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Interconnectedness: mapping the shadow banking system*

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Abstract

Systemic risk is the risk of collapse of the financial system resulting from inter-linkages, such that the failure of individual entities or the collapse of an individual market can cause a cascading failure. The essence of systemic risk is interconnectedness. Theory gives some guidance: if negative shocks are small, a more densely connected financial network spreads risk and enhances financial stability. But beyond a certain point, dense interconnections support transmission and propagation of shocks, hence a more fragile financial system. Direct interconnectedness may arise from counterparty relationships and exposures, whether on the asset or the liability side. Indirect interconnectedness may arise when entities have common exposures, so that if one is forced into fire sales, the fall in asset prices affects the balance sheets of others. Indirect interconnectedness is also a feature of collateral chains, in which entities that have no direct relationship are nevertheless linked because one holds collateral originating from the other. Reputational risk can also connect an entity whose reputation suffers a blow (e.g. suspicion of illegal activity) to others believed to share similar characteristics, though they have no direct institutional or transactional relationship. In many such cases, there may be a danger of contagion. Particular concerns arise in derivatives markets, securities financing transactions (SFTs), wholesale funding markets, leveraged open-ended funds doing significant maturity or liquidity transformation, and central counterparties. In all these cases, the first step must be to get data that document the interconnectedness. This amounts to “mapping” the shadow banking system, i.e. documenting and analysing interconnectedness. That is essential to advance our understanding not only of shadow banking, but also of the overall environment within which Capital Markets Union (CMU) is to progress.

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This paper will discuss interconnectedness among financial institutions (entities) and across financial markets, with particular attention to the shadow banking system. Even the term “system” here suggests a range of interconnections and interdependencies, which are deep and complex. Our data on these entities and activities are still very limited and are often accumulating unprocessed, despite major initiatives to throw light on the shadows. I shall focus primarily on the European Union (EU), where the latest collection and analysis of the data are in the *EU Shadow Banking Monitor* (European Systemic Risk Board – ESRB, 2017). Some of the issues are closely related to the EU drive for Capital Markets Union (CMU) launched with an action plan in 2015 (European Commission, 2015).

CMU may be broadly understood as non-bank financial integration. Both price and quantity composite indicators of the degree of financial integration in Europe, starting from 1995, show considerable rises to a peak in 2006, then disintegration accentuated by the crisis to a trough in 2012 (European Central Bank – ECB, 2017). Integration has since resumed, but the indices are still not back to their 2006 levels. Roughly the same is true for individual subindices for bond and equity markets, except that both show troughs also in 2003. The analysis here, however, will exclude bond and equity markets, with the main attention to shadow banking and derivatives markets. Also, we shall not be concerned with individual entities – from a policy viewpoint, we are concerned with macroprudential rather than microprudential oversight.

We need definitions to proceed. Unfortunately, they are not precise. CMU is the move towards deeper and more integrated capital markets to complement bank financing – a true single market for market-based finance in Europe, with no barriers at national borders. Shadow banking has been defined as “market-based (or non-bank) financial intermediation”, but this is much too broad, because taken literally it does include

bond and equity markets. The Financial Stability Board (FSB, 2017) regards shadow banking as “credit intermediation involving entities and activities (fully or partly) outside of the regular banking system”. Again, this seems very inclusive. The European Systemic Risk Board (ESRB) is considerably less so (while using the term “broad”): “The broad measure of shadow banking in the EU, comprising total assets of investment funds, including money market funds (MMFs) and other financial institutions, amounted to EUR 40 trillion at the end of the third quarter of 2016. This measure includes all entities of the financial sector except banks, insurance corporations and pension funds.” Here markets are clearly not entities, if only because they do not have assets as included in the “broad measure”. On the other hand, the exclusion of insurance corporations and pension funds may be difficult to justify, whether analytically or for policy purposes.

In contrast to the slowdown in shadow banking in the United States, the rapid growth of the sector resumed in Europe after 2007-09. The demand for its services has come mainly from institutions and corporates seeking “safe” but non-zero yields. The huge growth in managed assets has led to a major expansion of the amounts channelled into shadow banking. On the supply side, much of the activity comes from regulatory arbitrage: developing organisational forms and transaction strategies that avoid regulation. This often involves substitution of shadow banking for “traditional” banks. It poses problems because it is not formally supported by safety nets yet may require bailouts. This creates moral hazard and a form of implicit subsidy.

