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Efficiency of central clearing under liquidity stress

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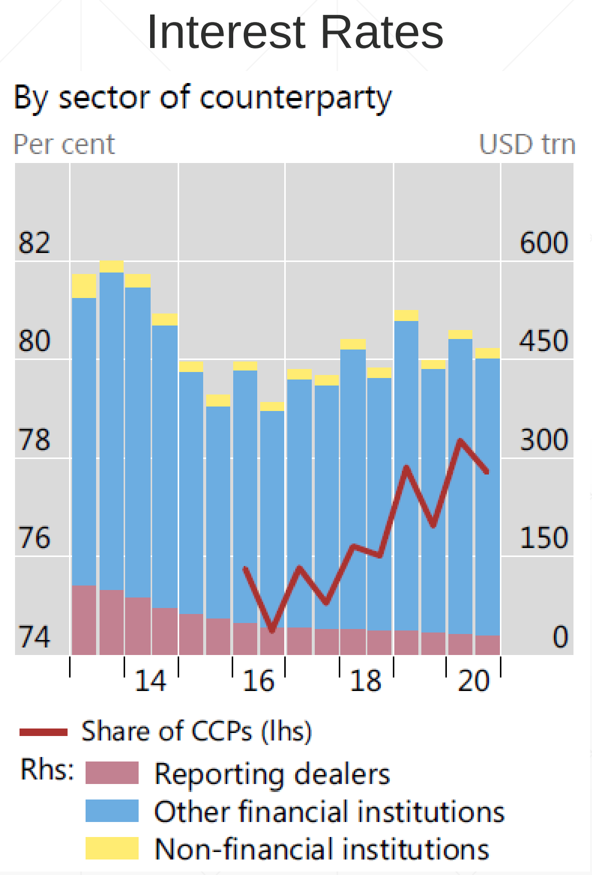
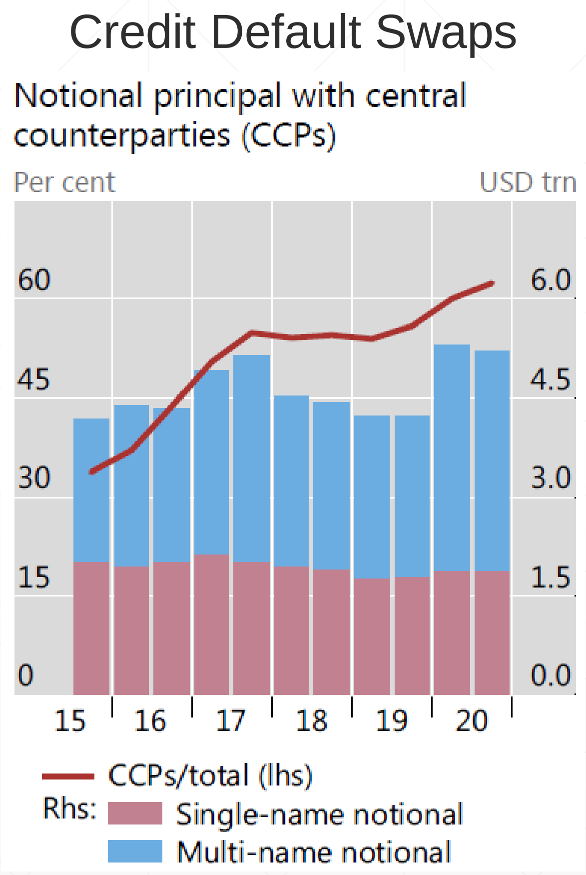
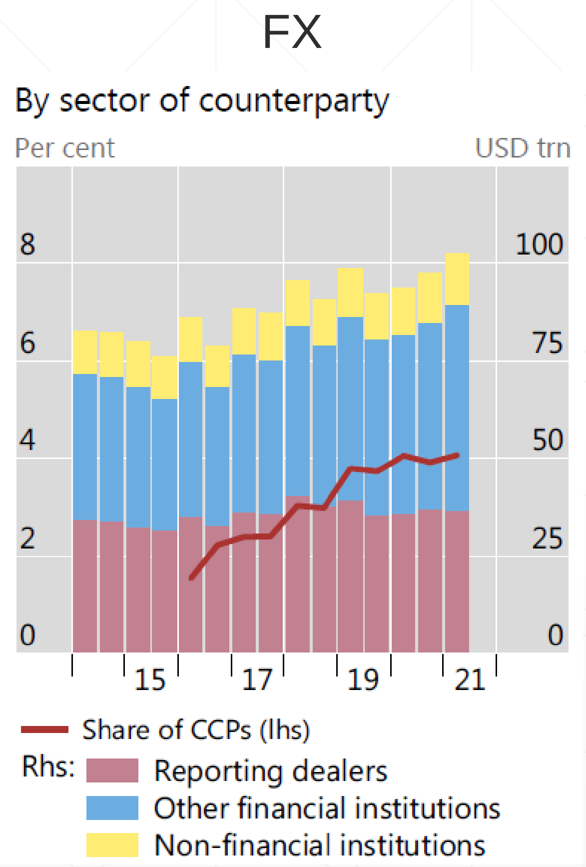
Central clearing and Collateralization

