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Indirect contagion: the policy problem

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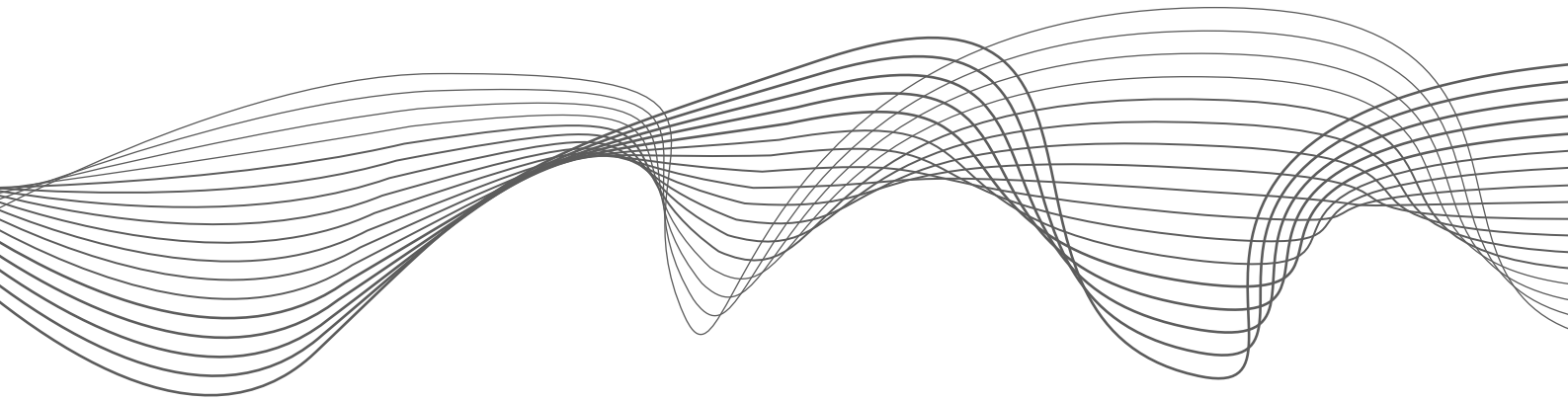

ESRB
European Systemic Risk Board
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Executive summary

An epidemiologist calculating the risk of a localised epidemic becoming a global pandemic would investigate every possible channel of contagion from the infected region to the rest of the world. Focusing on, say, the incidence of close human contact would underestimate the pandemic risk if the disease could also spread through the air. Likewise, calculating the quantity of financial system risk requires practitioners to understand all of the channels through which small and local shocks can become big and global.

Much of the empirical finance literature has focused only on “direct” contagion arising from firms’ contractual obligations. Direct contagion occurs if one firm’s default on its contractual obligations triggers distress (such as illiquidity or insolvency) at a counterparty firm. But contractual obligations are not the only means by which financial distress can spread, just as close human contact is not the only way that many infectious diseases are transmitted. Focusing only on direct contagion underestimates the risk of financial crisis given that other important channels exist.

This paper represents an attempt to move systemic risk analysis closer to the holism of epidemiology. In doing so, we begin by identifying the fundamental channels of indirect contagion, which manifest even in the absence of direct contractual links. The first is the *market price channel*, in which scarce funding liquidity and low market liquidity reinforce each other, generating a vicious spiral. The second is *information spillovers*, in which bad news can adversely affect a broad range of financial firms and markets.

Indirect contagion spreads market failure through these two channels. In the case of illiquidity spirals, firms do not internalise the negative externality of holding low levels of funding liquidity or of fire-selling assets into a thin market. Lack of information and information asymmetries can cause markets to unravel, even following a relatively small piece of bad news. In both cases, market players act in ways that are privately optimal but socially harmful.

The spreading of market failure by indirect contagion motivates policy intervention. Substantial progress has been made in legislating for policies that will improve systemic resilience to indirect contagion. But more tools might be needed to achieve a fully effective and efficient macroprudential policy framework. This paper aims to frame a high-level policy discussion on three policy tools that could be effective and efficient in ensuring systemic resilience to indirect contagion – namely macroprudential liquidity regulation; restrictions on margins and haircuts; and information disclosure.

Section 1
Indirect contagion: the theory[1]

Why did US sub-prime credit, which totalled $1tn in 2007, trigger global financial crisis – while the dot-com equity market crash, which destroyed $8tn of wealth in 2000, did not?

The scope for direct contagion, whereby counterparties fail to honour contractual obligations, was greater during the dot-com crash. The key ingredient in 2007 was indirect contagion, which occurs when firms' actions generate externalities that affect other firms through non-contractual channels.

Sub-prime losses triggered indirect contagion; the dot-com crash did not. Losses on sub-prime credit instruments over 2007-08 were primarily borne by highly leveraged financial intermediaries with substantial liquidity mismatch, as Bernanke (2012) highlights. Initial losses prompted these intermediaries to delever by selling assets – reducing their value and creating a fire sale externality. Uncertainty about the distribution of exposures drove a general risk retrenchment, causing short-term funding markets to evaporate. These channels were not triggered by the dot-com crash: losses were primarily borne by unlevered households with no liquidity mismatch and a low marginal propensity to consume.

The comparison of the dot-com crash with the sub-prime crisis illustrates a general insight, which is the motivation for this paper. The insight is that indirect contagion is the key ingredient through which small and local initial shocks become big, global and systemic. Microprudential regulation can help to mitigate indirect contagion by increasing the resilience of individual financial institutions. Macroprudential regulation should also be designed and calibrated with a view to mitigating the scope for indirect contagion to spread market failures.

Much of the empirical finance literature has focused only on "direct" contagion arising from firms' contractual obligations. Researchers' simulations using actual interbank loan data suggest that "domino defaults" arising from contractual violations are highly unlikely,[2] though they can be destructive in the event that they do materialise.[3] By contrast, models incorporating indirect channels of contagion are able to explain a distinct class of systemic crises that can occur even in the absence of contractual linkages.[4] Evidence suggests that losses owing to indirect contagion during systemic crises dwarf direct losses.[5] So it is not surprising that studies focusing only on direct contagion channels purport a much lower likelihood of distress than is suggested by a simple count of historical crises.

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1 This section was written by the authors, with substantial contributions from Silvia Gabrieli and Guillaume Vuillemey.

2 Representative papers in this literature are Furfine (2003) for the US; Elsinger *et al* (2006) for Austria; Upper and Worms (2004) for Germany; Mistrulli (2007) for Italy; Degryse and Nguyen (2007) for Belgium; and van Lelyveld and Liedorp (2006) for the Netherlands. Alves *et al* (2013) study contagion within a network of large EU banks, and is therefore one of the few cross-country analyses available. Upper (2011) surveys and critically assesses the direct contagion literature.

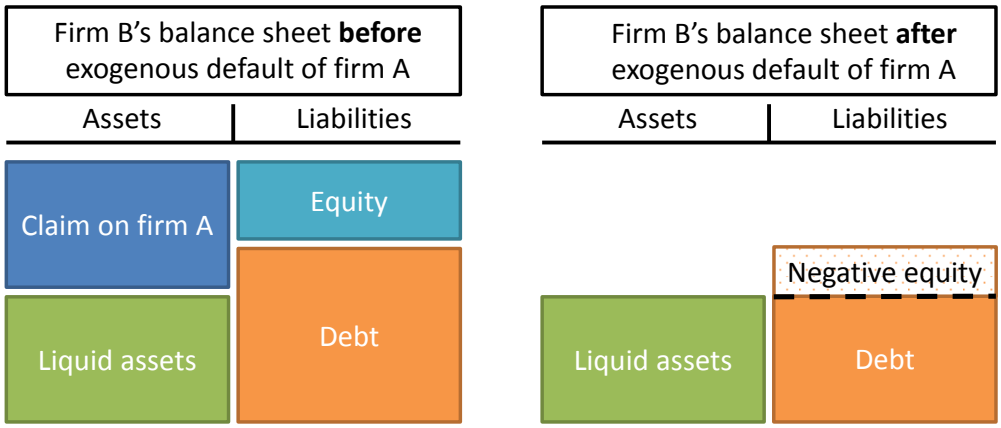
3 Gai and Kapadia (2010) elucidate this common feature of financial (and more generally complex) systems: that they tend to be generally robust, but fragile to targeted attacks on specific (systemically important) nodes.