Section 1 considers interconnectedness and systemic risk. Section 2 specifies the costs and benefits of interconnectedness. One cost is contagion, explored in Section 3. Section 4 details the risks associated with interconnectedness. Section 5 concludes with a discussion of available and forthcoming data and their use.

11 Interconnectedness and systemic risk

Interconnectedness is ubiquitous in the financial system, and it is key to systemic risk. The system is endangered if stress in an individual entity or activity is transmitted widely through various forms of interconnection. This is often called contagion, and we shall consider it below. A fundamental issue in evaluating financial integration is the balance between its benefits – more efficient allocation of capital, risk sharing – and the potential dangers posed by interconnectedness. When we think in systemic terms of the build-up of financial stress and vulnerability, our concerns arise from interconnectedness. With systemic vulnerabilities, shocks may propagate across wholesale funding markets, derivatives markets, and securities financing transactions (SFT).

Systemic risk is the risk of potential collapse of financial system resulting from interlinkages such that the failure of individual entities or collapse of a market can cause a cascading failure. Individual shadow banking entities may not seem large relative to major banks (still, recall American International Group's [AIG's] credit default swap [CDS] market presence before the crisis or consider BlackRock's balance sheet now). But tremors in the money market fund (MMF) sector, for example, can easily be transmitted.

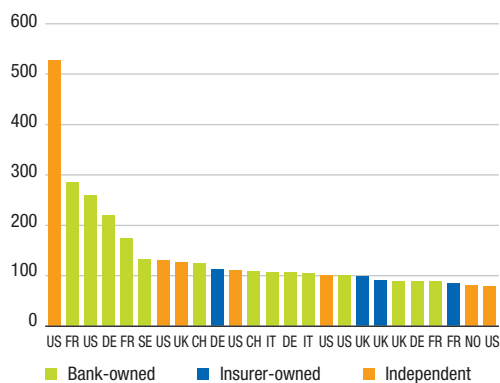
A recent theoretical analysis (Acemoglu et al., 2015) finds that if negative shocks are small, a more densely connected financial network spreads risk and enhances financial stability. But beyond a certain size of shock, dense interconnections support transmission and propagation of shocks, hence a more fragile financial system. This seems to contrast with the early paper of Allen and Gale (2000), which finds that a network in which all nodes are connected to all others – a “complete” network – will be more stable than an incomplete network. But the complete network is an extreme case, and the earlier paper does not distinguish the size of the shock, which is key to the later results. Gai and Kapadia (2010) obtain results similar to Acemoglu et al.

So dense interconnectedness may be a source of systemic risk if the shocks are large enough. What is “large enough”? Ex post, the failure of Lehman qualifies. But the “taper tantrum” and “flash crashes” of recent years were not, nor even the crisis in Cyprus. On the other hand, the discovery of a huge fiscal hole in Greece seemed to threaten the entire euro area financial system, to the point where the authorities were convinced of the need for a massive bailout. Suppose there had been at that time a true CMU, at least in the eurozone. Might the risks have been distributed sufficiently widely, or at least less towards banks and more towards non-bank finance, so that the expected impact of a Greek default would have been considerably less threatening? Or would asset managers holding Greek debt have been hit so hard that their European bank parents would have been imperilled? These questions suggest how important it is to have the data needed to map the European shadow banking system and its interconnections with the banks.

We must distinguish between direct and indirect interconnectedness. The former refers to direct counterparty relationships and the consequent exposures on balance sheets. The latter may include relationships induced for entities with common exposures, when an action by entity A (e.g. “fire sale”) will affect the mark-to-market value of the assets of B; collateral chains, in which collateral offered by A to B may through a further transaction by B with C put this collateral on C's balance sheet, so we now have an indirect connection between A and C, in which A is exposed to the risk that C may not be able to deliver the collateral to B; reputational risk, when an action by A may harm the reputation of B, which is linked to it not as a counterparty, but only by having some perceived common characteristics or ownership link; and step-in risk, if A were to have to support B, to which it has perceived ties beyond contractual obligations to B that could induce reputational damage to A if B were to fail.