- Two main reforms of derivative market after the global financial crisis: collateralization and central clearing
- The aim of central clearing is to reduce counterparty risk by interposing a third institution (the CCP) between two counterparties
- Collateralization trades counterparty risk for liquidity risk
  - Collateral is posted daily (sometimes multiple times in a day)
    - Variation margins (VMs): offset daily price movements
    - Initial margins (IMs): seized in case VMs are not paid, rarely topped-up
  - Derivative contracts are increasingly collateralised

Global derivatives market







Source: BIS OTC derivatives statistics November 2021

Research question

- CMs have to post collateral following a shock
  - The shock is not important here: it simply generates payment obligations for CMs
  - CMs can meet those obligations with their liquid asset buffers and with payments received from the CCP or from other CMs
  - When those are not sufficient, they record a shortfall
- Liquidity shortfalls are a measure of demand for collateral without remedial actions
- **What happens to liquidity shortfalls as more notional is centrally cleared?**

Literature review

- Bilateral vs multilateral netting:
  - Duffie and Zhu (2011): Central clearing can reduce netting efficiency
  - Cont and Kokolm (2014): Central clearing reduces interdealer exposures
- Similar set-up: with full central clearing shortfalls are smaller than with partial central clearing:
  - Amini, Filipovic, Minca (2016), Cui et al (2018), Ahn (2020), Amini, Filipovic, Minca (2020)
- Collateral demand:
  - Duffie, Scheicher, Vuillemey (2016): Central clearing reduces collateral demand, provided there is no CCP proliferation, but has distributional effects
  - Cont and Minca (2015): Central clearing reduces probability of systemic illiquidity spiral
  - Health et al (2016): Less institutions experience liquidity stress when all derivatives are centrally cleared
- Stress testing:
  - Paddrick, Rajan, Young (2020): Shortfalls from VM payments under different assumptions
  - Bardoscia et al (2021): Sequencing of payments matter

Preview of results

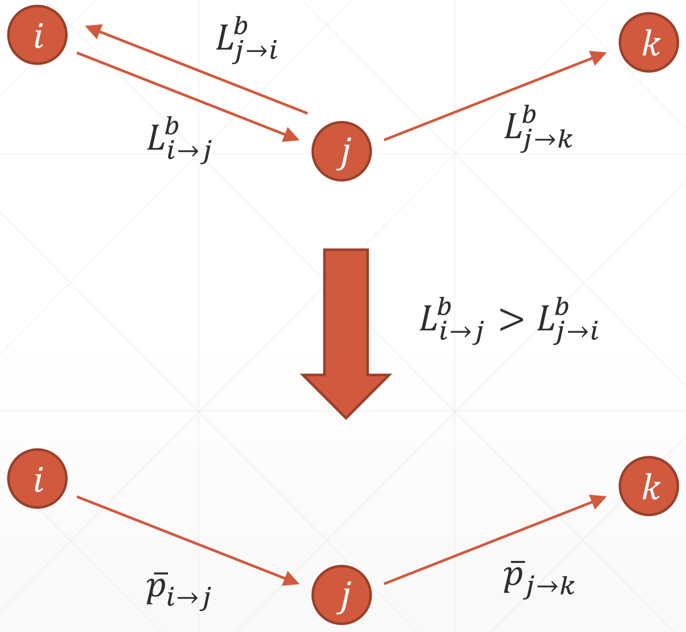
The network structure matters:

- When each institution has the same counterparties both on centrally cleared and bilateral contracts, increasing the fraction of centrally cleared notional always weakly reduces the aggregate shortfall.
- When those counterparties are different, there is often an optimal fraction of centrally cleared notional that minimize the aggregate shortfall.
- This effect disappears for:
  - Densely connected networks
  - Highly heterogeneous payment obligations