4 Luck and Schempp (2015) develop a model in which an idiosyncratic run can lead to a systemic run by inducing an overall scarcity of liquid funds via the fire sale channel – even in the absence of direct contractual linkages. Anand, Gauthier and Souissi (2015) develop a model-based stress-testing framework that integrates fundamental solvency risk with funding liquidity risk and information asymmetries.

5 In an application of the Greenwood, Landier and Thesmar (2015) "vulnerable banks" framework to EBA stress test data, Lopez (2015) shows that the second-round effects owing to fire sale externalities tend to be greater in magnitude than an initial shock by a factor of approximately five.

Figure 1

Direct contagion channels: Firm A defaults on obligations to firm B



Source: ESRB. Note: this stylised illustration assumes a loss given default rate of 100%.

Direct financial contagion occurs when firms are connected by contractual obligations, and one or more counterparty no longer honours those obligations following a shock of some kind. Figure 1 provides a stylised illustration of such direct contagion, showing the impact of firm A's exogenous default on firm B's balance sheet.

By contrast, indirect financial contagion does not require any initial contract violation. Rather, indirect contagion occurs when firms' actions generate externalities which affect other firms through non-contractual channels. We distinguish two main families of such channels:

(a) *Market-price channels*: liquidation of balance sheets affects financial asset prices, affecting all actors exposed to such assets. Such liquidations may also give rise to liquidity problems, as the fall in value of collateral may trigger margin calls.

(b) *Information channels*: bad news, or rumours, may trigger hedging behaviour by direct and indirect counterparties to the distressed firm.

These indirect channels of contagion are the outcome of significant endogeneity. They often operate simultaneously, interacting with each other with potentially nonlinear effects. These indirect channels are likely to interact with the direct contagion channel, too, leading to systemic outcomes that are more severe than if only one contagion channel had been operational.

Part A: Market-price channels

Financial firms' fortunes are connected when they hold common or correlated assets. One firm's decision to sell can reduce the asset's market price. This price reduction would affect the market value of assets held by all firms that did not sell. Since liabilities are fixed, a reduction in a firm's market value of assets moves that firm closer to its point of default.[6]

This indirect channel of contagion is typically called a "fire sale externality".[7] The externality arises as one firm's decision to sell the commonly held or correlated asset affects the probability of another firm defaulting. The selling firm does not internalise this effect, and so the outcome is likely to be socially inefficient.

The effect of the fire sale externality is illustrated in Figure 2, which shows the mark-to-market balance sheets of two firms, A and B, before and after firm A decides to sell a commonly held illiquid asset. In this stylised example, the price movement following firm A's fire sale is so large that firm B becomes insolvent, as its assets are worth less than its liabilities. An analogous effect occurs when firm A decides to reduce new lending to a particular sector or region: this credit contraction will reduce the market value of firm B's existing claims on that sector or region.

The situation before the fire sale can be thought of in terms of a strategic game. If firms coordinate, they are all better off. But if some firms stop coordinating, all other firms suffer a loss; at the extreme, the drop in the mark-to-market value of their assets (owing to the fire sale) may render them insolvent. In practice, the "co-ordination" equilibrium may be difficult to sustain, since there are many financial firms (rendering co-ordination costly), and the costs of breaking any co-ordination agreement (in terms of smaller balance sheet size) are small relative to the costs of being left with the fire-sold asset (in terms of mark-to-market losses and potential insolvency).

A firm's decision to fire-sell assets may be a discretionary choice or imposed by exogenous shocks. Adrian and Shin (2010) find that both commercial and investment banks target a specific leverage ratio. In the case of investment banks, this target leverage ratio tends to be pro-cyclical; commercial banks tend to target a constant (acyclical) leverage ratio. In both cases, an increase in a bank's leverage relative to its target can prompt fire sales in order to reduce balance sheet size relative to equity. Greenwood, Landier and Thesmar (2015) show how such fire sales can affect other financial firms holding assets correlated with the fire-sold asset, following the basic mechanism illustrated in Figure 2. Fire sales can also be a necessary response to binding liquidity constraints: if a firm has a shortfall of cash relative to short-term liabilities, it might be forced to sell illiquid assets in a fire sale in order to generate more cash.

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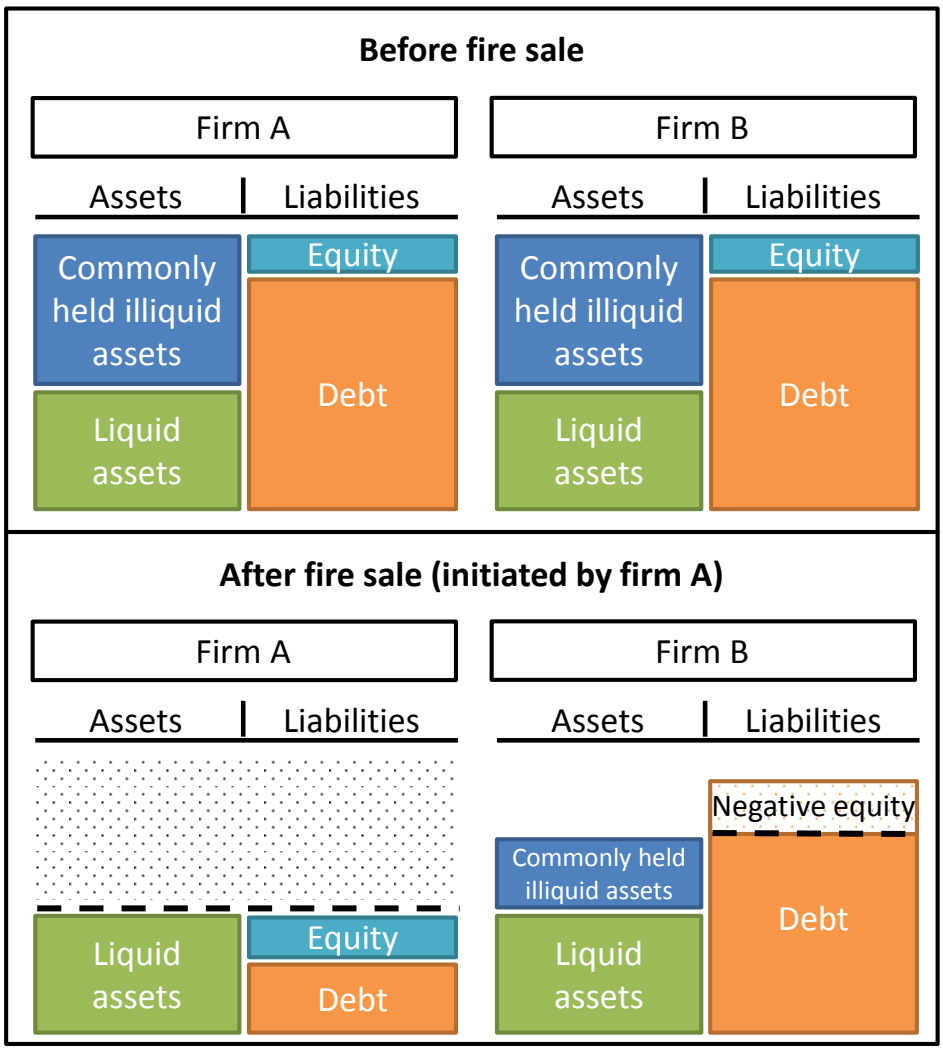
6 Another way of measuring the propagation of a market shock is through "excess price co-movements", i.e. price movements in excess of those which can be explained by fundamentals, with prices being alternatively stock market returns, interest rates, or exchange rates (Forbes and Rigobon, 2000). This contagion literature focuses on the transmission of shocks across countries; in this paper, we concentrate on the propagation of shocks across financial institutions.

