rajan and Young (2019), we can represent **variation margin** (VM) payment obligations by a matrix $\bar{P} = (\bar{p}_{ij})$, where $\bar{p}_{ij}$ is the net amount of VM owed by i to j as a result of the shock.

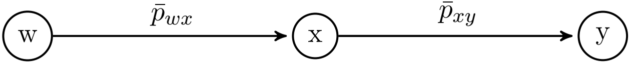
- VM payments are bilaterally netted.



$\bar{p}_{ij} = \mathrm{VM}_{ij} - \mathrm{VM}_{ji}$, is the net VM payment owed by i to j.

- Using detailed DTCC data and evaluating each position's value on a given date, we construct the network of expected VM payments given a shock.

Payments Model: Equilibrium Mechanics



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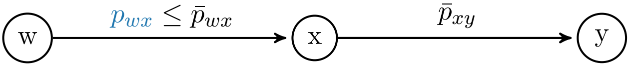
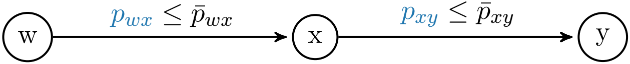


$$stress = [\bar{p}_{xy} - p_{wx}]_+$$

Payments Model: Equilibrium Mechanics



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- Payment reductions can result in further stress.

$$p_{xy} = [\bar{p}_{xy} - stress]_+$$

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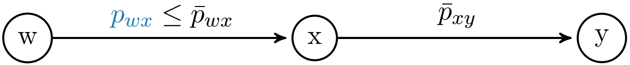

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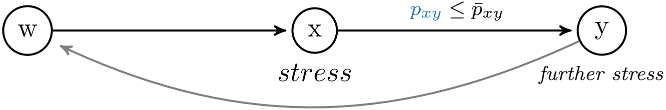
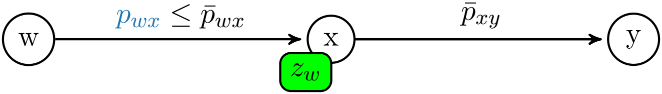


- Employ a *fictitious default algorithm* (Eisenberg and Noe (2001)) to reach the equilibrium set of payments, p.

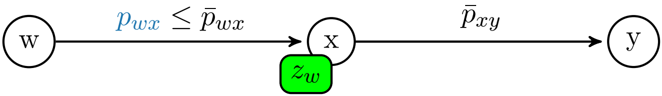
Payments Model: Initial Margin



$$stress = \left[\bar{p}_{xy} - min(\bar{p}_{wx}, \underbrace{p_{wx} + z_w}_{\text{recourse}}) \right]_+$$

- x keeps **initial margin**, z_w, from w as a recourse mechanism.

Payments Model: Initial Margin



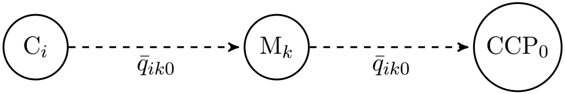
$$stress = \left[\bar{p}_{xy} - min(\bar{p}_{wx}, \underbrace{p_{wx} + z_w}_{\text{recourse}})\right]_+$$

- x keeps **initial margin**, z_w, from w as a recourse mechanism.
- **Estimation of IM**
  - Bilateral initial margin: 99.5% VaR over a 10-day holding period.
  - Exchange of IM depends on counterparty 'types.'

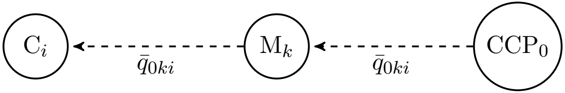
Client Clearing

In addition, our model accounts for client-clearing.

- **Client-clearing obligation** of client i to member k is denoted $\bar{q}_{ik0}$. The payment obligation from member k to the CCP is also $\bar{q}_{ik0}$.

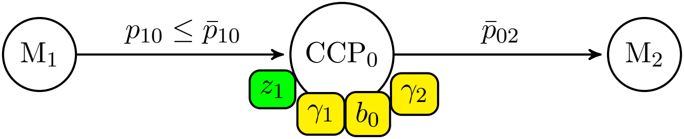


- **CCP-clearing obligation** owed by the CCP to client i and cleared through member k is denoted $\bar{q}_{0ki}$. The payment obligation from member k to client i is also $\bar{q}_{0ki}$.



- A member is obliged to cover the payments between its clients and the CCP, i.e. if a client defaults, the member is responsible for the payment.

CCP Default Waterfall



- **CCP Guarantee Fund**: Used to recover losses after initial margin of firms is taken by CCP.
  - Guarantee funds of defaulting member k, γ_k, is taken first, then CCP capital contribution, b_0, and then guarantee funds of non-defaulting firms.

Measuring Losses

Systemic Losses

- The CCP waterfall construction problem has two objectives:
  1. individual firm's desire to minimize individual relative losses:

$$l_b, \quad l_c, \quad \boldsymbol{l_m}, \quad l_0$$

  2. the regulator's desire to minimize total systemic losses, L

$$\boldsymbol{L} = \sum_{b \in B} l_b + \sum_{c \in C} l_c + \sum_{m \in M} l_m + l_0 \tag{1}$$

- Losses for each type of firm represent the difference between expected and received payments, plus consumption of resources in the default waterfall.