Model

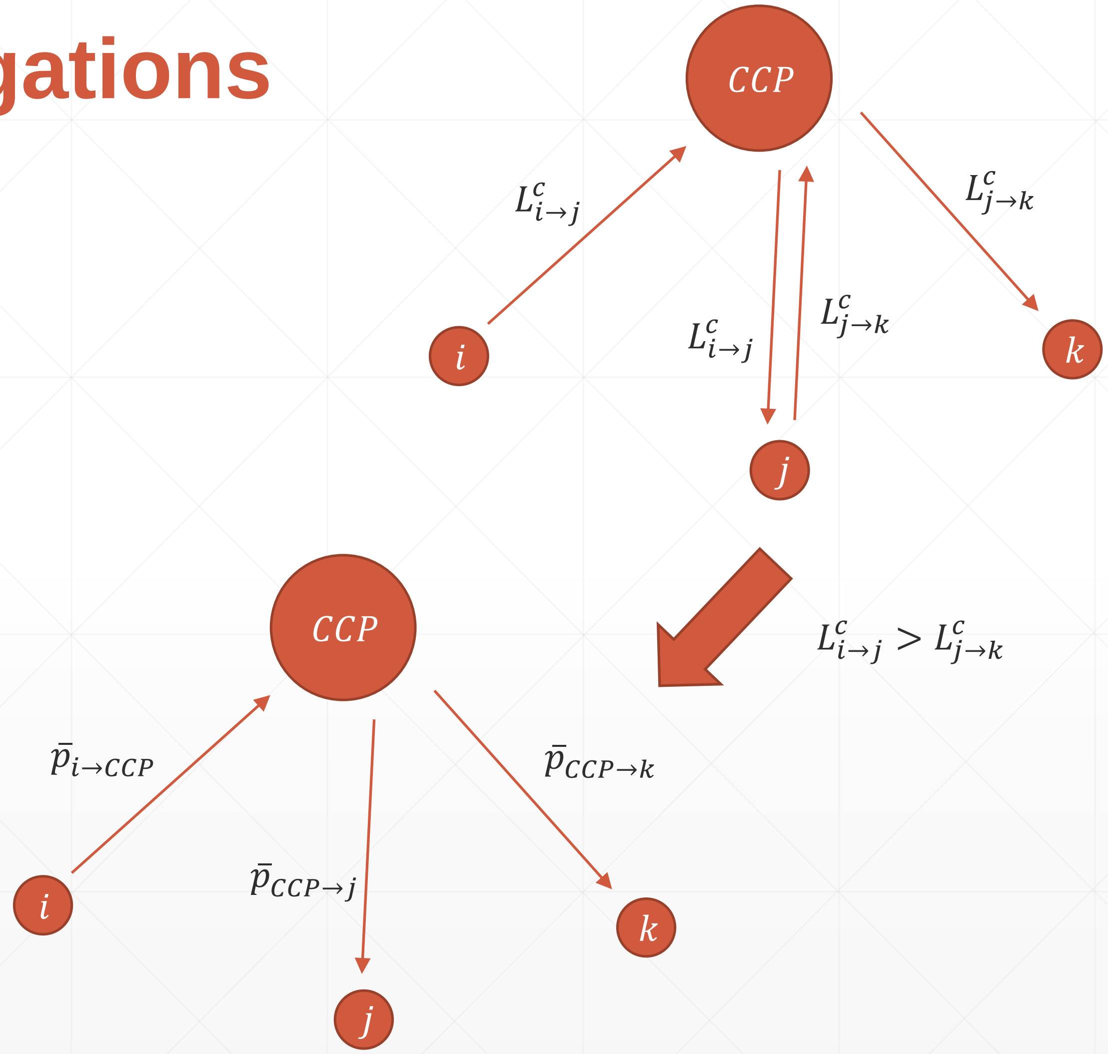
Bilateral VM obligations

- Network of financial institutions that have bilateral contracts with each other
- A shock generates variation margin (VM) obligations between banks: $L^b_{i \to j}$
- VM obligations are netted bilaterally
  - $\bar{p}_{i \to j} = \max\big((L^b_{i \to j} - L^b_{j \to i}), 0\big)$
- Institutions can meet those obligations with :
  - Liquid asset buffer (cash): e_i
  - Payments from other institutions



Centrally cleared VM obligations

- Obligations exist in pairs. $L^c_{i\to j}$ are two obligations: from i to the CCP and form the CCP to j
- Obligations are netted multilaterally
  - $\bar{p}_{i\to CCP} = \max(\sum_j (L^c_{i\to j} - L^c_{j\to i}), 0)$
  - $\bar{p}_{CCP\to i} = \min(-\sum_j (L^c_{i\to j} - L^c_{j\to i}), 0)$



Mixed VM obligations

- We introduce α: the fraction of notional that is centrally cleared
- Un-netted VM obligations are proportional to the notional, so this is also the fraction of centrally cleared VM obligation
- We have:

$$L_{i\to j}^{tot} = \alpha L_{i\to j}^{c} + (1-\alpha) L_{i\to j}^{b}$$

- Since we are interested in the relative importance of centrally cleared vs bilateral VM obligations we make total obligations for all banks independent of α
  - This implies that $\sum_j L_{i\to j}^{c} = \sum_j L_{i\to j}^{b}$
  - But $L_{i\to j}^{c} \neq L_{i\to j}^{b}$ in general

Novation strategies

- In previous studies: $\mathbf{L}^c = \mathbf{L}^b$
  - Counterparties on centrally cleared contracts are different than those on bilateral contracts
  - Individual exposures on centrally cleared contracts are proportional to those on bilateral contracts
  - All contracts are novated at the same time when $\alpha \rightarrow \alpha' > \alpha$
- In general: $\mathbf{L}^c \neq \mathbf{L}^b$
  - Counterparties on centrally cleared contracts are different than those on bilateral contracts
  - Individual exposures on centrally cleared contracts are not necessarily proportional to those on bilateral contracts
- Does it matter?