7 For a selective review of some of the research on fire sales, focussing on both concepts and supporting evidence, see Shleifer and Vishny (2011).

Figure 2

Stylised illustration of the fire sale externality in operation



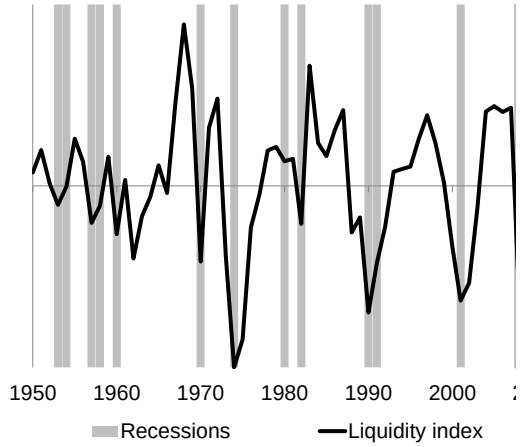
Source: ESRB.

Market illiquidity worsens the fire sale externality. If a market were very liquid, one firm's decision to sell would have a small impact relative to the total volume of buy and sell orders, and so the market price would be insensitive to this decision. By contrast, if one firm's sell order is large relative to total market turnover, that sell order will trigger a price movement in excess of that which can be explained by fundamental asset value. The price movement is most severe for "crowded" trades in which many traders wish to sell simultaneously into an illiquid market.

Fire sales are most likely to occur during financial crises because market liquidity tends to be pro-cyclical: it is high when asset prices are rising during economic booms, and low when prices are falling during recessions (Figure 3). As such, the fire sale externality is likely to be potent precisely when firms are more prone to sell, at the trough of the business cycle. Moreover, there is some

evidence that correlation across asset classes increases during crises.[8] Fire sale externalities have broader implications when cross-asset correlations are high, since the fire sale reduces prices across a broader set of asset classes.

Figure 3
Pro-cyclicality of market liquidity



Source: Næs, Skjeltorp and Ødegaard (2011).

Empirical analysis shows that fire sale externalities can be sizable. Duarte and Eisenbach (2015) empirically implement the framework proposed by Greenwood, Landier and Thesmar (2015) using regulatory balance sheet data for US commercial banks and repo market data for broker-dealers. They construct a new measure of "aggregate vulnerability" to fire sale spillovers: their results show that a 1% exogenous shock to assets can produce sizable fire sale externalities as a percentage of system capital, and that fire sale externalities were between two and three times larger during the 2007-08 financial crisis.

Fire sale externalities interact dynamically with balance sheet vulnerabilities – potentially creating an adverse feedback loop of illiquidity. A key balance sheet vulnerability is liquidity mismatch, which is a structural feature of many financial firms' business models, particularly banks and certain mutual funds.

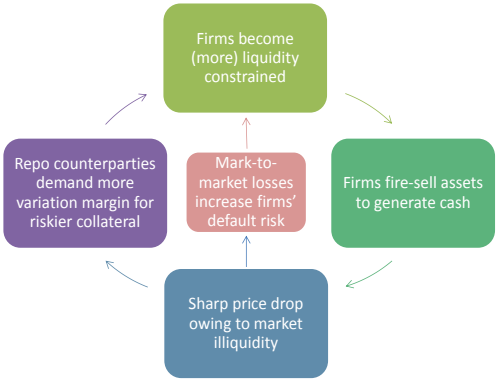
Liquidity-constrained firms typically borrow cash, sometimes unsecured, but often secured against a liquid security in a sale and repurchase ("repo") transaction. In a repo, the amount of cash which is borrowed is almost always less than the face value of the security which is pledged. This haircut relative to face value is a function of the perceived riskiness of the security. Risk is higher if the underlying security is being fire-sold because the fire sale reduces the market value of the asset, thus prompting the repo counterparty to impose a higher haircut, or even to forestall new repos altogether.

Repo counterparties' behavioural response to an increase in market illiquidity reduces aggregate funding liquidity in the financial system. As liquidity-constrained firms start selling their more liquid assets, their balance sheet becomes more and more illiquid. As a result, they have a higher tendency to sell illiquid assets at a large discount. This creates the conditions for a system-wide illiquidity spiral: market liquidity and funding liquidity negatively interact with each other and coincidentally deteriorate. The stylised dynamics of this illiquidity spiral are illustrated in Figure 4.

Repo transactions can therefore become an unreliable source of liquidity during financial crises, as liquidity transformation can cease to take place on the benign terms with which the cash-borrower had become familiar. In the case of secured lending, a fall in collateral quality might prompt a de facto "run" by creditors in the form of calls for additional (variation) margin. The mechanics of such runs contributed to the collapse of Lehman (Duffie, 2010).

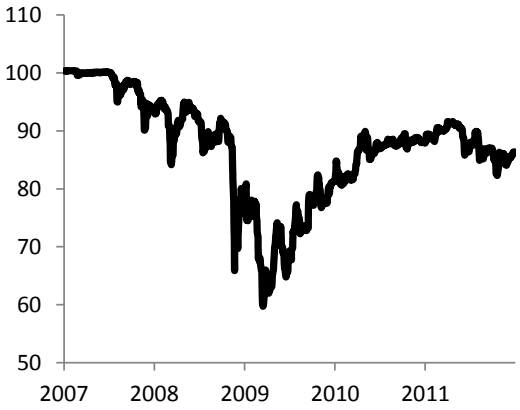
[8] For example, Longin and Solnik (2001), Ang and Chen (2002), Bekaert, Harvey and Ng (2005) and Corsetti, Pericoli and Sbracia (2005) find evidence that cross-asset correlation increases when returns are negative. However, evidence is mixed: Forbes and Rigobon (2002) attribute higher correlation during negative-return periods to the procyclicality of market volatility documented by Næs, Skjeltorp and Ødegaard (2011).

Figure 4
Illiquidity spiral



Source: Adapted from Brunnermeier and Pedersen (2009).

Figure 5
Price index of sub-prime ABS



Source: JP Morgan Datametrics.

Gorton and Metrick (2012) show that the crisis of 2007-08 was effectively a run in the US repo market, which led to a spiral of declining asset values and increasing repo haircuts. The declining asset values can be observed in Figure 5, which shows the evolution of the price for a basket of US sub-prime ABS initially rated AAA (ABX index vintage 2006-1). Note the strong temporary decline starting in late 2008 and followed by a recovery from summer 2009 onward. As Gorton and Metrick argue, this price collapse led to several asset classes becoming ineligible as collateral – equivalent to a haircut of 100%.[9] Gorton and Metrick's analysis reveals how the crisis spread from sub-prime housing assets to other assets classes with no direct connection to the housing market.

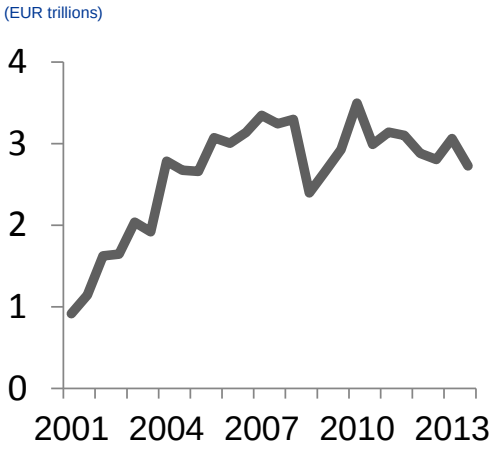
The potential unreliability of short-term repo transactions as a source of funding liquidity during crises is a common feature across repo markets. However, repo markets differ in important ways, implying that some repo markets might be particularly vulnerable to runs. For example, one of the key technical characteristics which contributes to the fragility of the US repo tri-party repo market is that of the "unwind procedure".[10]

In addition to repo, contagion via runs also affected other classes of short-term debt during the crisis. This is particularly true of asset-backed commercial paper and structured investment vehicles (Covitz, Liang and Suarez, 2009; Acharya, Schnabl, and Suarez, 2009). However, the possibility to "rehypothecate" collateral in a repo contract – i.e. the fact that a depositor of cash in the bank takes physical possession of bond collateral and then can reuse that collateral – makes a run in the repo market potentially more systemic.