C1 Aggregate net assets of the top 25 asset management companies in the European Union

(Q4 2016; total net assets in EUR billions)

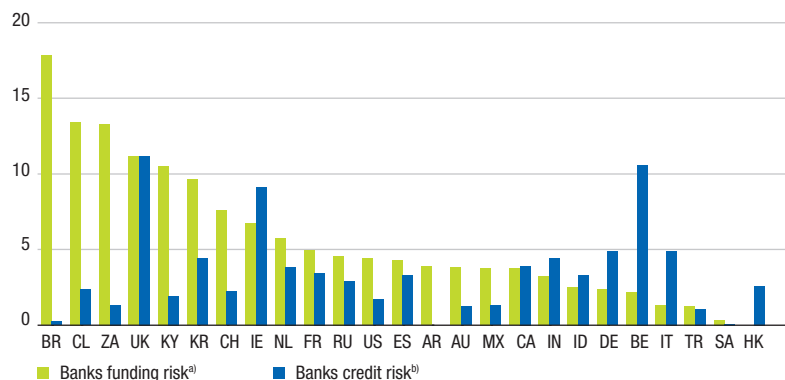


Source: European Systemic Risk Board – ESRB, *EU Shadow Banking Monitor 2017*, p. 43.
 Primary sources: Thomson Reuters Lipper and European Central Bank calculations.
 Notes: Asset managers are classified as held by banks/insurers when the asset manager is a subsidiary of the bank/insurer (this excludes cases where bank/insurance activities are a subordinate business of the group or where the holding company also holds banks/insurers) or has a bank/insurer as a majority shareholder. The horizontal axis shows the domicile of the asset manager.
 See list of countries below.

A particular form of direct interconnectedness is ownership, and this may be a link between banks and asset managers in the shadow banking system. In Europe, banks and insurers have significant ownership stakes in asset managers that are important in the shadow banking system (see Chart 1). FSB (2017, Section 3) has an extensive survey of interconnectedness between banks and other financial institutions, mainly asset managers and funds. In the context of CMU, the country aggregate data in Chart 2 are of particular interest. They show that of EU countries, the United Kingdom (UK) and Ireland have the highest links between banks and other financial institutions (OFIs)¹ on assets and liabilities; Belgium shows especially high claims of banks on OFIs as a share of the banking sector’s assets. Chart 3 shows that six of the top 25 asset managers (by assets in eurozone) are domiciled outside the eurozone – indeed, two of the five largest. But we see no proposals of CMU with the United States.

C2 Banks’ interconnectedness to other financial institutions (OFIs)

(end-2015, % of bank assets)



Source: Financial Stability Board, *Global Shadow Banking Monitoring – Report 2016*, p. 33.
 a) Banks’ liabilities to OFIs as a share of bank assets.
 b) Banks’ claims on OFIs as a share of bank assets.
 Note: See list of countries below.

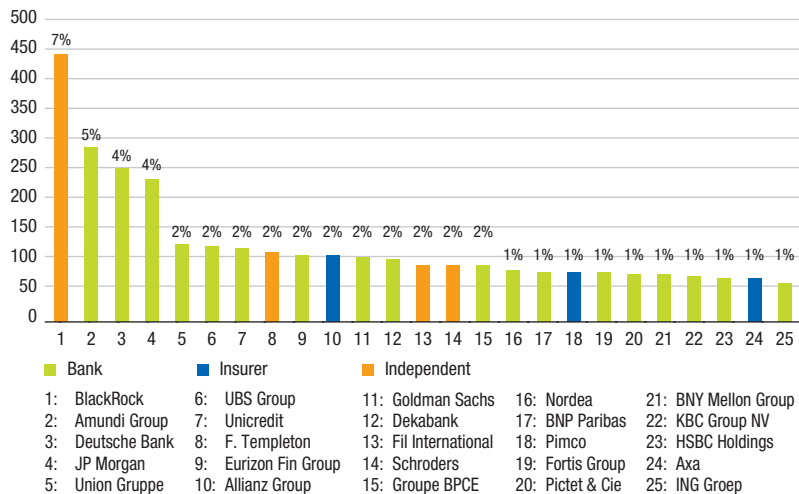
¹ Other financial institutions (OFIs) here include all non-bank financial intermediation except pension funds and insurers: so trust companies, money market funds, hedge funds, equity funds, bond funds, and mixed funds.