- With our model we can examine how modifying the structure of the default waterfall influences the achievement of these two objectives.

Empirical Test of the Model

Empirical Analysis

- We examine quantitatively what our model suggests are ways ICE Clear Credit could have improved their default waterfall.
- Using their quarterly disclosures, we examine their waterfall and exposures as of the end of 2014.

Tranche	**Total Amount**
Initial Margins	\$14.1 billion
Guarantee Fund	\$2.4 billion
CCP Capital	\$0.05 billion

Source: ICE Clear Credit (2016)

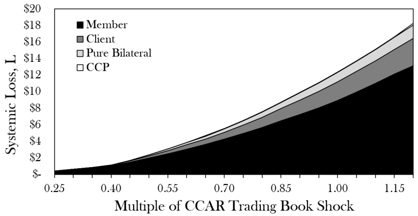
Empirical Analysis: CCAR Stress Event

- We adopt the Federal Reserve's CCAR Global Market Shock as our benchmark scenario and investigate a range of shocks above and below this level. 2015 CCAR Global Market Shock
  - The date of the shock is October 6, 2014.
  - The CCAR shock size is large, but not implausible.
- The shock triggers bilateral VM flows between counterparties.
  - Large outgoing payments can create severe balance sheet stress for some firms.

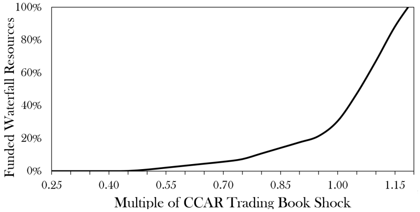
Empirical Results

Systemic Losses

- We stress the US CDS market by a multiple of the CCAR trading book shock.
  - Majority of systemic losses are suffered by member firms, though at higher stress levels client and bilateral losses increase.
  - The utilization of the waterfall is convex in the shock size.



(a) CDS Market Losses by Firm Type

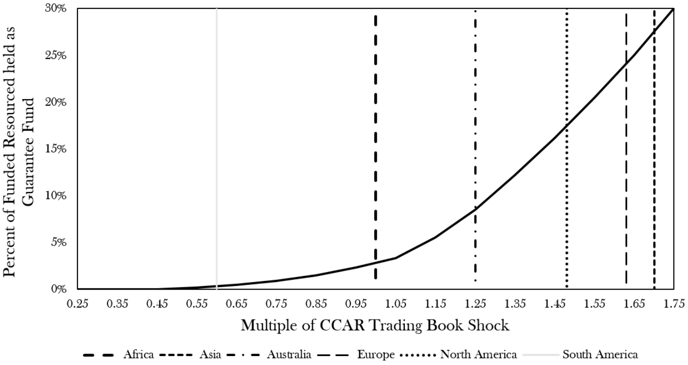


(b) CCP Funded Waterfall Resources

Source: Authors' calculations using data provided to the OFR by the Depository Trust & Clearing Corporation and Markit Group Ltd.

Waterfall Structure and Systemic Resiliency

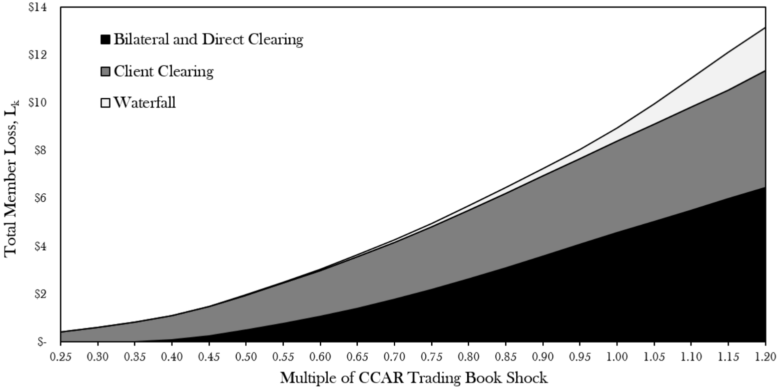
- To determine ways to improve CCP resiliency, we vary where the resources are held across the funded stages.
- The figure plots the funded resource frontier for different guarantee fund-to-initial margin ratios, holding total resources constant



Source: Authors' calculations using data provided to the OFR by the Depository Trust & Clearing Corporation and Markit Group Ltd.