9 Gorton and Metrick show how in 2007-2008 higher counterparty credit risk, hence higher bank credit spreads, resulted in lower values for repo collateral (often consisting of securitised bonds). Then concerns about the liquidity of markets for the bonds used as collateral led to increases in repo haircuts. The combination of declining asset values and increasing haircuts resulted in a *de facto* insolvency of the financial system, analogous to the banking panics of the 19th century.

10 The daily time gap between the unwind and rewind of repos drives much of the dealers' demand for intraday funding liquidity from the clearing banks. By contrast, "through-the-day collateral substitution" is prevalent in European tri-party repo markets: this is a process by which dealers can substitute collateral (including cash) into repo deals without unwinding them, in order to extract a needed security, possibly at multiple points in the business day. Thus, the contract design prevalent in European tri-party repo markets virtually insulates euro repos from several (possibly systemic) threats inherent in the US tri-party repo mechanism, including the collapse of clearing banks, and the adverse consequences for repo sellers if the clearing bank exercises its right to withdraw the intraday credit extensions (see Copeland *et al* (2011) and Mancini *et al* (2016)).

Figure 6
Total value of 68 EU firms' outstanding repos



Source: ICMA survey.

The total quantity of repo transactions is voluminous, which magnifies the potential impact of illiquidity spirals on banks' balance sheets (Rosengren, 2014). According to the International Capital Market Association's (ICMA) survey of 68 EU institutions, the total value of outstanding repos has remained relatively stable at around €3tn since 2004 (Figure 6). At the end of 2013, the precise figure was €2.7tn, amounting to about 6.5% of EU banks' total assets.[11] This is a relatively large share of short-term financing, given that most of banks' assets are illiquid.

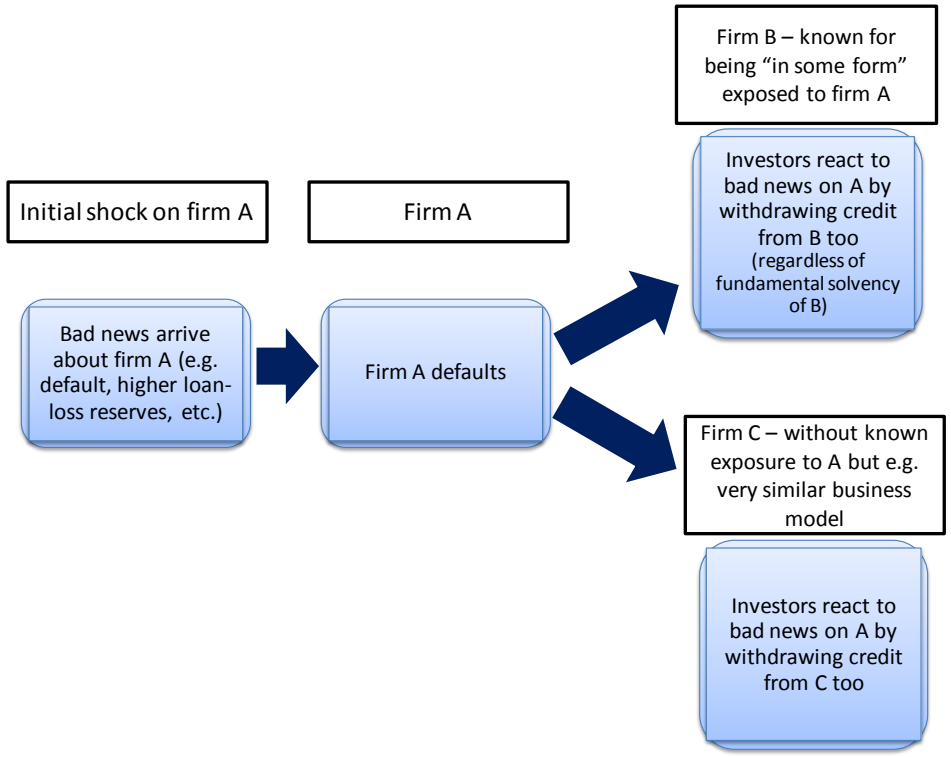
Part B: Information spillovers

When investors are sensitive to fundamental changes in information, bad news about one financial firm can prompt a run on that firm and also affect other financial firms. Reserve Primary Fund, a large money market mutual fund, is a case in point. On 16 September 2008, Reserve Primary wrote down the value of its $785m claims on Lehman to zero and reduced its net asset value per share from $1 to $0.97. In response, Reserve Primary's investors "ran" by requesting redemptions en masse, which Reserve Primary was unable to honour. A more general run on money market funds followed.

In this example, there are two types of information contagion. The first type of information contagion is captured in Figure 7, which illustrates the effect on Firm B of Firm A's default. The revelation of Lehman's default, combined with knowledge of Reserve Primary's $785m exposure to Lehman, triggered a run on the fund by its short-term investors. Without the run, Reserve Primary would have been able to survive by lowering its yield and organically growing its net asset value per share back to $1. At 1.2% of its total assets, Reserve Primary's exposure to Lehman was substantial but manageable. But the widespread redemption calls by short-term investors precluded this solution. Thus the substantial-but-manageable information innovation (i.e. Reserve Primary's exposure to Lehman's default) interacted negatively with Reserve Primary's structural liquidity mismatch to generate an unmanageable run.

[11] This comparison underestimates the importance of the repo market, since ICMA's survey includes only 68 institutions, whereas the total assets figure includes all EU banks.

Figure 7
Potential information spillovers



Source: ESRB.

The second type of information contagion is captured in Figure 7, which illustrates the effect of these events on Firm C. In our example, a more general run on money market funds followed the run on Reserve Primary. Over three days, $169bn was redeemed from prime institutional funds, even though most of these funds were not directly affected by Lehman's bankruptcy.

Why did Lehman's bankruptcy trigger a run on Reserve Primary and the wider industry of money market funds? Answering this question is key to understanding the mechanics of information spillovers, and requires us to return to the theory of runs.

In the classical banking model of Diamond and Dybvig (1983), runs by banks' unsecured short-term creditors or depositors arise as pure panic-based phenomena, and can happen at any time, not only during an economic or financial crisis. Empirically, however, runs are rarely driven by pure hysteria; they rather tend to be related to fundamental changes in information, such as bad news about the health of a bank or the financial system.[12] For instance, Iyer and Peydró (2011) find that, following the sudden failure of a large cooperative bank in India, banks with higher interbank exposures to the failed bank suffered larger withdrawals by their depositors. In this case, information spillovers amplified the initial effect of direct contagion.

[12] Empirical studies on bank contagion test whether bad news, such as a bank failure or the announcement of an unexpected increase in loan loss reserves, adversely affect other banks using a variety of indicators (intertemporal correlation of bank failures, bank risk premia and stock price reactions). See, for example, Hasan and Dwyer (1994) and Calomiris and Mason (2003).

In the theories of runs based on fundamentals, runs are usually triggered when the realisation of a fundamental variable (e.g. the return of the long-run project) is below some threshold. As a result, relatively small changes in the information environment can lead to large changes in behaviour (Jacklin and Bhattacharya, 1988). In the model of Acharya, Gale and Yorulmazer (2011), a small change in the fundamental value of an asset used as collateral in the short-term debt market can be associated with a sudden collapse in the debt capacity of a firm. This result is related to the lack of arrival of good news about the value of the asset used as collateral to roll over debt when the tenor of the debt is very short.

