Central Clearing and Systemic Risk: A Network Approach

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Benefits of Central Clearing

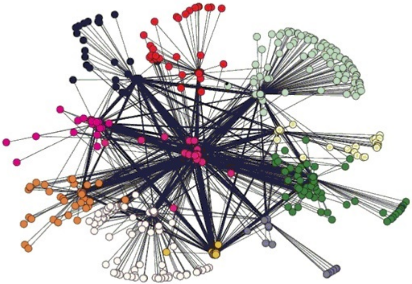
- Novation and netting
- Elimination of counterparty credit risk
- Transparency of OTC derivatives markets
- But: many participants argue that credit risk is replaced by liquidity risk
- **The question is: what are the benefits of central clearing for financial system stability?**

Network approach

- Simulation-based
- Maximally realistic construction of hypothetical systems
- Networks of CMs and their clients
- Compare default characteristics of a hypothetical system with and without CCP

Why networks?

Figure: Example of a financial system



Network approach

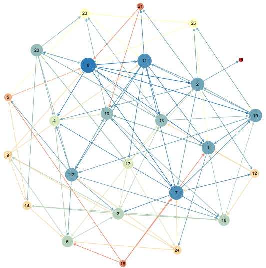
- "Skeleton" of the network: nodes (FIs) and (directed) links
- "Weights" of the links: size of lending/borrowing and derivatives exposures
- Type of external shock the network is exposed to
- **Sources of systemic risk**: contagion due to connections AND simultaneous shock to assets

Types of Networks/Graphs

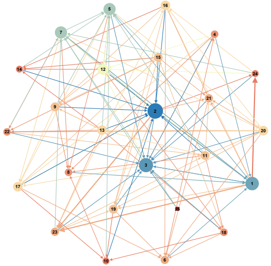
- **Complete Networks** - homogeneous; used in past empirical studies.
- **Random Networks** (Erdös-Rényi Graphs): each edge is present with probability p - homogeneous.
- **Tiered random networks**: two types of nodes (highly connected / less connected) - non-homogeneous.
- **Core-Periphery structure**: extreme interconnectedness of core nodes.

Random Networks

Figure: Erdös-Rényi Graphs: $n = 25$



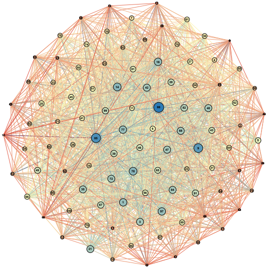
(a) Random $p = 0.2$



(b) Tiered Structure $p_l = 0.5, p_s = 0.16$

Random Networks Cont.

Figure: Erdös-Rényi Graphs: $n = 100$



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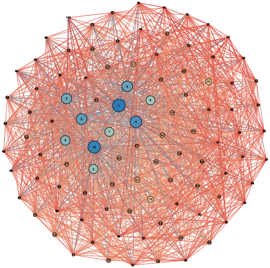
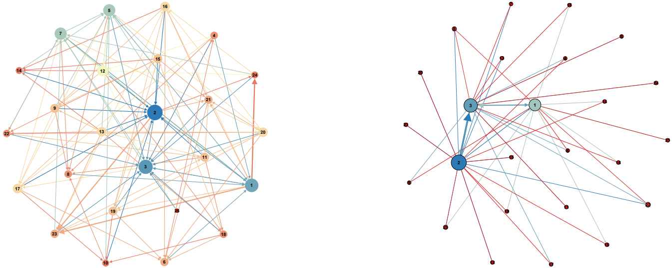


(b) Tiered Structure $p_l = 0.5, p_s = 0.17$

Core-Periphery Networks

Figure: Core-Periphery Structure: $n = 25$, assume that 10% of GCMs control 80% of the OTC derivatives market

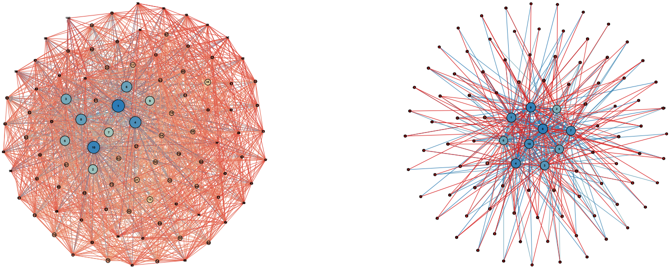


(a) Tiered Structure

(b) Core-Periphery Structure

Core-Periphery Networks Cont.

