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How to measure interconnectedness between banks, insurers and financial conglomerates?

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Interconnectedness of financial institutions is a key component of systemic risk. Monitoring interconnectedness is therefore on all supervisors' agenda. However, there is still no consensus on the best way to assess it. Using a unique dataset on the exposure network of French financial institutions, we implement various measurement strategies and show that they capture different dimensions of interconnectedness. Our results suggest that some characteristics of the interconnectedness can only be assessed using contagion stress test models.

The latest financial crisis, with the defaults of AIG, Lehman Brothers and Bear Stearns, has highlighted the risk of contagion through financial institutions' interconnections. Interconnectedness has thus become a major concern for supervisory authorities. In particular, the Financial Stability Board uses three criteria –size, substitutability and interconnectedness– to identify Systematically Important Financial Institutions (SIFIs). Qualifying a financial institution as SIFI may lead to requirements in terms of "higher loss absorption" (HLA), i.e. to an increase in minimum capital. The challenge is to define indicators of interconnectedness, or summary statistics of the degree of interconnection, that are linked to contagion risk.

We examine a unique dataset of exposures between 21 French financial institutions of which six financial conglomerates,[1] four pure banks and eleven pure insurers, representing at least 85% of the French financial sector. The dataset includes all the cross-exposures between these institutions, as well as balance sheet information.[2] To the best of our knowledge, it is the first comprehensive dataset of balance sheet exposures including banks and insurance companies. Previous studies were mostly based on banking networks or on a correlation of asset returns (Craig and Von Peter, 2014, Billio *et al.*, 2012, Alves *et al.*, 2013). We collected all balance sheet exposures at 31 December 2011, distinguishing between debt instruments (debt securities, loans, subordinated debt, etc.) and equity instruments (shares, capital investment, etc.). This is a unique snapshot of the French financial sector.

We should bear in mind that interconnectedness is a manifold concept, there are several views of what interconnectedness is, or should be. We do not advocate that there is only one true perspective. We compare several empirical strategies of measurement and discuss how informative they are with respect to contagion risk.

1 *We adopt a definition that may differ from the one sometimes found in the economic literature -where a conglomerate often equates a universal bank- by considering here groups that are active in the banking and in the insurance sector.*

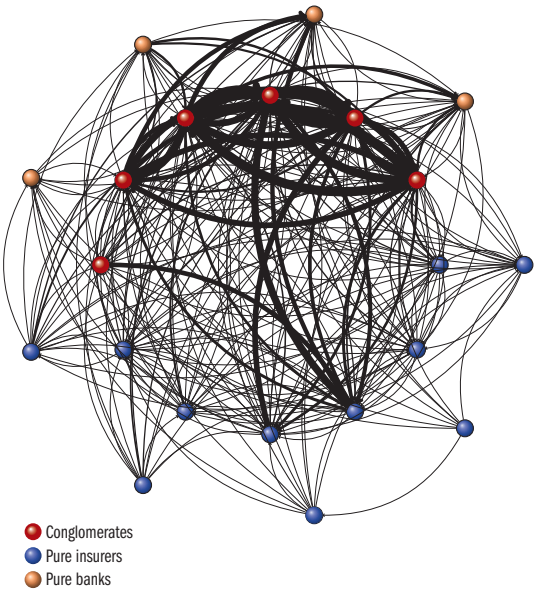
2 *Balance sheet information is also a way to assess exposures to institutions that are outside the network under study (foreign financial institutions, sovereigns, etc.).*

What does the French financial network look like?

Cross-exposures between these 21 institutions amount to EUR 227 billion, 90% of which are composed of debt instruments. The exposure distribution is not uniform. Most of the exposures are small but large exposures are not uncommon. The average bilateral exposure is thus EUR 0.5 billion but the standard deviation is about EUR 1.2 billion. Moreover, institutions are not similar in the network. Financial conglomerates, which are the largest French financial institutions, report the largest exposures. The average exposure between two financial conglomerates is EUR 3 billion, which is more than twice the overall average exposure. In contrast, pure insurers report smaller exposures (with an average of EUR 0.3 billion). Besides, there are few exposures to pure insurers, and almost none between pure insurers. This feature is in line with the traditional functioning of the market. We do not expect insurers to generate any exposures since their liability is mostly composed of commitments to their policyholders. Usual banking activity involves finding funding on the liability side which is to be a potential exposure for other financial institutions, such as insurers.