Both the pure panic-based and the fundamentals-based views of runs are synthesised by the global games literature, in which poor fundamentals trigger self-fulfilling beliefs about a financial crisis: a crisis occurs if a sufficiently large proportion of depositors withdraw from a bank, creditors do not roll over debt or currency speculators attack a peg.[13] Ahnert and Kakhbod (2015) show how a small change in public information about bank fundamentals can result in a large change in the proportion of informed investors and thus increase the probability of a financial crisis.

Instead of focusing on the ex post effects of a failure or change in the fundamental value of assets, Acharya and Yorulmazer (2008) analyse the ex ante response of banks to adverse news about other banks. They show that information contagion can occur when bank loan returns have a common systematic factor: a bank's borrowing cost increases following adverse news about another bank since such news conveys adverse information about the common factor. Ex ante, the likelihood of such "information contagion" induces bank owners to herd with other banks and undertake correlated investments, for instance by lending to similar industries, in order to minimise their expected borrowing costs.

The link between commonality in bank asset portfolios and information contagion is analysed in a network setting in Allen, Babus and Carletti (2012). They show that when bank debt is short-term, and the portfolio quality of individual banks is opaque, creditors can decide not to roll over debt in response to adverse aggregate signals about bank solvency. Greater commonality in bank portfolios increases the likelihood of information contagion.

Caballero and Simsek (2013) provide a related theoretical model embedding uncertainty about the asset structure of banks. In their model, the complexity of financial linkages creates uncertainty about the network of cross-exposures of banks. Since domino effects are more likely in crises, banks become concerned that they can be affected via third parties. The structure of the network matters since uncertainty is higher for "distant" exposures. Such uncertainty can dramatically amplify banks' perceived counterparty risk, and make them reluctant to buy risky assets. Ultimately, banks can even turn into sellers: the model features a fire sale equilibrium, in which the price of legacy assets collapses.

[13] See Goldstein and Pauzner (2005), Rochet and Vives (2004) and Aldasoro and Faia (2015) for an application to bank runs.

Section 2
Existing policies to mitigate indirect contagion[14]

Effective policy design must be firmly grounded on the identification of market failures or other externalities which policy intervention can correct. For example, the propagation of financial shocks through the liquidation of positions in securities is not necessarily the manifestation of a market failure. In certain circumstances, such propagation is simply a natural process by which the financial system absorbs shocks.

However, one place to look for social losses is bankruptcy. Bankruptcy entails deadweight losses, and the risk in a systemic event is the accumulation of numerous bankruptcies. Many of the behaviours we have described in this paper are triggered by financial firms' concern about getting close to the zero equity constraint. Similarly, liquidity constraints are an additional determinant of financial actors' behaviour in response to shocks; the trigger of bankruptcies is often illiquidity, rather than insolvency.

As a result, indirect contagion tends to spread market failures. This motivates policy intervention to reduce the risk of indirect channels of contagion. Since 2008, a wide array of policy reforms has helped to fix the fault lines that caused the global financial crisis. The FSB (2014) describes this job as "substantially complete". Since illiquidity spirals and information spillovers played an integral role in the recent crisis, as they have in crises throughout financial history, many of these policy reforms help to build systemic resilience to indirect contagion. This section highlights the main reforms from the point of view of mitigating the effects of indirect contagion.

Policies that strengthen the financial system against direct contagion also improve systemic resilience to indirect contagion. For example, by improving banks' loss-absorbency capacity, capital regulation makes each bank more resilient to losses on direct exposures, while simultaneously reducing the extent to which banks are forced to fire-sell assets to meet short-term obligations.

The list of policies considered below will therefore look familiar, but we consider them in terms of their effectiveness in dampening indirect channels of contagion. As in Section 1, we focus on the market-price channel and the information channel. We do not seek to be exhaustive in characterising the full range of policies that can mitigate each channel; instead, we focus on the most relevant elements, with a view to characterising the current regulatory landscape.

The market price channel

- **Capital regulation.** Limiting the degree of leverage on financial firms' balance sheets ensures that there is sufficient equity to absorb unexpected losses in most adverse scenarios. Firms are hit by mark-to-market losses when they hold assets correlated with a fire-sold asset. With sufficient equity, these losses can be managed – allowing the firm to hold on to illiquid assets at least until the fire sale is over and asset prices have returned to their fundamental value. Well capitalised financial firms are also more likely to retain their access to sources of short-term funding, such as the repo market, during crises. In this way, less leveraged firms have a lower conditional contribution to fire sale

[14] This section was written by the authors, with substantial contributions from Alex Hodbod.

externalities, as shown empirically by Duarte and Eisenbach (2015). The strengthening of the quality and quantity of capital for credit institutions under the CRD IV and CRR package therefore helps to mitigate EU banks' tendency to exacerbate illiquidity spirals. Moreover, the introduction of macroprudential capital regulation – including time-varying buffers, add-ons for systemically important institutions and the systemic risk buffer – ensures that requirements are targeted when and where they are most valuable.

- **Liquidity regulation.** In the absence of strong liquidity regulation, banks with deposit insurance and access to central banks' lender of last resort facilities have an ex ante incentive to take additional liquidity risk. The result of this moral hazard is a socially excessive liquidity mismatch within the financial system. The introduction of microprudential liquidity regulation within the CRR, including the liquidity coverage requirement (which aims to ensure that short-term funding is matched by liquid assets) and the net stable funding requirement (which requires that illiquid assets are funded by stable liabilities), improves banks' liquidity positions, and thereby lowers their conditional contribution to spirals of illiquidity. However, liquidity regulation could be improved by introducing a macroprudential component, including variation both over time and in the cross-section of financial firms, as described in Section 3.
- **Regulation on securities financing transactions.** Securities financing transactions and collateral reuse are employed by many financial institutions – including banks, securities dealers, insurance companies, and funds – with the purpose of obtaining additional cash or achieving additional flexibility in carrying out a particular investment strategy. The reuse of collateral to support multiple securities financing deals permits increased leverage and interconnectedness in the system. The G20 and the FSB have thus concluded that securities financing transactions have the propensity to increase the build-up of leverage in the financial system and to create contagion channels between different financial sectors. The EU regulation on the reporting of securities financing transactions shall enable central banks, regulators and supervisors to correctly assess and monitor risks and interconnectedness in the financial system arising from SFTs.
- **Proposed regulation on money market funds.** MMFs are important owing to the direct connections between banks and MMFs – via the large amounts of funding that MMFs provide to banks, and via the implicit sponsorship role that banks can play for MMFs – and as a potential source of indirect contagion through the market price channel. MMFs typically undertake some degree of maturity and liquidity transformation, but without the same prudential regulation to which banks are subject – and without formal access to the central bank lender of last resort function. This left MMFs vulnerable to runs, which in turn made them potential fire-sellers of assets. In recognition of these concerns, the European Commission proposed an MMF Regulation in September 2013. This proposal aims to broaden the perimeter of prudential regulation to MMFs and to make the MMFs more resilient – and thereby less susceptible to the risk of runs and fire sales.
- **Proposed regulation on bank structural reform.** A key issue brought to light by the global financial crisis is the systemic importance of large, complex and interconnected institutions, which are therefore difficult to manage, supervise and resolve. The European Commission proposal for structural reform of the European banking system – which is currently being negotiated at the EU level – is aimed at addressing the issue of too-big-to-fail banks, thus complementing other post-crisis reforms introduced in the EU. Structural reforms should contribute to building more resilience; decreasing the risk of bank failures; and facilitating supervision and resolution. The Commission proposal tries

to achieve these goals by providing for a ban on speculative trading (proprietary trading) and for the separation of other activities which can be particularly risky, such as derivatives trading.