Figure: Core-Periphery Structure: $n = 100$, again, assume that 10% of GCMs control 80% of the market



(a) Tiered Structure

(b) Core-Periphery Structure

Types of Networks

- Random homogeneous networks, e.g., $p = 0.2$
- Tiered networks: 10% of FIs are "large" and well-connected ($p_l = 0.5, p_s = 0.16$ so that $p = 0.2$)
- Core-periphery networks: assume e.g., that 10% of FIs control 80% of derivatives market. Then e.g., for $p_l = 0.6$, $p_s \approx 0.02 - 0.03$.
- Total size of the banking system, derivatives market and overall connectivity is the same for all networks - this is important for comparison

Typical FI's Stylized Balance Sheet

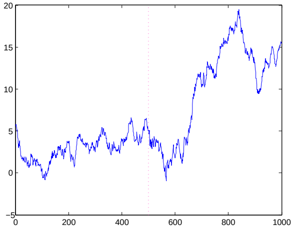
Assets	Liabilities
Fixed Assets A_i^F	Capital $L_i^C =: c_i$
Liquid Assets A_i^L	Deposits L_i^D
Interbank Assets A_i^{IA}	Interbank Liabilities A_i^{IL}
Margins M_i	

Clearing what: Interest Rate Swaps

- For each FI, we determine a portfolio mix of interest rate swaps (e.g., 5 tenors)
- A 1:1 relation between size of FI and portfolio size
- IRS values are determined from the simulated IR curve: choose your favorite IR curve model
- Each FI has 50% chance of holding fixed or floating leg of a swap
- Counterparties are chosen randomly, but taking into account tiering structure

Swap Value Simulation

Figure: Simulated path of $V_{\text{swap}}(t, T)$



External shock: to IR curve, until first FI defaults (3 or more σs)

CCP's default waterfall

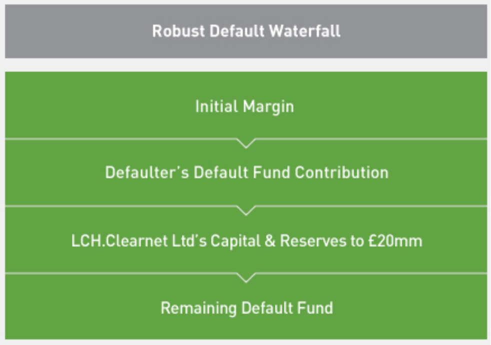


Figure: Robust default waterfall as applied by e.g., SwapClear

CCP Assets

- **Variation margins**
- **Initial margins:** based on 99% 5-day VaR, held in segregated (CM) or omnibus (clients) accounts
- **Default fund contribution:** stressed market conditions; fixed percentage of initial margins (10%), held in omnibus account
- CCP has limited own capital ($\leq 5\%$)
- CCP can opt for top-up to DF if needed; only operating CMs are considered

Default Dynamics

- At time t there is a shock to the balance sheet of party i (e.g., via an adverse IR change).
- FI i defaults if its required collateral $(VM_{i,t} + IM_i + DFC_i)$ is greater than its capital.
- We call this *fundamental default* (can be more than one at any time).
- Losses are absorbed by VM_i and IM_i, then by the default fund (own contribution, then that of the rest).
- CCP transfers all IRSs of the defaulted FI to other FIs (at the market value), charging new IMs, VMs and possibly extra DF contributions.
- This can lead to further (*contagion*) defaults and the process is repeated.

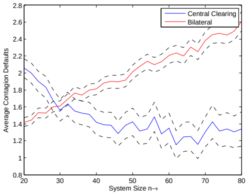
Simulations results

All the results are CONDITIONED on the first fundamental default, so all probabilities are CONDITIONAL probabilities!

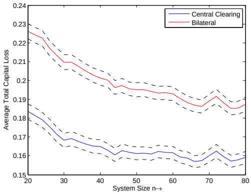
In 2-d figures: Blue lines: CCP cleared situation, Red: bilateral system.