Chart 1 shows the exposures between the 21 French financial institutions. Nodes represent institutions while links are exposures. The substantial role of conglomerates (red nodes) is clear since most of the largest links are shaped between them. Pure insurers (blue nodes) display numerous but small links suggesting a diversified profile of exposures. Pure banks are depicted in yellow nodes.

C1 Network of exposures between French financial institutions



Source: Hauton and Héam (2014).

Most exposures are small in absolute and relative terms

The first, and maybe simplest, way to measure the interconnectedness of a financial institution is to consider its inter-financial assets and liabilities. One drawback of this approach is combining interconnectedness and size in the same number chart. For example, when one of the largest financial institution grants a EUR 1 billion loan to a counterpart, it faces less risk than a small institution granting the same EUR 1 billion loan. Similarly, risk depends on the size of the borrower. A EUR 1 billion loan does not represent the same risk exposure when it is received by a small or by a large bank.

It is also useful to refer to *credit risk* on the asset side and *funding risk* on the liability side of a given institution. All in all, we consider that credit risk incurred by the lender (or owner of a security) depends on the size of the lender. Therefore, we standardise all exposures by the size of the lender to analyse the credit risk associated with the exposures. These scaled exposures are simply termed credit risk exposures.

In the same fashion, we control for the size of the borrower in order to assess the funding risk associated with the exposures. Funding risk is associated with difficulties in renewing the source of funding in case of stress. The funding risk exposure of institution A to institution B is the amount lent by B to A divided by the equity of A.

We thus have two additional sets of exposures: credit risk exposures, capturing risk on the asset side; funding risk exposures on the liability side. To avoid any confusion, the exposures in amounts (i.e. before rescaling) are termed volume exposures. The first step is to examine these scaled exposures using descriptive statistics. Like volume exposures, we note that most credit risk exposures and funding risk exposures are small even though significant levels are not rare. Half of exposures represent less than 1.3% of the equity of the lender, but on average a bilateral exposure accounts for 3.5% of the equity of the lender. Overall credit risk is therefore small since most exposures represent a small share of total equity. The riskiest exposures, in terms of credit risk, are scarce and can be closely monitored. We find similar features as regards funding risk. Only a quarter of bilateral exposures are larger than 2% of the equity borrower's.

These measures are easy to compute, are not polluted by size effects and distinguish between two sources of risk. However, one can argue that these measures consider the institution individually without taking into account the whole structure.

Taking account of size yields a structurally different network

In order to assess interconnectedness, another strategy may be not to measure –i.e. provide an index number to– each institution but to compare them. In that sense, we consider that two institutions are close in terms of size when they exhibit similar outstanding exposures (regardless of the counterpart). It is possible to formalise this concept with statistical tools to obtain a measure of the distance between any two institutions according to this aspect of interconnectedness. Note that this approach describes the similarity of financial institutions without providing a clear guidance on how to interpret the statistical results. Then, there are statistical methods, in particular hierarchical clustering, that transform this information on distance into groups of institutions. Two institutions from the same group are very close whereas two institutions from two separate groups are very different. Since we have three sets of exposures (volume exposures, credit risk exposures and funding risk exposures), we look at groups of institutions with similar volume exposures, similar credit risk exposures or similar funding risk exposures. One should compare the different groups to analyse overlapping as well as separation.

We show that, in terms of volume, conglomerates, which are the biggest players, are a distinct group, whereas it is hard to distinguish pure banks from pure insurers. At first glance, conglomerates have a much more specific role in the network than other financial institutions. However, results are different when the size is controlled for. In particular, analysing the similarity of funding sources provides a different picture. Conglomerates are not all similar from this perspective. Moreover, distinguishing between banks and insurers becomes possible. A consequence of this gap is that the structure in terms of volume (exposures in EUR billions) can differ from the structure in terms of risk. Since the similarity of institutions is different whether one looks at volumes or risks, a good measure of interconnectedness in terms of volume may be a poor proxy for contagion risk. When measuring interconnectedness one should therefore keep in mind its objective.