- **Proposed initiatives on the "capital markets union".** The capital markets union agenda aims to integrate and deepen Europe's fragmented capital markets (Juncker, 2014; Hill, 2014; Hill, 2015). Deeper capital markets mitigate the risk of illiquidity spirals by increasing market liquidity, thereby reducing the scope of fire sale externalities generated by a highly leveraged banking sector (Langfield and Pagano, 2016). A diverse array of policies could help to deepen capital markets, and thereby mitigate the systemic risk arising from indirect contagion (European Commission, 2015a). These policies are mostly structural, and would therefore not be implemented by macroprudential authorities – but they are nevertheless of macroprudential interest.

Information spillovers

- **Transparency of banks' balance sheets.** The opacity of bank balance sheets is a major cause of financial instability, as we say in part B of Section 1. In the absence of adequate information disclosure, distress at one institution can quickly spread others. CRDIV improves transparency regarding the activities of credit institutions, in particular with regard to profits, taxes and subsidies in different jurisdictions. In addition, a substantial quantity of information has been disclosed as part of the EU-wide stress test exercises mandated by the EBA regulation. These disclosure enhancements are essential steps towards diminishing the potency of the information channel of contagion across the financial system.
- **Market infrastructure.** Extensive use of central clearing implies a substantial reduction in systemic risk. The adoption by the G20 (2009) of a commitment to centrally clear standardised OTC derivative contracts, which in the EU was implemented in the European Market Infrastructure Regulation (EMIR), should therefore be lauded. By stepping into a formerly bilateral trade, central counterparties help to reduce network complexity and opacity and thereby the potential for indirect contagion arising from information spillovers. Furthermore, central counterparties protect clearing members from the default of a counterparty, thereby minimising the risk of a disorderly sell-off of the securities that would have been pledged as collateral in non-centrally cleared transactions. However, CCPs can also be a source of systemic risk. Some CCPs may be "super systemic" (Tucker, 2014): too big and interconnected to fail without triggering financial instability. The increasingly central role played by CCPs within the financial system underscores the importance of ensuring that CCPs are sufficiently resilient.
- **Resolution.** Financial firms which become insolvent can cause wider disruption if they are wound up using ordinary insolvency proceedings, owing to their direct and indirect connections with other firms. Disorderly insolvency can also cause information spillovers via a broader loss of confidence, as observed following the bankruptcy of Lehman Brothers owing to uncertainty about the loss allocation mechanism. Special procedures, such as those provided for in the EU's Bank Recovery and Resolution Directive, ought to be superior to ordinary insolvency law. Moreover, the BRRD provides greater clarity about how losses will be allocated among liability holders in the event of resolution.

Section 3
New policies to mitigate indirect contagion

Indirect contagion spreads market failure. In the case of illiquidity spirals, firms do not internalise the negative externality of holding low levels of funding liquidity or of fire-selling assets. Lack of information and information asymmetries can cause markets to unravel owing to relatively minor news. In both cases, market players act in ways which are privately optimal but socially harmful.

These market failures motivate policy intervention. The role of macroprudential policy is to enhance systemic resilience to indirect contagion with minimal unintended distortions to intermediation. In Section 2, we described the post-crisis regulatory reforms that go in this direction. However, additional reforms may be necessary owing to the confluence of three factors.

- First, a flurry of reforms was introduced over 2008-15 with the primary objective of achieving greater systemic stability. Understandably, the efficiency of regulations was of second-order concern. The regulatory community now has the opportunity to reflect on whether the same degree of systemic stability can be achieved with lower impediments to financial intermediation. In this respect, the EU Commission (2015b) has launched a consultation on "whether there are unintended barriers to new market players and innovative businesses preventing them from entering markets and challenging incumbents". Part A of this section – which focuses on the efficiency gains from a macroprudential application of liquidity regulation – aims to enhance efficiency.
- Second, financial institutions respond endogenously to policies. Given that regulations are invariably costly, institutions have an incentive to avoid regulations by performing the same economic function within a different legal structure. In macroprudential policy, an activities-based, rather than entities-based, approach is generally more robust to regulatory arbitrage, since requirements apply regardless of entities' legal structures. Part B of this section – which proposes restrictions on margins (for derivatives transactions) and haircuts (for derivatives and securities financing transactions) – puts forward one such arbitrage-robust macroprudential policy.
- Third, although post-crisis reforms to financial regulation have been extensive, policy could benefit from some extensions in order to ensure maximal systemic resilience. In the past, the ESRB has pointed to aggressive anti-trust policy with respect to large banks (Pagano et al, 2014) and a macroprudential application of the leverage ratio (ESRB, 2015) as potential policy innovations worthy of consideration. In Part C of this section, we highlight the potential benefits of enhanced information disclosure. Historically, authorities in Europe have been more reticent than those in other jurisdictions, such as the US, to liberally disclose information on financial institutions. We argue that this tradition is misguided, and that enhanced disclosure can help to mitigate the negative information spillovers described in Section 1.

Macroprudential policymakers should consider whether these three policy tools – macroprudential liquidity regulation, restrictions on margins and haircuts, and enhanced information disclosure – would effectively enhance resilience to indirect contagion, and how these policies could be designed to achieve maximum effect with minimum cost.

These three tools are presented in general terms in order to frame a high-level policy discussion. The paper therefore refrains from examining detailed implementation issues (such as the calibration of policy tools), which should be conducted by technical working groups.

Part A: Macroprudential liquidity regulation[15]

The policy objective is to dampen illiquidity spirals through the macroprudential application of liquidity regulation. Effective liquidity regulation dampens illiquidity spirals by mitigating and preventing excessive maturity mismatch and by reducing moral hazard (ESRB, 2013).[16]

Traditionally, common insurance for retail deposits allowed banks to credibly co-insure against idiosyncratic runs (Diamond and Dybvig, 1983). But deposit insurance is likely to be insufficient in modern financial markets, given that banks are substantially funded by debt and wholesale deposits.

The ultimate backstop for banks' structural liquidity mismatch is the central bank, which can act as lender of last resort (LOLR) to illiquid-but-solvent institutions. But this LOLR promise creates moral hazard: banks have an incentive to increase their liquidity mismatch in good times (to boost profitability) in the knowledge that funding will be available from the central bank in bad times.

One solution to this moral hazard problem is to price LOLR funding in such a way that banks pay a penalty for accessing emergency central bank funding (Bagehot, 1873). However, penalty policies might not be time-consistent, as central banks have an incentive to offer cheap liquidity when a crisis occurs.[17] Moreover, LOLR funding is socially costly when illiquid institutions' insolvency risks, and the risks of changes in the market price of pledged collateral, are non-zero – since any credit or market losses suffered by the central bank are implicitly borne by taxpayers.

New liquidity regulations – the liquidity coverage requirement (LCR) and the net stable funding requirement (NSFR)[18] – aim to overcome market failures arising from interconnectedness and the moral hazard borne by LOLR facilities. When a firm makes its balance sheet more robust to liquidity shocks, it not only improves its own liquidity position, but also benefits those of its creditors. This generates a positive externality; as such, there is a potential for market failure (as liquidity may be under-supplied by private agents). Moreover, liquidity regulation also aims to decrease the moral hazard generated by backstops such as deposit insurance, government bail-outs and central banks' lender of last resort facilities (Ratnovski, 2009; Farhi and Tirole, 2012; Stein, 2013), which is largest for banks in general and systemically important institutions in particular (Santos and Suarez, 2015).

Liquidity regulation entails a trade-off. On one hand, liquidity regulation needs to be stringent enough that banks rely less on costly LOLR facilities. On the other hand, a regulatory system based on quantities should avoid creating excess demand for high-quality liquid assets, which are in finite

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15 This part was written by the authors, with substantial contributions from Iñaki Aldasoro.