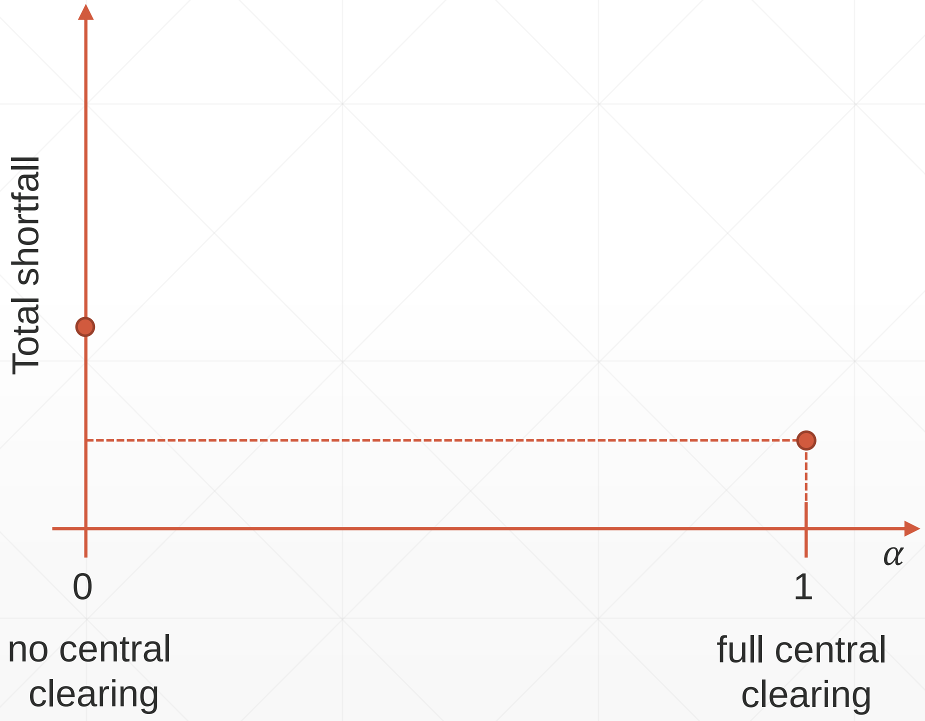
Payments

1. CMs rely only of their cash to pay the CCP:
   - $p_{i \to CCP} = \max(\, \bar{p}_{i \to CCP}, e_i)$
   - When they cannot pay in full, they record a shortfall: $s_i^c = \bar{p}_{i \to CCP} - p_{i \to CCP}$
2. CMs are always able to source the collateral to pay the CCP:
   - The CCP does not default: $p_{CCP \to i} = \bar{p}_{CCP \to i}$
3. Payments between CM according to Eisenberg and Noe model:
   - $e_i \to e_i - p_{i \to CCP} + p_{CCP \to i}$
   - Use cash and payments received to make payments
   - Either pay full obligations
   - Or pay pro rata using available resources and record a shortfall: $s_i^b = \bar{p}_i - p_i$

Results: $\mathbf{L}^c = \mathbf{L}^b$

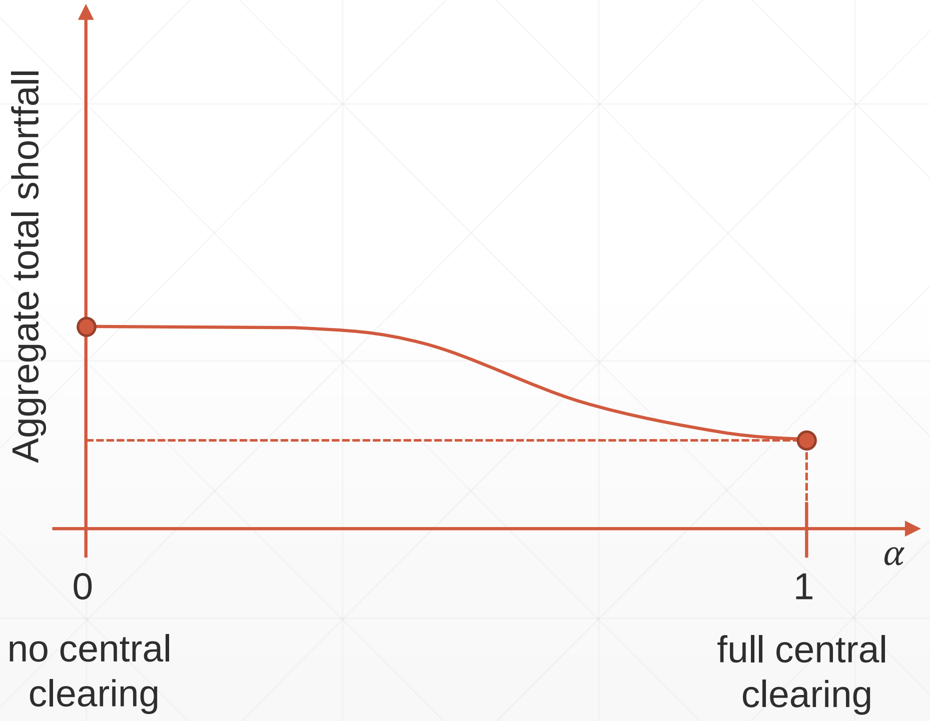
Fully bilateral vs fully centralized market

- For any institution, the shortfall in a fully bilateral market is larger than or equal to the shortfall in a fully centralized market



Mixed market

- The aggregate total (bilateral + centralized) shortfall is weakly decreasing with α
  - Shortfall to the CCP is increasing
  - Bilateral shortfall is decreasing