Composition of Member Losses

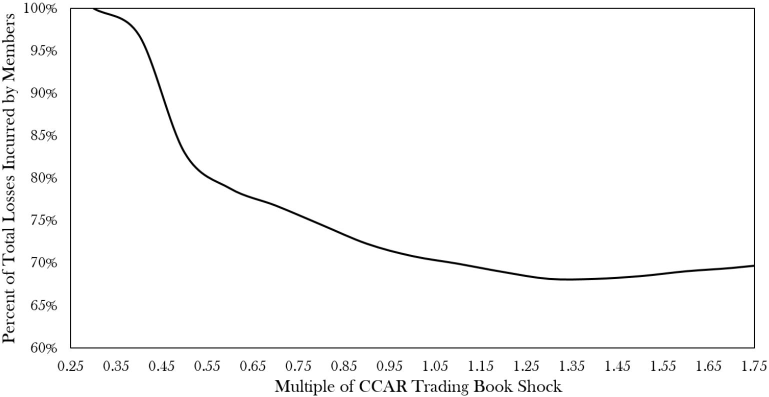
- We find client clearing is a major proportion of member losses, especially at lower shock levels.
- Waterfall-related losses grow non-linearly as shock levels increase due to contagion.



Source: Authors' calculations using data provided to the OFR by the Depository Trust & Clearing Corporation and Markit Group Ltd.

Waterfall Structure and Member Losses

- As more guarantee fund is collected from members, the percentage of total losses suffered by members eventually increases.



Source: Authors' calculations using data provided to the OFR by the Depository Trust & Clearing Corporation and Markit Group Ltd.

Conclusion

- Optimally aligning waterfall resources is difficult for a CCP. Our model provides a means to measure:
  1. the resiliency of a CCP's default waterfall structure.
  2. whether the structure is beneficial to participating firms.
- A risk-sharing limit exists after which more member contributions to shared waterfall resources increases member losses.
- Client-clearing-related losses are substantial and must be properly accounted for in funding the default waterfall.

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Paddrik, M. E., Rajan, S., and Young, H. P. (2019). Contagion in derivatives markets. *Management Science*, forthcoming.

Appendix

Related Literature

- CCP Default Waterfall Design
  - Nahai-Williamson, P., Ota, T., Vital, M. and Wetherilt, A. (2013); Duffie, D. (2015); Cont, R. (2015); Amini, H., Filipovic, D. and Minca, A. (2015); Paddrik, M. and Young, H. P. (2017); Capponi, A., Wang, J.J. and Zhang, H. (2018).
- CCPs and Systemic Risk
  - Duffie, D. and Zhu, H. (2011); Cont, R. and Kokholm, T. (2014). Ghamami, S. and Glasserman, P. (2016); Ali, R., Vause, N. and Zikes, F. (2016); Paddrik, M., Rajan, S. and Young, H. P. (2019).
- Network Structure and Systemic Risk (selected references)
  - Allen, F. and Gale, D. (2000); Eisenberg, L. and Noe, T. (2001); Cont, R., Moussa, A. and Santos, E. B. (2013); Glasserman, P. and Young, H. P. (2015).

2015 CCAR Global Market Shock

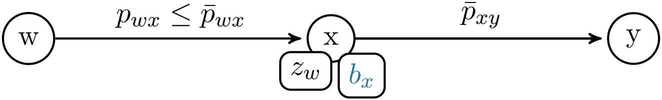
Corporate Credit							
Advanced Economies							
	AAA	AA	A	BBB	BB	B	<B or Not Rated
Spread Widening (%)	130.0	133.0	110.2	201.7	269.0	265.1	265.1
Emerging Markets							
	AAA	AA	A	BBB	BB	B	<B or Not Rated
Spread Widening (%)	191.6	217.2	242.8	277.5	401.9	436.4	465.8

Loan							
Advanced Economies							
	AAA	AA	A	BBB	BB	B	<B or Not Rated
Relative MV Shock (%)	-6.2	-6.7	-13.4	-22.6	-26.9	-30.5	-39.8
Emerging Markets							
	AAA	AA	A	BBB	BB	B	<B or Not Rated
Relative MV Shock (%)	-23.2	-27.6	-32.0	-36.4	-61.3	-66.7	-72.2

State & Municipal Credit							
	AAA	AA	A	BBB	BB	B	<B or Not Rated
Spread Widening (bps)	12	17	37	158	236	315	393

Back

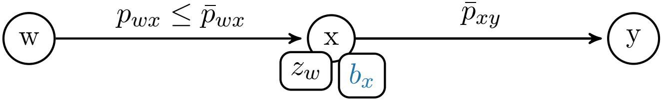
Payments Model: Liquidity Buffers



$$stress = \left[\bar{p}_{xy} - min(\bar{p}_{wx}, p_{wx} + z_w) - \underbrace{b_x}_{\text{reserves}}\right]_+$$

- x has a **liquidity buffer**, b_x, to cover its net portfolio losses

Payments Model: Liquidity Buffers



$$stress = \left[\bar{p}_{xy} - min(\bar{p}_{wx}, p_{wx} + z_w) - \underbrace{b_x}_{\text{reserves}} \right]_+$$

- x has a **liquidity buffer**, b_x, to cover its net portfolio losses
- **Estimation of *b***
  - Liquidity buffers are computed for each firm using historical net VM payments at 99.7% (worst observed loss in data).
  - There is substantial heterogeneity among firms in the liquidity buffers required to manage their CDS operations.