16 Moral hazard with respect to liquidity risk-taking is generated by deposit insurance and access to lender of last resort facilities. Deposit insurance reduces incentives for depositors to monitor banks' activities and for banks to self-insure against liquidity risk. LOLR facilities distort *ex ante* incentives by encouraging eligible institutions to take socially excessive liquidity risks (Acharya *et al*, 2014). Once solvency problems have materialised, eligible institutions with low franchise value have an incentive to extract rent from the subsidy implicit in undercollateralised LOLR facilities by shifting downside risk onto the LOLR (Drechsler *et al*, 2016).

17 Even time-consistent commitment devices – such as Australia's Committed Liquidity Facility (CLF), which requires banks to pay up-front fees – risk under-pricing future LOLR access, since liquidity crises are infrequent and uncertain, while banks' CLF subscriptions are immediate and certain.

18 The LCR requires banks to hold enough unencumbered high-quality liquid assets (with differential weights) to meet stressed outflows over one month (BCBS, 2013). In the EU, implementation of the LCR is being phased in, starting from 60% in October 2015 to 100% in January 2018. The NSFR will require banks to hold a certain quantity of stable funding (defined as customer deposits, long-term wholesale funding and equity) relative to long-dated assets (with differential weights by asset and maturity classes) (BCBS, 2014).

supply, as this would disrupt banks' provision of liquidity to the real economy (Weitzman, 1974). Optimally balancing this trade-off requires policymakers to have a more precise empirical grasp of illiquidity spirals and the social costs of LOLR facilities (Rochet, 2008).

Liquidity regulation is currently applied via microprudential requirements, which operate by reducing individual firms' liquidity risk. Microprudential requirements also help to contain systemic liquidity risk (Ahnert, 2014). To further contain systemic liquidity risk, the LCR and NSFR could be applied in a more explicitly macroprudential manner (ESRB, 2014).

The macroprudential application of liquidity regulation has two dimensions: time-variation and cross-sectional variation in requirements. These two dimensions of macroprudential liquidity regulation, summarised in Table 1, could be used by authorities once the effects of the microprudential application of the LCR and NSFR have been fully observed and understood.[19] In the longer-term, more innovative policy tools could be considered:

- a simple tool analogous to the leverage ratio, such as liquid assets to non-equity liabilities (Hardy and Hochreiter, 2014);
- price-based tools, such as a Pigouvian tax (Perotti and Suarez, 2011);
- variation – for macroprudential reasons – of the weights assigned to assets or liabilities in the calculation of the NSFR (Bicu et al, 2014). A similar approach could be taken for the LCR by varying eligibility criteria for HQLA.

Macroprudential liquidity regulation promises greater efficiency, because requirements bind only when and where they are most needed (see Box 1) – when liquidity risks are building up and in the institutions which make the greatest contribution to systemic liquidity risk. Greater efficiency is important, because tighter aggregate liquidity requirements increase the costs of firms' liquidity transformation services (Segura and Suarez, 2014). Macroprudential liquidity regulation therefore allows society to reap the benefits of lower systemic risk, while keeping the costs of tighter aggregate requirements to a minimum.

[19] For example, one potential drawback of liquidity regulation is that it encourages regulated institutions to invest in similar portfolios, which become more correlated. The application of microprudential liquidity regulation will permit authorities to fully understand this effect, and therefore appropriately calibrate the macroprudential application of these tools.

Table 1
A macroprudential approach to liquidity regulation

	Time-variation	Cross-sectional variation
Description	Tighter liquidity requirements in the upswing, when funding liquidity is abundant and interconnectedness as well as liquidity risks are building up; and looser requirements in the downswing.	Tighter liquidity requirements for "liquidity SIFIs", and looser requirements for relatively unimportant institutions.
Objective	Raise resilience to and lean against the build-up of systemic liquidity risk over time.	Reduce the externalities created by institutions which contribute most to systemic liquidity risk.
Legal basis	Pillar 2 (CRDIV, Art.103) or stricter national measures (CRR Art.458).[20]	Institution-specific requirements to address "systemic liquidity risk" (CRDIV, Art.105) applied to banks with similar risk profiles (Art.103).
Calibration	Calibrated to time-varying measures of the availability of funding liquidity (e.g. bank debt issuance relative to history) and its cost (e.g. spreads such as Libor-OIS and longer-term funding costs). Other measures of liquidity risk, such as loan-to-deposit ratios, refinancing profiles or a "liquidity mismatch index" (Brunnermeier *et al*, 2014; Bai *et al*, 2015) could also be considered. See Bicu *et al* (2014); Bonfim and Kim (2014); Dijum and Wierts (2016).	Calibrated to institutions' contribution to systemic liquidity risk – measured by the extent of institutions' importance in providing short-term funding liquidity to other institutions; their exposure to sudden margin calls and evaporation of short-term intra-financial lending; and their exposure to commonly held illiquid assets (market liquidity). See Aldasoro and Faia (2015) and Ferrara *et al* (2016).

[20] Temporary non-compliance with the LCR is provided for in CRR Art.414, but only for microprudential purposes.

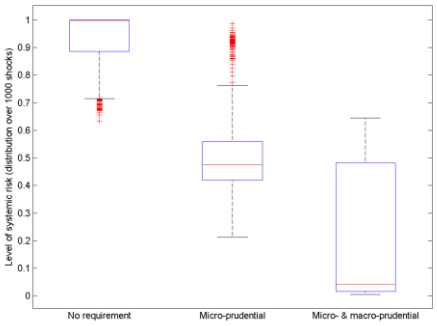
Box 1

Macroprudential liquidity regulation: Lower systemic risk at no extra cost

Imagine that authorities have decided at a given point in time the prudential policy stance for liquidity regulation: that is, the level of *aggregate* liquidity requirements for the system as a whole. How should this *aggregate* requirement be distributed across firms?

The microprudential answer is: "the same requirement for each individual firm". For example, the microprudential application of the LCR would require *all* firms to hold sufficient liquid assets to survive an outflow of liabilities over the specified period. But if the policy objective is to reduce systemic risk, then firms which contribute most to systemic liquidity risk should face a tighter requirement, while relatively unimportant firms should face a looser requirement (Perotti and Suarez, 2011).

Figure 8
Systemic risk under three policies



Source: Aldasoro and Faia (2015).

This view is reflected in a model of optimising banks with a network structure and multiple channels of contagion and amplification (Aldasoro and Faia, 2015).[21] Figure 8 shows the results in terms of the level of systemic risk (over 1,000 simulated shocks) under three policy regimes. When authorities set liquidity requirements at zero, systemic risk across the 1,000 simulated shocks is relatively high. A flat microprudential liquidity requirement (calibrated as a minimum of 10% liquid assets to total deposits) decreases median systemic risk by about 50%. Systemic risk is further reduced through the macroprudential application of liquidity regulation: when the 10 most systemically important banks are subject to a liquidity requirement of 12.5%, while all other banks are subject to proportionally lower requirements, systemic risk unambiguously decreases.

Ferrara et al (2016) obtain a similar result using Bank of England data on banks' short-term liabilities, including interbank borrowing and lending. They find that tighter LCR requirements for "liquidity SIFIs" would reduce the severity of a systemic liquidity crisis for a given aggregate stock of liquid assets in the banking system.

A similar logic applies to time-varying liquidity requirements. In principle, it is more efficient for aggregate liquidity requirements to be relatively tight when funding liquidity is abundant and interconnectedness and liquidity risks are building up.

[21] The model features optimising risk-averse banks interacting in the interbank market and investing in non-liquid assets. Contagion occurs via fire sale externalities, interbank exposures and liquidity hoarding on the asset side, and runs on short-term funding on the liability side, the latter based on an underlying global game. Systemic risk is measured as the share of assets of defaulting banks to total assets following a shock to the system, while systemic banks are identified based on the G-SIB methodology. while systemic banks are identified based on the G-SIB methodology. The model is calibrated to the network of large European banks (as in Alves *et al*, 2013).