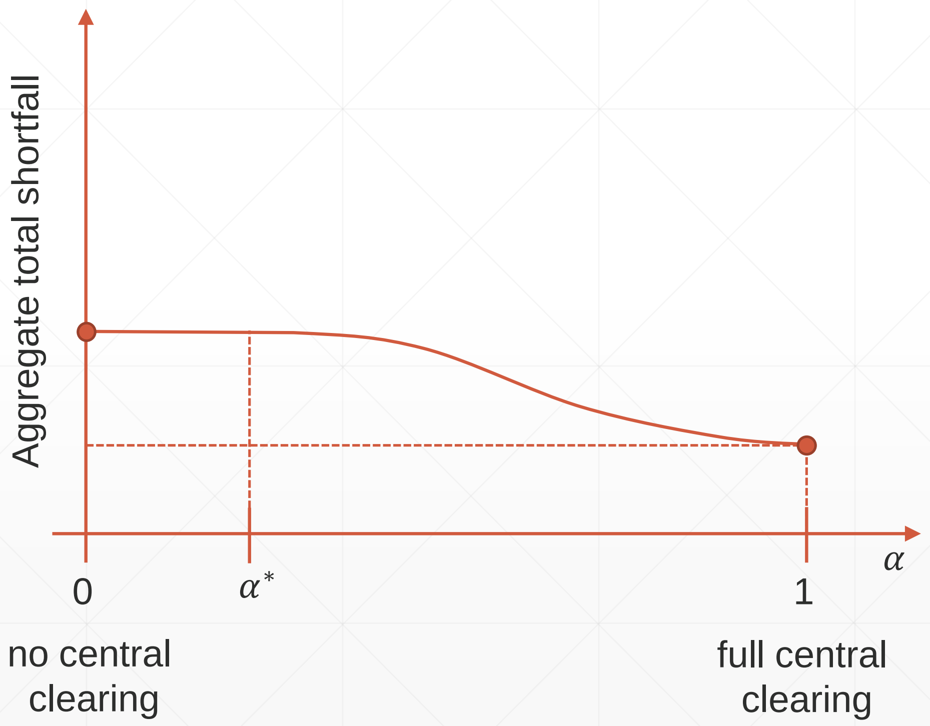
Threshold effect for aggregate shortfall

- The aggregate total shortfall is constant at least up to:

$$\alpha^* = \min_i \frac{e_i}{\max(\sum_j(\bar{p}_{ij} - \bar{p}_{ji}), 0)}$$

- This is conceptually similar to the Liquidity Coverage Ratio

- When institutions hold a lot of cash or when net obligations are smaller one needs to push central clearing more to have some benefits