Homogeous Network

Figure: Defaults as a function of n



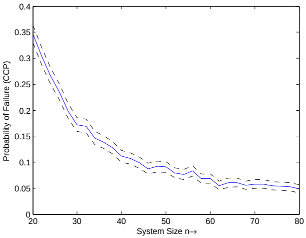
(a) # of defaults



(b) Average Total Capital Loss

Homogeous Network

Figure: Probability of CCP Failure vs. n



Tiered Network

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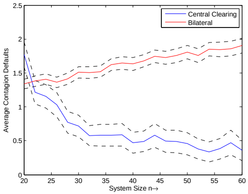

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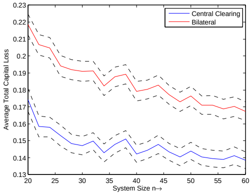

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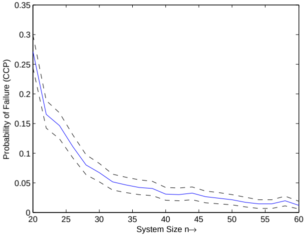
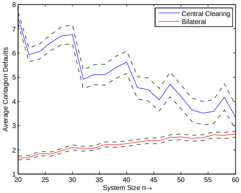


Tiered Network : Conditioning on a default of a LARGE CM

Figure: Defaults as a function of n



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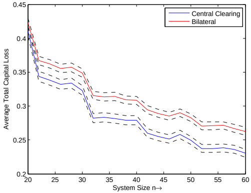

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Tiered Network : Conditioning on a default of a LARGE CM

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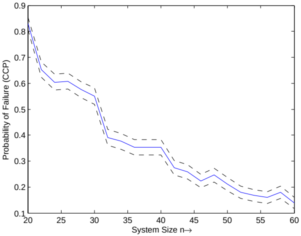
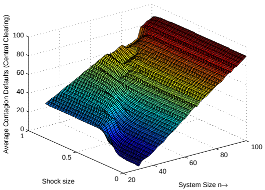
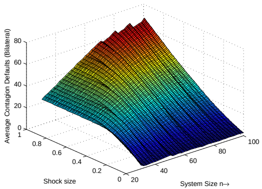


Core-Periphery Networks: Conditioning on a default of a LARGE CM

Figure: # of defaults vs. system size n and shock size



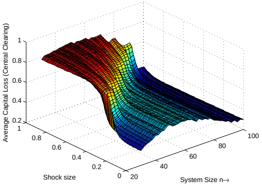
(a) Central Clearing



(b) Default rates (Bilateral)

Core-Periphery Networks : Conditioning on a default of a LARGE CM

Figure: Average Total Capital Loss vs. system size n and shock size



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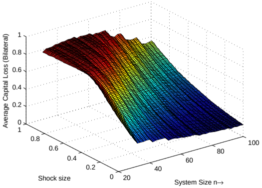

(b) Bilateral

Core-Periphery Networks : Conditioning on a default of a LARGE CM

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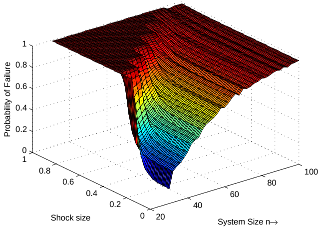

To summarize:

- **The effect of CCP clearing on the financial system is complex**, highly dependent on the system's structure and the source of fundamental default (SIFI or not).
- Our simulation results indicate that **smaller, peripheral FIs are generally sacrificed** (unevenly punished) for financial stability.
- For financial stability, it seems more useful to focus on the capitalization of **core CMs**, to prevent their (fundamental) default, rather than to debate RM measures for CCPs.

Building a real financial network

- Two-layer network: interbank balance sheet exposures and derivatives contracts
- Balance sheet exposures: some information, but mostly in aggregate form
- Algorithms such as Maximum Entropy allows us to fill in exposure matrix, preserving CP structure and overall characteristics of real financial networks

Derivatives transactions data

- EMIR: registration of all derivatives transactions in TRs as of Feb 2014.
- Sources: DTCC, other TRs, AFM, ...
- In theory: an ideal source of information on derivatives transactions (counterparty, type, size, maturity, collateral,â)
- In reality: a total mess: gaps, errors, identifiers.
- But also legal: e.g., DNB observes only contracts of participants located within Dutch jurisdiction

Solutions

- Qualitative or semi-quantitative information: central banks questionnaire
- TARGET II: all interbank payments
- Possible to separate payments that correspond to derivatives transactions
- Build interbank network according to aggregated daily interbank payments

Further information

- s.a.borovkova@vu.nl
- *Systemic Risk and CCPs: A Network Approach*, SSRN white paper
- http://www.mejudice.nl/video/detail/svetlana-borovkova-over-een-nieuw-systeemrisico