Common asset holdings and systemic vulnerability across multiple types of financial institutions\(^1\)

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\(^1\)The views expressed here are those of the authors and do not necessarily reflect those of the Bank of England or its committees. The results presented in this paper are used with the permission of the Bank of England and are based on fully anonymised data.
Fire sales of commonly held assets are one way through which systemic risk can crystallise.

Existing work focuses on vulnerabilities due to price mediated contagion (e.g., Greenwood et al. (2015), Cont and Schaanining (2016), Cont and Wagalath (2013)), and on portfolio similarity and diversification (Delpini et al. (2015), Getmansky et al. (2016)) of asset holdings between institutions of the same type.

In this work, we are the first to combine granular asset holding data for UK banks, UK insurers and European open-ended investment funds to study diversification, overlaps in asset holdings, portfolio similarity and systemic vulnerabilities across multiple types of financial institutions.
Key questions

Questions that we seek to answer:

- What is the level of diversification of different types of financial institutions?
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- How big is the overlap in debt and equity security holdings of different types of institutions?
- What is the degree of similarity between financial institutions' portfolios?
- What are the implications for fire sale vulnerabilities?
Data sources

**Data** as of Q1 2016:

- **Banks**: COREP Large Exposures (CRD IV reporting rules apply) and FINREP for 24 banks (regulatory data).
- **Insurance companies**: Solvency II (new regulatory data) for PRA regulated insurance companies not subject to exemptions; 139 solos and 52 groups in total.
- **Open-ended investment funds**: Morningstar (private data) representing the top 1260 open-ended funds (in terms of total assets) domiciled in Europe.

Granularity and scope of the analysis were driven by consideration of quality and completeness of the data available as well as theoretical basis.
Data preparation

Building up from the most common granular level, through pre-processing and data cleansing it was possible to obtain a consistent dataset of debt and equity security holdings at issuer level across all three datasets.

Coverage:

<table>
<thead>
<tr>
<th></th>
<th>IC</th>
<th>B</th>
<th>F</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of FI</td>
<td>139</td>
<td>24</td>
<td>1260</td>
<td>1423</td>
</tr>
<tr>
<td>Tot debt holdings (£bn)</td>
<td>643.7</td>
<td>1509.7</td>
<td>1100.9</td>
<td>3254.3</td>
</tr>
<tr>
<td>Mapped debt holdings/ tot debt holdings</td>
<td>0.90</td>
<td>0.86</td>
<td>0.73</td>
<td>0.82</td>
</tr>
<tr>
<td>Tot equity holdings (£bn)</td>
<td>582.8</td>
<td>68.6</td>
<td>925.3</td>
<td>1576.73</td>
</tr>
<tr>
<td>Mapped equity holdings/ tot equity holdings</td>
<td>0.81</td>
<td>0.93</td>
<td>0.78</td>
<td>0.80</td>
</tr>
<tr>
<td>Total Assets* (£tr)</td>
<td>1.6</td>
<td>6.5</td>
<td>10.2</td>
<td></td>
</tr>
</tbody>
</table>

*UK insurance companies as of Q4 2015 from the Association of British Insurers; UK banks as of Q4 2015 from the PRA; European open-ended investment funds as of Q1 2016 from EFAMA.
Study of diversification

Comparison of diversification estimated as degree in the network of common asset holdings and using a standard measure of diversification (HHI)

- Debt holdings appear less diversified than equity holdings.
- All sectors appear far from full diversification.

- Investment funds seem to be almost fully diversified in their equity holdings.
Analysis of overlaps in asset holdings

Analysis of the network of common asset holdings
Bipartite network following Delpini et al. (2015)

Debt holdings

Equity holdings

Vertices correspond to both financial institutions and securities. Vertex sizes represent total holdings (financial institutions) and total amount held (securities). Different colours correspond to different communities.
Quantifying overlaps in asset holdings

Overlaps in asset holdings in terms of communities in the common asset holding network

**Debt holdings - Communities**

- Very large community both in terms of volumes and number of securities dominated by banks.
- Second largest community is composed by all other sectors.
- Remaining communities are dominated by funds or banks.

**Equity holdings - Communities**

- 4 very large communities both in terms of volumes and number of securities. Investment funds and unit-linked insurance companies dominate these large communities.
Portfolio similarity

Analysis of the network of portfolio similarity
Similarity defined following Getmansky et al. (2016).

Num of portfolios = 1464

Debt
Density = 0.29;
Sub-network densities:

\[
\begin{pmatrix}
IC_{nonL} & ICL & B & F \\
0.72 & 0.59 & 0.51 & 0.37 \\
0.58 & 0.46 & 0.31 & \\
0.31 & 0.24 & & \\
0.26 & & & \\
\end{pmatrix}
\]

Equity
Density = 0.16;
Sub-network densities:

\[
\begin{pmatrix}
IC_{nonL} & ICL & B & F \\
0.05 & 0.20 & 0.05 & 0.09 \\
0.62 & 0.22 & & \\
0.03 & 0.07 & & \\
& & 0.18 & \\
\end{pmatrix}
\]

- Some institution types are more similar than others. Both unit-linked and non-unit linked insurance company debt holdings are very similar to debt holdings of other insurance companies, banks and investment funds. Unit-linked insurance company equity holdings are similar to those of other institution types.
Liquidity and fire sale vulnerabilities

Simple assumptions (Cont and Wagalath (2013), Cont and Schaanning (2016)):
- ‘proportional sales’
- linear price impact