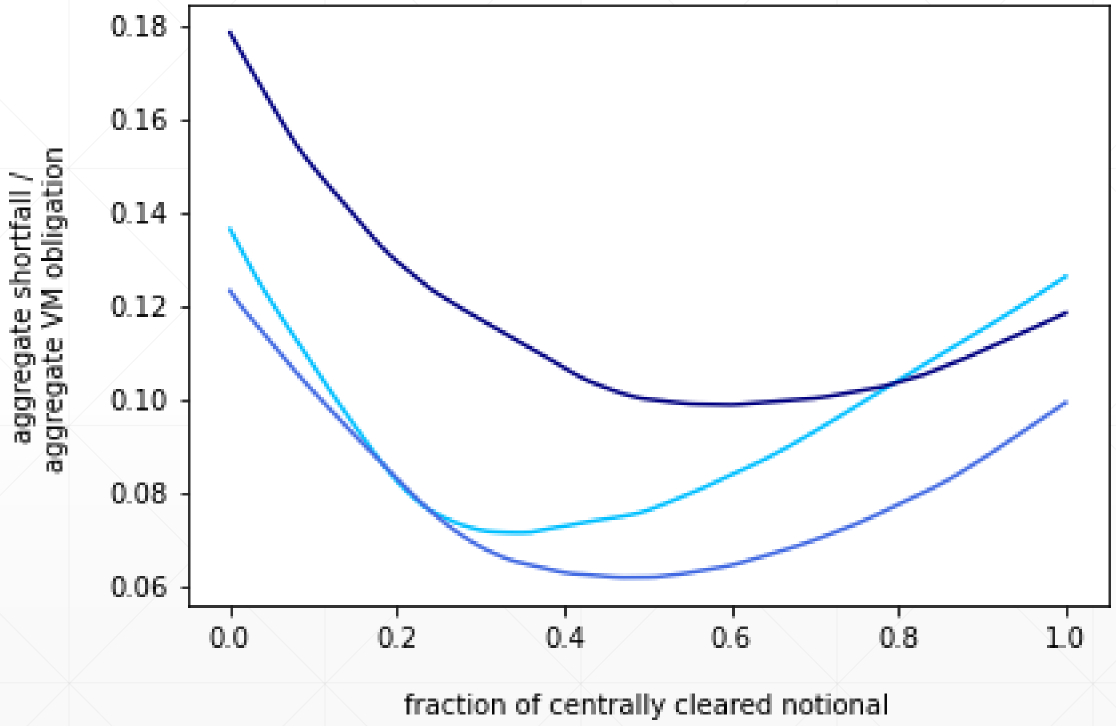


Results: $\mathbf{L}^{c} \neq \mathbf{L}^{b}$

Simulations

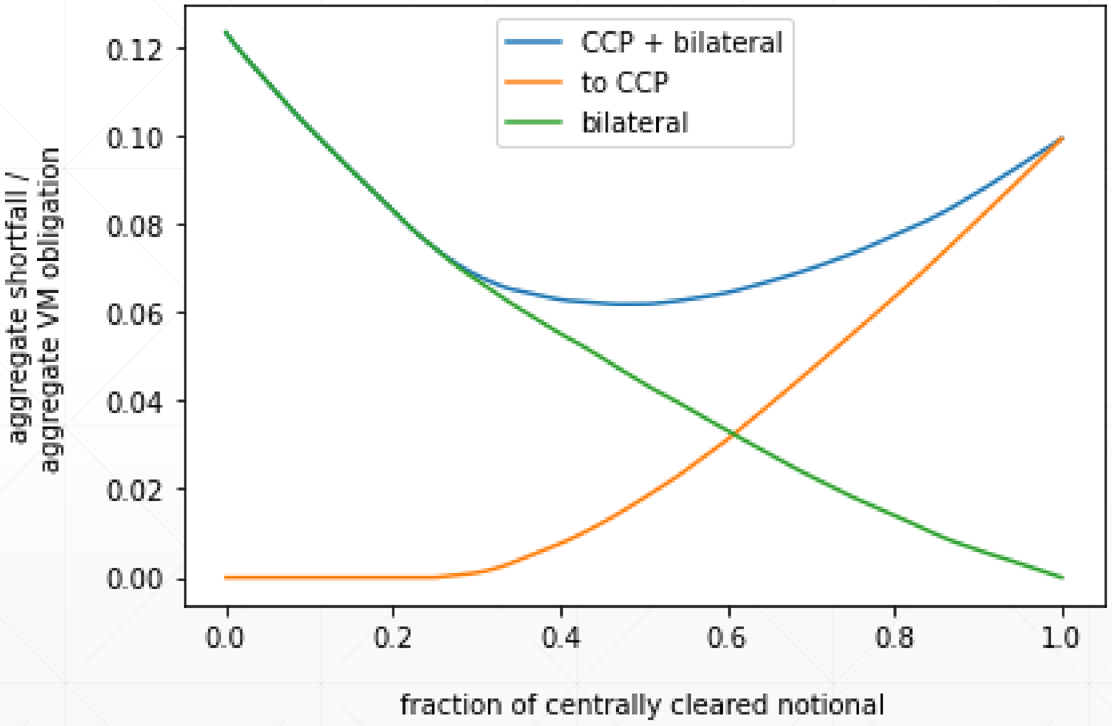
- Same cash for all institutions: $e_i = 1$
- We generate random networks of un-netted payment obligations:
  - Each obligation exists independently with probability c (aka density)
  - Amount of obligations (size of shock relative to cash):
    - Homogeneous: same un-netted total obligations for all banks
    - Heterogeneous: un-netted total obligations from a Gaussian distribution
    - In all cases we spread obligations uniformly across counterparty banks
- Robustness checks:
  - With and without sequencing of payments
  - Re-drawing obligations for different values of α

Existence of optimal α



c = 4%, VM obligation per bank = 4.00

Existence of optimal α



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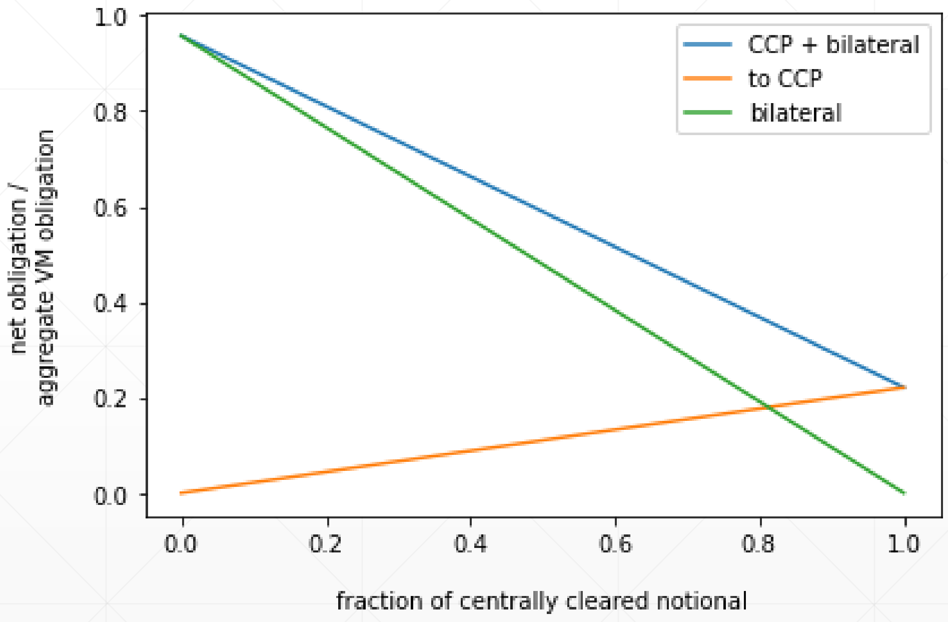
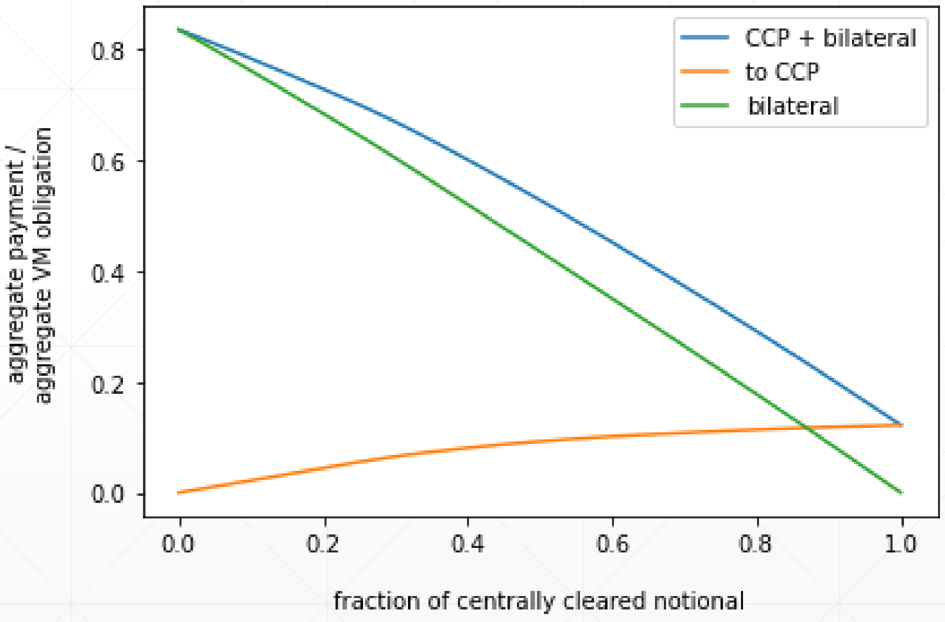
Existence of optimal α