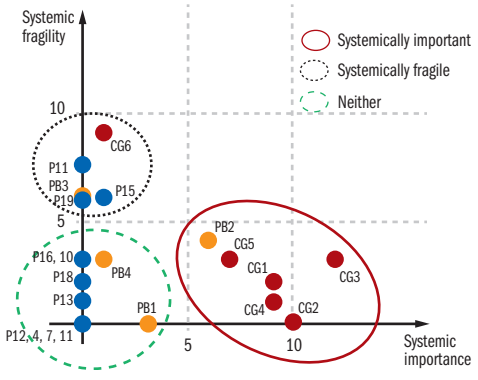
Directly measuring contagion risk through stress tests

As already mentioned, interconnectedness is considered as a characteristic of systemic institutions for contagion risk. Supervisors and academics have developed contagion models over the last decade. We use the model put forward by Gouriéroux *et al*. (2012) to analyse contagion risk. Following Alves *et al*. (2013), we derive two metrics of interconnectedness: *systemic importance* and *systemic fragility*. Systemic importance measures the impact of one institution on the other. It gauges the degree of contagion risk generated by the financial institution (the direction of stress is "firm-to-system"). Systemic fragility is the sensitivity of one institution to the default of other institutions. It assesses the exposure of a financial institution to contagion risk (the direction of stress is "system-to-firm"). There is no obvious automatic link between the systemic importance and the systemic fragility of an institution.

To measure the systemic importance of a financial institution, we assume its default and count the number of financial institutions suffering a loss above 10% of their equity. To measure the systemic fragility of a given financial institution *i*, we count the number of other financial institutions *j*, the default of which would generate a loss above 10% of the equity of institution *i*.

In Chart 2, each point represents a financial institution positioned according to its systemic importance (x-axis) and its systemic fragility (y-axis). Three groups are visually identified: financial institutions that are only systemically important (red unbroken circle), financial institutions that are only systemically fragile (black dashed circle) and

C2 Systemic importance and systemic fragility of French financial institutions



Source: Hauton and Héam (2014).

financial institutions that are neither systematically fragile nor important (green dotted circle). No institution is both systematically important and fragile. It suggests that a long chain of contagion –the so-called "domino effect"– is unlikely. One policy implication could be to provide additional incentives for fragile banks to further diversify their exposures to rely less on systematically important institutions.

Interconnectedness measures are partially linked to contagion risk

Measuring contagion risk through stress test exercises is often more costly in terms of operational resources than using a measurement of interconnectedness based on statistical tools (such as descriptive statistics or the closeness analysis previously presented). It is therefore tempting to assess the correlation between the results of the various methods in order to predict the results of contagion risk. Such a strategy needs a clear assessment of the "predictive power" of the statistical measures.

To do so, we compare the results based on descriptive and statistical methods for the three identified groups according to systemic importance and systemic fragility. Statistical theory helps us to formalise the match between groups. We find that systemic importance can be linked to statistical measures of interconnectedness. However, we fail to uncover any clear association between these statistical measures and systemic fragility. Consequently, running contagion models on a regular basis is a key tool for assessing contagion risk and measuring interconnectedness from a supervisory perspective.

The right tool for the right job

To conclude, our research implements several strategies to measure interconnectedness (see the background paper for more details). We do not advocate using one single tool. However, we argue that the measure(s) should be in line with the policy maker's objectives. The analysis of credit risk and funding risk, based on the standardisation of the exposure matrix by the size of the lender or the borrower, can be used for regular monitoring. Automatic classification techniques are useful to perform cross-market or cross-institution comparisons to spot potential uncommon financial institutions. Stress testing methods appear to be the most appropriate tools for assessing contagion risk in a comprehensive and accurate way, even if other techniques for measuring interconnectedness provide interesting insights.

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