List of countries (Charts 1 and 2; Table 1)

| | | | | | |
|---------------|-----------------|---------------|--------------------|------------------|--------------------|
| AR: Argentina | CH: Switzerland | HK: Hong Kong | JE: Jersey | MX: Mexico | SE: Sweden |
| AU: Australia | CL: Chile | ID: Indonesia | JP: Japan | NL: Netherlands | TR: Turkey |
| BE: Belgium | DE: Germany | IE: Ireland | KR: Korea | NO: Norway | UK: United Kingdom |
| BR: Brazil | ES: Spain | IN: India | KY: Cayman Islands | RU: Russia | US: United States |
| CA: Canada | FR: France | IT: Italy | LU: Luxembourg | SA: Saudi Arabia | ZA: South Africa |

C3 Top 25 asset management companies, ownership by sector

(Q3 2015; total net assets in EUR billions; share in the Lipper IM sample in %)



Source: Thomson Reuters Lipper for Investment Management (Lipper IM); European Central Bank calculations.

Notes: Asset managers are classified as held by banks/insurers when the asset manager is a subsidiary of the bank/insurer (this excludes cases where bank/insurance activities are a subordinate business of the group or where the holding company also holds banks/insurers) or have a bank/insurer as a majority shareholder.

T1 Distribution of European Union institutions' exposures to shadow banking entities by country of domicile and type of shadow banking entity

(weighted by size of exposure)

| Country/type of "shadow banking entity" | UCITS MMFs | Non-UCITS MMFs | Non-MMF investment funds | Finance companies | Broker-dealers | Credit insurers/financial guarantors | Securitisation | Non-equivalent bank/insurers | Other | Total |
|---|------------|----------------|--------------------------|-------------------|----------------|--------------------------------------|----------------|------------------------------|-------------|--------------|
| DE | 0.0 | 0.0 | 3.7 | 1.0 | 0.0 | 0.0 | 1.2 | 0.0 | 0.4 | 6.3 |
| ES | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.1 | 0.3 | 0.0 | 0.1 | 0.7 |
| FR | 0.7 | 0.0 | 0.5 | 0.6 | 0.0 | 0.0 | 2.2 | 0.0 | 0.4 | 4.5 |
| GB | 0.0 | 0.4 | 2.5 | 2.0 | 0.4 | 0.5 | 2.2 | 0.0 | 2.4 | 10.5 |
| HK | 0.1 | 0.0 | 0.5 | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 | 0.1 | 1.3 |
| IE | 0.0 | 0.0 | 0.8 | 0.7 | 0.0 | 0.0 | 4.5 | 0.0 | 0.3 | 6.3 |
| JE | 0.0 | 0.0 | 0.2 | 0.1 | 0.0 | 0.0 | 2.7 | 0.0 | 0.0 | 3.0 |
| JP | 0.0 | 0.0 | 0.2 | 0.1 | 0.6 | 0.0 | 0.0 | 0.4 | 0.2 | 1.5 |
| KR | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 1.9 | 0.5 | 2.6 |
| KY | 0.0 | 0.0 | 3.4 | 0.7 | 0.0 | 0.0 | 1.8 | 0.1 | 0.5 | 6.5 |
| LU | 0.3 | 0.0 | 2.3 | 0.7 | 0.2 | 0.0 | 1.2 | 0.0 | 0.4 | 5.2 |
| NL | 0.0 | 0.0 | 0.2 | 0.6 | 0.0 | 0.0 | 1.5 | 0.0 | 0.1 | 2.5 |
| RU | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 1.7 | 0.1 | 1.9 |
| TR | 0.0 | 0.0 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 3.0 | 0.0 | 3.5 |
| US | 0.7 | 0.2 | 4.0 | 8.2 | 0.3 | 0.3 | 7.1 | 1.6 | 4.7 | 27.1 |
| EU other ^{a)} | 0.1 | 0.0 | 2.0 | 1.4 | 0.0 | 0.0 | 0.4 | 0.1 | 0.3 | 4.4 |
| RW other ^{b)} | 0.0 | 0.1 | 1.9 | 1.2 | 0.6 | 0.6 | 0.8 | 4.4 | 2.5 | 12.1 |
| Total | 2.0 | 0.9 | 22.3 | 18.2 | 2.8 | 1.4 | 26.2 | 13.3 | 13.0 | 100.0 |

Source: Abad et al. "Mapping the interconnectedness between EU banks and shadow banking entities", *ESRB Working Paper Series*, No. 40, March 2017.

a) Other European Union countries.

b) Rest of the world.