$\Rightarrow$ second-round losses $\propto$ liquidity weighted portfolio network

**Stylised Portfolio**

<table>
<thead>
<tr>
<th>Asset class</th>
<th>IC (£bn)</th>
<th>B (£bn)</th>
<th>F (£bn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Government bonds</td>
<td>232.35</td>
<td>75.15</td>
<td>44.28</td>
</tr>
<tr>
<td>General governments</td>
<td>64.24</td>
<td>493.88</td>
<td>345.50</td>
</tr>
<tr>
<td>Corporate bonds</td>
<td>279.41</td>
<td>182.46</td>
<td>349.65</td>
</tr>
<tr>
<td>Other bonds</td>
<td>72.66</td>
<td>5.90</td>
<td>361.44</td>
</tr>
<tr>
<td>Equity</td>
<td>360.53</td>
<td>15.09</td>
<td>925.28</td>
</tr>
<tr>
<td>Illiquid assets</td>
<td>779.08</td>
<td>2838.4</td>
<td>199.7</td>
</tr>
<tr>
<td>Cash</td>
<td>61.19</td>
<td>391.12</td>
<td>249.54</td>
</tr>
</tbody>
</table>
Liquidity and fire sale vulnerabilities

**Centrality measures**

average by institution type

<table>
<thead>
<tr>
<th></th>
<th>IC nonL</th>
<th>IC L</th>
<th>B</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overlap (£mn)</td>
<td>0.31</td>
<td>0.29</td>
<td>0.81</td>
<td>0.24</td>
</tr>
<tr>
<td>Holdings (£bn)</td>
<td>18.65</td>
<td>43.98</td>
<td>171.95</td>
<td>12.89</td>
</tr>
<tr>
<td>Eigenvector</td>
<td>0.05</td>
<td>0.04</td>
<td>0.15</td>
<td>0.04</td>
</tr>
</tbody>
</table>

- Banks are the ‘most central’ institutions on average in the liquidity weighted portfolio network.
- Comparison of two indicators of fire sales vulnerabilities: average cosine similarity of Getmansky et al. (2016) and eigenvector centrality of Cont and Schaanning (2016).
- The two measures are complementary: average cosine similarity can be big for institutions with low eigenvector centrality, while eigenvector centrality assign relevance to big institutions.
Key findings

Summary:

- Most financial institutions are far from complete diversification, only investment funds appear to be fully diversified in their equity holdings.

- There are large overlaps (communities) in debt and equity security holdings. Vulnerabilities might arise if overlapping securities were to be sold at discounted prices.

- Some institution types are more similar than others. Non-unit linked insurers have debt holdings more similar to all other institution types; unit-linked insurers have equity holdings more similar to all other institution types.

- When considering liquidity of assets and under simple assumptions in a fire sale framework, banks appear to be the most important (‘central’) on average.

- Both portfolio similarity and liquidity weighted portfolio overlap can be useful tools for understanding vulnerabilities due to fire sales.
References


Approach

- **Network of asset holdings**, in which one financial institution is ‘linked’ to a security if it holds it directly.

- **Network of portfolio similarity**, in which one financial institution is ‘linked’ to another financial institution if their securities portfolios are similar (in a well-defined way).

Both networks have two layers describing respectively debt and equity holdings.
Methodology

- **Degree**: number of links attached to a given vertex.
- **Density**: number of existing links with respect to the number of all possible links.
- **Eigenvector centrality**: measure of the extent to which a vertex is connected to important vertices.
- **Communities**: clusters of vertices densely connected internally.
- **Herfindhal-Hirschman index (HHI)**: index of diversification of the portfolio of securities held by each financial institution, equal to 1 in absence of diversification and to $1 / \text{degree}$ in case of full diversification

\[
HHI_i = \sum_{k=1}^{K} \left( \frac{H_{ik}}{V_i} \right)^2.
\]

where $H_{ik}$ represents holdings of security $k$ by $i$ and $V_i$ is total holdings of $i$. 
Pre-processing for asset holdings and portfolio similarity

Pre-processing I – Granular asset holdings

CRDIV COREP data (Individual holding level) Unconsolidated entities

Solvency II Assets table (Individual holding level) Solo entities

Morningstar Mutual Funds data (Individual holding level)

LEI Database

Direct matching against LEI database

Distillation of counterparty names and LEI names

Matching of distilled names

Filtering and anonymisation of cleansed data

Cross-referencing of common fields

Matrix product with transpose

1. Bi-layer network of common asset holdings

Entity and Asset counterparty matrix

2a. Portfolio similarity network by number of common asset holdings (unweighted)

2b. Cosine similarity (weighted) monopartite network
Pre-processing for liquidity weighted network

Pre-processing II – Liquidity weighted portfolio similarity

- CRD/IV FINREP data (IFRS basis) Consolidated
- Solvency II Assets table (Summarised by asset class) Group entities
- Morningstar Mutual Funds data (Individual holding level)

Mapping of asset classes across datasets → Apply amount / data quality based thresholds → Apply liquidity weighting based on asset class → Liquidity weighted matrix of portfolio similarity (Monopartite) → Anonymisation of data
Heatmap of portfolio similarity for the debt and equity holdings.
Financial institutions are grouped by communities.

Centrality measures
average by institution type

<table>
<thead>
<tr>
<th></th>
<th>Debt</th>
<th>Equity</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>ICnonL</td>
<td>ICL</td>
</tr>
<tr>
<td>Cosine Similarity</td>
<td>0.07</td>
<td>0.05</td>
</tr>
<tr>
<td>Holdings (£bn)</td>
<td>2.76</td>
<td>4.74</td>
</tr>
</tbody>
</table>