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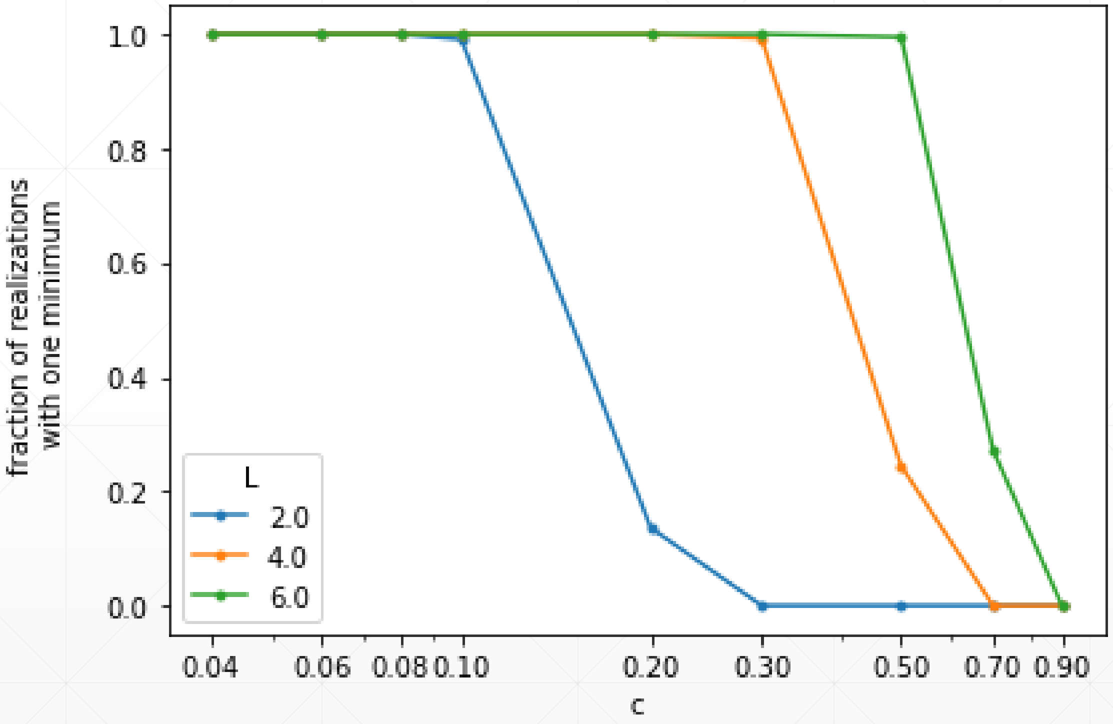
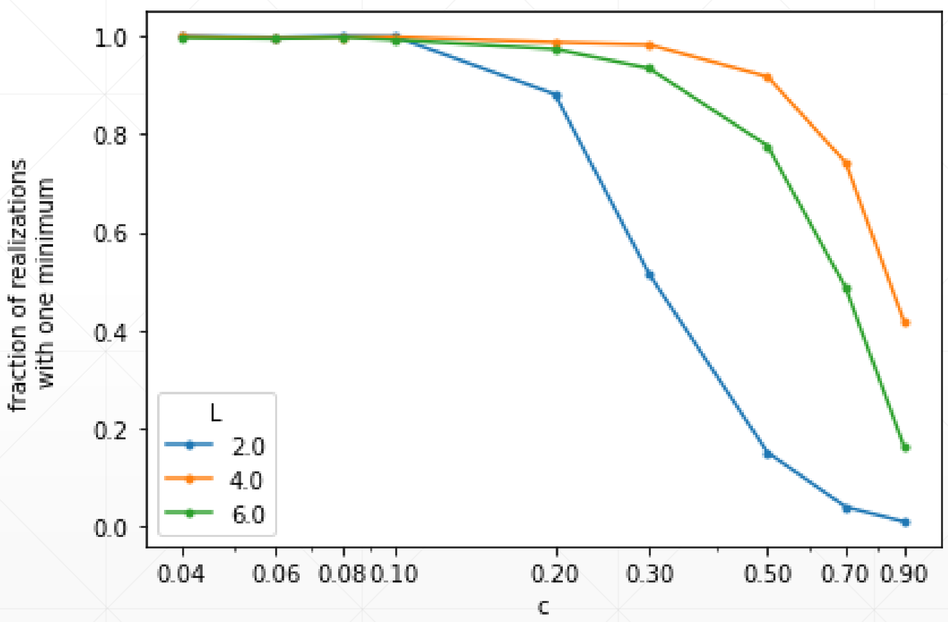
Homogenous VM obligations