Note: See list of countries on the previous page. GB : Great Britain.

More seriously, there are issues regarding the regulatory perimeter. Those issues arise in acute form in Table 1, where we see that around 60% of the total exposure of euro area banks to shadow banks is with entities outside the EU.

There are many reasons for concern about the vulnerabilities of shadow banks and their interconnections among themselves and with the banks. Intermediation has gone from regulated banks to shadow banks without prudential regulation, deposit insurance, or lender of last resort (LOLR). Using volatile short-term funding (wholesale market) to finance long-maturity assets entails liquidity mismatch and maturity mismatch. Financial innovation (some generated to avoid regulation) may create opaque securities, often held in banks' off-balance-sheet vehicles. So a negative shock will come in a context where there are incentives for lenders to "run", hence borrowers may face rollover risk. Asset managers like BlackRock and Vanguard hold huge positions in a wide range of assets that are also held by other entities. If redemptions were to force them to liquidate some of these positions, the market impact could be substantial, with effects on other holders of the assets. And then we have the substantial exposures of banks to shadow banks explored by Abad et al (2017). For completeness at this stage, we should also note the particular vulnerabilities discussed in the *EU Shadow Banking Monitor 2017*: derivatives markets and synthetic leverage, securities financing transactions (SFTs), wholesale funding markets, leveraged open-ended funds doing significant maturity or liquidity transformation, and central counterparties (CCPs). There are specific reasons – in terms of liquidity transformation, maturity transformation, and leverage – for concern regarding these areas of the shadow banking system.

Finally, we note that interconnectedness (financial integration) gives rise to the "financial trilemma" discussed by Cecchetti and Schoenholtz (2017) and Berner (2017), following Schoenmaker (2011). They posit the inconsistency of three major

objectives: financial integration, financial stability, and national rather than supranational financial regulation. If we believe interconnectedness is not easily reversible, except as the consequence of a major crisis, and may indeed be desirable, then the argument suggests that we must choose supranational financial regulation if we wish to minimise financial instability. Many steps have been taken in this direction since the crisis, both through the FSB and the EU authorities, including for the latter the creation of several new supranational institutions.² But the national regulatory bodies are still very much there, and in most cases the European authorities can issue only recommendations to them, rather than binding regulations. So there is considerable "ring-fencing" and national policymaking that sometimes even stretches the limits of legality (EU regulations). The national authorities often put barriers in the way of cross-border financial flows and institutional integration – i.e. they directly limit interconnectedness. This is one source of the financial disintegration we saw after 2006 and the slow recovery of financial integration.

21 Costs and benefits of interconnectedness

Financial integration eases the process of financial intermediation, moving funds from savers to investors. It also promotes portfolio diversification, the erosion of home bias, and hence risk sharing across asset holders and across borders. The deeper markets and more extensive network of financial institutions should favour investment and economic growth. But as we have noted, an environment with wider and deeper interconnections in the financial system can be more sensitive to large shocks that might then threaten financial stability. Interconnections can heighten systemic risk.

Cross-border capital flows, facilitated by such interconnections, have long been recognised as a particular source of systemic risk. "Capital flow bonanzas" can lead to excessive domestic credit

² European Systemic Risk Board (ESRB), European Stability Mechanism (ESM), European Banking Authority (EBA), European Securities Markets Authority (ESMA), European Insurance and Occupational Pensions Authority (EIOPA), Single Supervisory Mechanism (SSM), Single Resolution Board (SRB).

growth, which the home financial system may be unable to intermediate well. The inflows then go into unproductive uses that do not create the export capacities needed to finance repayment; more important for our purposes, they may feed the accumulation of vulnerabilities in domestic financial markets that create systemic instability, and a sudden reversal of the inflows can itself lead to a crisis. Moreover, if the capital inflows go into the non-traded sectors, that will lead to an appreciation of the real exchange rate (relative price of traded and non-traded goods); real exchange rate appreciation is the single most reliable forward-looking indicator of financial crisis. And they are likely to contribute to asset price inflation, perhaps even bubbles. A common example is foreign investment in commercial real estate and housing.

