Portfolio Compression in Financial Networks: Incentives and Systemic Risk

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Financial interconnectedness gives rise to systemic risk via financial contagion
To reduce interconnectedness, eliminate cycles = Portfolio Compression
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Research Questions:
1. When socially beneficial?
2. Incentives to do it?
Compression is mandatory today

When counterparties have more than 500 contracts outstanding with each other, [there is an] obligation to have procedures to analyse the possibility to conduct the exercise [of portfolio compression].

— EMIR Regulations, 2017
Portfolio Compression: Process

1. Financial Institution
2. Financial Service Provider
3. Contracts
4. Find Cycles
5. Unwind Proposal
6. Accept / Reject

All involved banks need to accept for the compression to become effective!
Prior Work

• Central Clearing and Systemic Risk: A lot
  • Duffie and Zhu (2011), Duffie et al. (2015), Amini et al. (2015), ...

• Portfolio Compression: Algorithms / Compressed Amount
  • O’Kane (2017), D’Errico and Roukny (2019)

• Portfolio Compression and Systemic Risk: Very little
  • Schuldenzucker, Seuken, Battiston (note, 2016): Can be socially detrimental
  • Veraart (WP, 2019): Can be detrimental; simple sufficient conditions

• Network Structure & Systemic Risk
  • Elliott ea. (2014), Acemoglu ea. (2015), Glasserman and Young (2015), ...

• Change in Network Structure
  • Feinstein et al. (WP, 2017): Sensitivity to changes in network, keep absolute liabilities the same (≠ compression)
Formal Model: Financial Network (Rogers and Veraart, 2013)

\[ X = (N, e, l, \alpha, \beta) \]

- **Financial System**
  - Set of banks: \( N \), single bank \( i \in N \)
  - External Assets: \( e \) with \( e_i \in \mathbb{R}^+ \) (shocked)
  - Nominal Liabilities: \( l \) with \( l_{i,j} \in \mathbb{R}^+ \) = what \( i \) owes to \( j \)
  - Default Cost Parameters: \( \alpha, \beta \in [0, 1] \)
Formal Model: Clearing Payments (Rogers and Veraart, 2013)

**Theorem** (Rogers and Veraart, 2013): There is a unique point-wise maximal matrix $p$ of payments such that:

$$p_{i,j} = \begin{cases} l_{ij} & \text{if } a_i(p) \geq l_i \quad \text{(No Default)} \\ \frac{l_{ij}}{l_i} \cdot a'_i(p) & \text{if } a_i(p) < l_i \quad \text{(Default)} \end{cases}$$

where...

- **Total Assets of i**
  \[ a_i(p) = e_i + \sum_j p_{ji} \]

- **Total Assets after Default Costs**
  \[ a'_i(p) = \alpha e_i + \beta \sum_j p_{ji} \]

- **Total Liabilities of i**
  \[ l_i = l_i^* \]
Formal Model: Portfolio Compression

A compression: \( c = (c_{ij}) \) that is a circulation in \( l \), i.e.:

1. \( 0 \leq c_{ij} \leq l_{ij} \quad \forall i, j \)
2. \( \sum_j c_{ij} = \sum_j c_{ji} \quad \forall i \)

Cf. D’Errico and Roukny (2019)

Compressed Financial System: \( X^c := (N, l - c, e, \alpha, \beta) \)
Research Questions, formal

Bank’s Utility := Equity = \( E_i = \max(0, a_i(p) - l_i) \)
Social Welfare = Total Equity = \( E_\Sigma := \sum_i E_i \)

Given \( X, c \):

1. When is \( c \) socially beneficial?
   i. Pareto improvement: \( E_i^c \geq E_i \ \forall i \)
   ii. Welfare improvement: \( E_\Sigma^c \geq E_\Sigma \)

2. When is \( c \) incentivized for participating banks?
   \( E_i^c \geq E_i \ \forall i \in N(c) \)
   where \( N(c) = \{i \in N \mid c_i > 0\} \) and \( c_i := \sum_j c_{ij} \)
Compression may be socially detrimental / not incentivized

\[ \alpha = \beta = 0.5 \]

\[ E_\Sigma = 6.75 \]

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The effect depends on the parameters in a complex and non-monotonic way
Sufficient conditions for Pareto Improvement: Relative Liability Change

Relative Liabilities: $\pi_{ij} := \frac{l_{ij}}{l_i}$

Difference in Relative Liabilities: $\Delta \pi_{ij} = \pi^c_{ij} - \pi_{ij}$

$\Delta \pi_{ij} < 0 \rightarrow$ "inside"
$\Delta \pi_{ij} > 0 \rightarrow$ "leaving"
Theorem: Assume for all \( i, j \) with \( \Delta \pi_{ij} > 0 \), we have at least one of:

a) High Recovery: \( r_i \geq \beta \)

b) High capitalization wrt. compressed liabilities:
\[
\frac{e_i}{l_i - c_i} \geq \frac{\beta}{\alpha}
\]

c) Full default costs on interbank liabilities: \( \beta = 0 \)

d) Sufficiently not leaving / uniform compression at \( (i, j) \):
\[
\eta \left( \frac{c_{ij}}{l_{ij}} \right) \geq \beta
\]

Then \( c \) is a Pareto improvement.
Homogenous $\Rightarrow$ Pareto Improvement

$(X, c)$ homogeneous if all equal across $i \in N(c)$:

- $e_i$
- $\sum_{j:c_{ji}=0} p_{ji}$
- $\sum_{j:c_{ji}>0} l_{ji}$

Theorem: homogeneous $\Rightarrow$ Pareto improvement
Conjecture: Degree of Homogeneity

E: 0
B: 0.5
C: 0.5
F: 0
A: 0.5
D: 0
Conclusion

• Ex-post analysis of portfolio compression = cycle elimination
• Compression may be socially detrimental / not incentivized
• Feedback paths necessary for non-incentivized compression
• Sufficient Conditions for Pareto Improvement
• Homogeneity is good for compression

Future Work:
• Additional benefits $b_i \geq 0$ from compression $\Rightarrow$ No qualitative change?
• Ex-ante view / distribution of shocks

http://ssrn.com/abstract=3483919