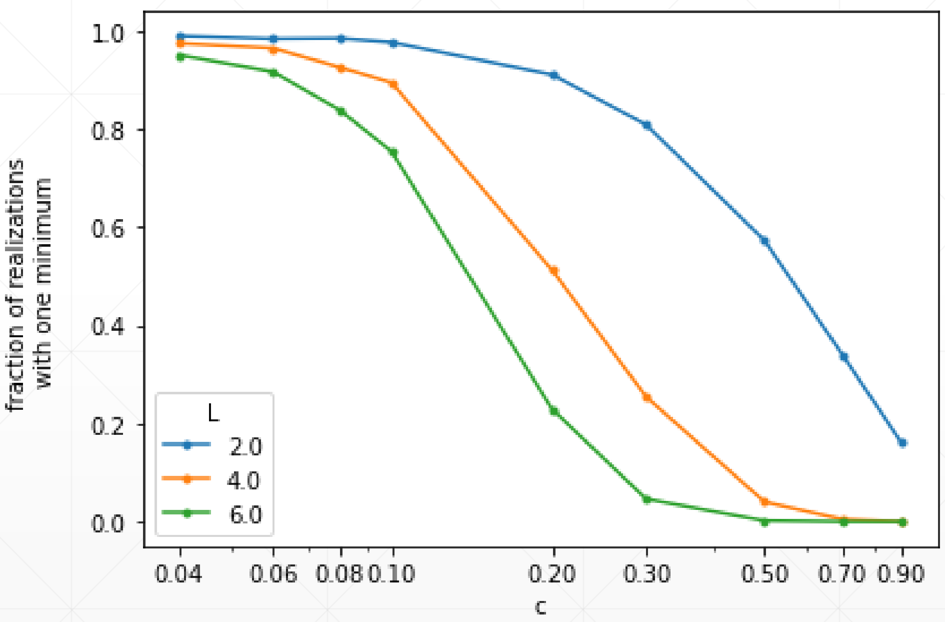
VM obligations equal for all banks and split uniformly across counterparties

Heterogeneous VM obligations

$\sigma = L/6$



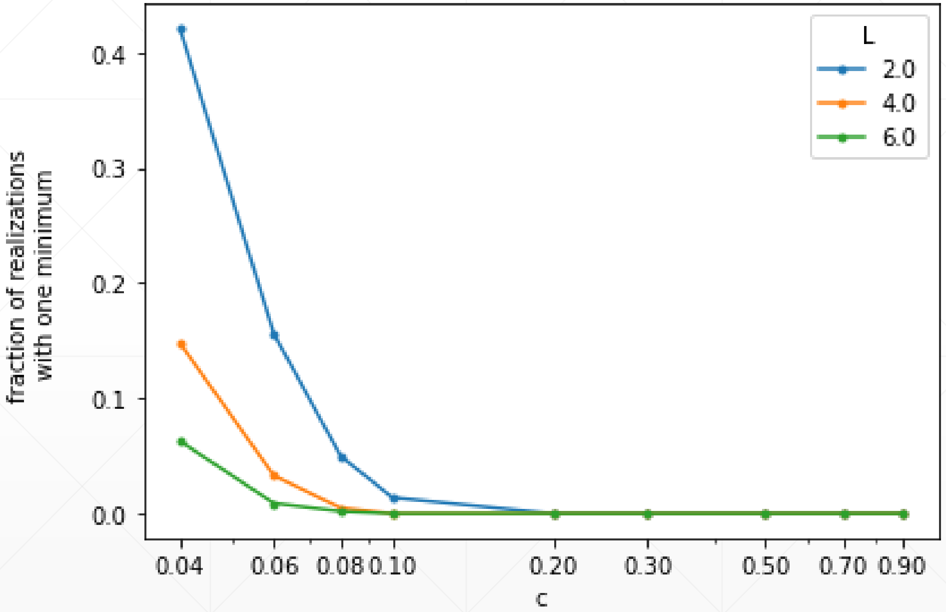
$\sigma = L/3$



Gaussian VM obligations split uniformly across counterparties

Heterogeneous VM obligations

$\sigma = L$



Gaussian VM obligations split uniformly across counterparties

Summary

- When counterparties on centrally cleared and bilateral contracts are the same:
  - The aggregate shortfall is non-increasing with the fraction of centrally cleared notional
  - The benefit of central clearing kick-in only when the fraction of centrally cleared notional is sufficiently large
- When counterparties on centrally cleared and bilateral contracts are not the same:
  - There is an optimal fraction of centrally cleared notional
  - The optimum disappears:
    - For sufficiently dense networks
    - For highly heterogeneous VM obligations