Greater financial openness, integration, interconnectedness are likely to have contributed to the development of a global financial cycle, in which monetary impulses from financial centres (in particular, the United States) are transmitted to the rest of the world (Rey, 2016). This is doubtless related to the rising correlations of asset prices across financial markets. Together with the trend to passive investment (in index tracking funds and exchange-traded funds) and a fixation on short-term investment performance, this in turn creates a structural bias towards herd behaviour in asset management.

Evidently, interconnectedness is not responsible for all the ills of modern finance, nor even for all sources of systemic instability. But we must not ignore that financial integration comes with costs as well as benefits. And this is one reason for the wider acceptance post-crisis of the case for capital flow controls, as a potential macroprudential tool that could block some of the interconnections between domestic and foreign markets and the build-up of balance-sheet relationships between domestic and foreign entities. These can create special vulnerabilities if the domestic entities take on unhedged foreign currency liabilities.

Other macroprudential tools, such as limits on mortgage lending, seem to be less effective in financially more open economies and where financial systems are more sophisticated – i.e. where interconnections are deeper and more extensive (Cerutti et al., 2017). This empirical evidence on the effects of interconnectedness is directly relevant to structural vulnerabilities that might be created by CMU and efforts to mitigate such vulnerabilities.

31 Contagion

We must first distinguish between direct and indirect contagion, a distinction related to that between direct and indirect interconnectedness. Direct contagion occurs when following a negative shock, a counterparty to a transaction cannot or will not fulfil its commitments, so that there is a direct impact on the other counterparty. Indirect contagion can propagate through price effects or informational channels. Entities may be vulnerable to the same shocks, may have common exposures, may be perceived by markets to face related risks. If one must sell assets, others holding the same or related assets will experience a fall in their values that adversely affects their own balance sheets. Bad news about one firm may affect market perceptions of others and trigger hedging behaviour (Clerc et al., 2016). All these instances of both direct and indirect contagion operate through various forms of interconnections.

Informational contagion is of special interest in regard to asset managers. The higher the commonality of their portfolios, the greater the likelihood and extent of informational contagion, hence the greater the systemic impact of a shock perceived by one that becomes known to others (Allen et al., 2012). But there are also other systemic dangers posed by contagion that operates through bank ownership of asset managers, the extent of which we discussed above. Banks derive revenues from asset management fees and sales commissions; even if the entities in question may be off-balance sheet for the bank, it might undertake credit and

liquidity risk in respect of the asset manager that brings step-in risk; and market perceptions of problems in the asset management entity might bring reputational risk to the bank.

We note at this stage that conventional bank stress tests miss much if not all of these contagion effects, direct as well as indirect. But there is evidence that the second-round or feedback effects of a shock to an entity, operating through contagion, are considerably greater than those of the initial shock. In an agent-based model, Bookstaber et al. (2014) find that it is the “reaction to initial losses rather than the losses themselves that determine the extent of the crisis”. And because shadow banks are typically not individually as important systemically as large banks, their systemic importance derives from their interconnectedness and the contagion they can create.

4I Where are the risks?

Different risky shadow banking activities concentrate in different segments of the shadow banking sector (ESRB, 2017). We find liquidity transformation mainly in real estate funds and bond funds. Maturity transformation is particularly great in bond funds. Leverage is highest in real estate funds and hedge funds. And since asset managers have corporate bond funds and increasingly do direct lending to non-financial corporations, they undertake classic risks associated with credit intermediation.

There are more specific shadow banking risks, some of which are not yet well understood. One particularly opaque form of interconnectedness is the synthetic leverage created by use of derivatives. We now have the data to trace the interconnections, but the true extent of leverage created in this way is very hard to quantify in a form that gives comparability to conventional leverage. We do not even have a common definition of synthetic leverage at a global level. But ESRB (2017) clarifies it somewhat: “Synthetic leverage is a specific form of leverage which differs from financial leverage in

so far as it does not involve outright borrowings. Leverage can be created synthetically by generating unfunded exposures through derivative instruments which do not fully show up on the balance sheet, thus allowing a financial institution to control a larger amount of exposures with a smaller amount of invested capital.” The risks are the same as with conventional leverage created through borrowing.

Another growing risk in asset management, particularly important for real estate and bond funds, is the rising share of assets in “redeemable funds”, coupled with a trend decline in their liquid assets and portfolio shifts towards longer maturities (“search for yield”). Many now have redemption gates, but they have seldom been tested on a wide scale, and again interconnectedness might amplify the effects of doing so.

Perhaps the two most important examples of interconnections in the shadow banking sector are the repo markets and the central counterparty (CCP) set of entities. Much of the volume of activity in the repo markets is transactions between shadow banks and banks. Seizures in the repo markets are recognised to have been a key factor in the contagion observed after the failure of Lehman Brothers. The stated objective of CCPs is to reduce the likelihood of systemic risk arising from the failure of one counterparty and resulting chains of failure because of interconnectedness. But the size and complexity of the CCP sector and some of its individual entities, the inherent concentration risk, give cause for concern. Hence the authorities have rightly put considerable effort into designing rescue and resolution procedures for CCPs. Fortunately, they have not yet been tested.

Stress tests have not yet been applied in the shadow banking sector. We might think this a glaring omission on the part of the regulators, but the weaknesses of stress testing in the conventional banking sector suggest that it will be difficult.

Even the most sophisticated stress tests applied to banks do not take account of direct contagion

through exposures, nor of indirect contagion through deleveraging and fire-sale externalities. In the stress tests, the banks are passive, so the proxy for feedbacks is to increase the severity of the shocks (adverse scenario). This can be taken to the point of apparent absurdity. Cross-border effects are typically ignored – e.g. a bank in the jurisdiction of country A may have a major subsidiary in country B, but the stress test for this bank will focus on impact of change in macro conditions in country A. There is no attempt to incorporate the shadow banking system into bank stress tests, much less to stress test the shadow banks. In short, it is difficult to see how stress tests as currently carried out can be useful in assessing system-wide vulnerabilities.

5| Data

We have granular data on bank exposure to shadow banks (used in Abad et al., 2017). As yet, however, we do not have such data on the exposure of shadow banks to banks. Data that have been generated in response to the requirements of the Alternative Investment Funds Directive are in the hands of the national regulators, of which several have been dilatory in transferring them to the European Securities Markets Authority (ESMA). So there is as yet no such unified database which could be used by EU-level regulators or academic researchers. Impatience is justified, because these are granular data on the holdings of alternative investment funds, which will illuminate their interconnections with the rest of the financial system.

The role of academics here is important. These are “big data”. Manipulating them and bringing out

patterns, formulating appropriate models for empirical work and deriving results, all require the time and skills of experienced researchers. They may also be commercially sensitive, so it would not be possible to open them up to the private sector. But the possibilities have been illustrated by the success of collaborations between academics and staff from ECB and national authorities that have given rise to several papers recently published in the *ESRB Working Paper Series*. These use data generated by EMIR (European Market Infrastructure Regulation) reporting requirements. The data are collected by the ECB for every derivatives transaction effected within its jurisdiction. The research issues addressed include: “How is interest rate risk allocated within the banking sector and across other sectors?”; analysis of counterparty networks (interconnections!) in the centrally cleared interest rate derivatives markets in the EU; and measuring the systemic impact of a global adoption of multilateral portfolio compression in the EU over-the-counter (OTC) derivatives markets (interconnectedness, often explicitly in networks). These papers illustrate the tremendous potential payoffs offered by the availability of these data. The more recent Securities Financing Transactions Regulation will also generate data that can be used to understand the interconnections among banks and shadow banks in securities lending and repos.

This will enable us to map the shadow banking sector, i.e. to document and analyse interconnectedness. This work is essential to advance our understanding not only of shadow banking, but also of the overall environment within which CMU is to progress.

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