Significant liquidity mismatches can also be present in non-bank financial firms – even though asset managers differ from banks or insurers in that they typically act as "agents" rather than "principals". The systemic externality arises when investors wish to have shares or units redeemed, but the cash amount in the fund is not sufficient – in this scenario, investment funds might be forced to fire-sell illiquid assets, potentially triggering or exacerbating illiquidity spirals in the whole financial sector.

The macroprudential application of liquidity regulation could therefore be extended beyond the banking sector. From an investor perspective, both UCITS[22] and AIFMD[23] already have various requirements in relation to liquidity management which are designed to limit institution-specific liquidity risks. However, these microprudential regulations do not necessarily mitigate systemic liquidity risk directly as they are not targeted at externalities (such as fire sale externalities).

In the first instance, authorities should better understand the creation of systemic liquidity risk by non-banks, in particular by:

- engaging in a data collection initiative to fully understand and quantify non-banks' liquidity mismatches;
- undertaking an empirical assessment of the importance of the fire sale channel, by quantifying the elasticity of asset prices to these sales both in normal times and in times of generalised distress;
- carrying out macroprudential stress tests to assess potential systemic liquidity risks due to specific products or underlying asset markets; and
- designating global systemically important non-bank and non-insurer financial institutions and subjecting them to intensive supervision and regulation, following a common global methodology (FSB-IOSCO, 2015).

In the longer term, authorities could consider developing measures to reduce the creation of systemic liquidity risk by non-banks. For money market funds and certain types of investment funds, measures could include redemption gates, which quantitatively restrict outflows by investors; redemption fees, which disincentivise outflows; and liquidity requirements at the fund-level. When there are negative externalities, authorities could pay particular attention to investment funds' existing obligations to ensure that redemption frequencies correspond to their investments.[24]

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22 The UCITS requirements are more prescriptive than those for AIFMs, reflecting the fact that UCITS are supposed to be liquid products that can be sold cross-border to retail clients on the basis of an EU passport. The Eligible Assets Directive of 2007 requires liquidity to be ensured for all investments by UCITS, and sets out specific rules for the eligibility of transferable securities, money market instruments and financial derivative instruments.

23 The AIFMD requires AIFMs to put in place liquidity management requirements if they manage open-ended AIFs or closed-ended AIFs which are leveraged. This includes an alignment of the investment strategy, liquidity profile and redemption policy of the fund, as well as putting in place appropriate liquidity management limits and stress tests.

24 For example, authorities could require certain investment funds to bring their redemption profiles in line with the liquidity of underlying assets, so that funds investing in relatively illiquid assets (e.g. high-yield bonds, leveraged loans) are not allowed to provide daily or intraday liquidity to end investors.

Part B: Restrictions on margins and haircuts[25]

The policy objective is to dampen illiquidity spirals, which could be exacerbated by sudden, large and pro-cyclical increases in margins and haircuts.[26] Risk management models are prone to generate sudden increases as they are sensitive to volatility spikes.[27] These increases in margins and haircuts reduce counterparties' funding liquidity and potentially force them to sell assets at discounted prices. This could create the conditions for a systemic illiquidity spiral, whereby the fire sale leads to additional increases in margins and haircuts, exacerbating funding illiquidity.

Restrictions on margins and haircuts could reduce pro-cyclicality by dampening illiquidity spirals.[28] Restrictions on margins could be applied to derivatives transactions (whether centrally cleared or non-centrally cleared);[29] restrictions on collateral haircuts could be applied both to derivatives transactions and securities financing transactions.

Restrictions could be applied to the level of or the change in margins and haircuts (see Table 2). Minimum haircuts have already been envisaged by the FSB (2015) for non-centrally cleared securities financing transactions.[30] This approach could be broadened by setting *time-varying minimum requirements*[31] or by setting *step limits on the change in margins and haircuts* within a given time period.[32] These two macroprudential policy options have pros and cons, which are discussed here.

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25 This part was written by the authors, with substantial contributions from Henrik Hansen and Falk Mazelis.

26 This broadly corresponds to the intermediate objective of macroprudential policy to mitigate and prevent "excessive maturity mismatch and market illiquidity". Time-varying restrictions on margins or haircuts would also help to reduce leverage in the expansionary part of the financial cycle, and thereby contribute to another intermediate objective of macroprudential policy – to lean against "excessive credit growth and leverage" (ESRB, 2013).

27 For example, initial margins set by CCPs on foreign exchange futures contracts increased substantially following the surprise removal by the Swiss National Bank of the EUR/CHF floor of 1.2 on 15 January 2015. In the case of CME, initial margins on CHF/USD futures approximately doubled immediately following the SNB's announcement (see **http://goo.gl/kmo0xY**). ICE implemented a similar increase for CHF/USD. For CHF/EUR futures with an exercise date of March 2016 (see **https://goo.gl/rw4MH1**), ICE's increase was even higher: initial margins increased by a factor of over six according to ICE data (see **https://goo.gl/Rfwn9K**).

28 Hardouvelis and Theodossiou (2002) find that high margin requirements when asset prices are rising may have a stabilising impact on stock market volatility, with no negative impact caused by lowering margins when asset prices are declining substantially. More recently, BIS-CGFS (2010) reviewed margining practices in SFTs and OTC derivatives markets and recommended that macroprudential authorities consider measures that involve counter-cyclical variations in margins. This sentiment is echoed in BCBS-IOSCO (2015) and in FSB (2014b), where it is noted that authorities could vary numerical floors as a macroprudential tool.

29 For CCPs, the EMIR RTS (article 28) currently requires that a CCP shall employ at least one of the following three options to limit the pro-cyclicality of margin models: (i) a floor on margins that is calculated using volatility estimated over a 10-year historical look-back period; (ii) a buffer margin that can be temporarily exhausted during periods in which calculated margin requirements are rising significantly; and (iii) assigning at least a 25% weight to stressed observations in the look-back period.

30 The FSB published a regulatory framework for haircuts on non-centrally cleared securities financing transactions (SFTs) in November 2015. This framework includes numerical haircut floors that would apply to transactions in which collateral other than government securities is used.

31 A broadly equivalent policy option would be to set a counter-cyclical add-on on top of constant minimum requirements.

32 Furthermore, these instruments could be supplemented by setting static minimum haircuts also for derivatives transactions.

Table 2

The application of restrictions to margins or haircuts

	Time-varying minima (see Figure 9)	Step limits (see Figure 10)
Description	A time-varying floor on the level of margins or haircuts.	A ceiling on the size of the increase in margins or haircuts over a given time period.
Objective	Dampen the effect of sudden, large and pro-cyclical increases in margins and haircuts on the exacerbation of illiquidity spirals.	
Legal basis	For derivatives, the EMIR review is an opportunity to consider whether macroprudential tools could be useful to address the pro-cyclicality of margins and haircuts, both for cleared and non-centrally cleared derivatives. For SFTs, regulatory restrictions on haircuts on collateral could be implemented in the regulation on SFTs – or in other primary legislation in the longer-term future, permitting deeper analysis of the effects of such haircut restrictions.	
Calibration	Calibrated by regulators according to indicators of business and financial cycles or asset-specific measures of stress (e.g. bid-ask spreads; volumes traded).	Calibrated by market participants according to their own risk management models (pursuant to supervisory guidance). The onus is thus on participants to apply their risk management models prudently given the step limit constraint.

The difference between the outcomes generated by time-varying regulatory minima and step limits is illustrated in figures 9 and 10 with stylised examples. All panels consider the impact of a shock event, which results in an increase in the margin or haircut that would be requested by a counterparty in the absence of regulatory intervention (illustrated by the jump in the dashed black line). The solid red line illustrates the regulatory requirement in each scenario: in panel A, regulators and market participants are assumed to have no foresight about future events; in panel B, they have partial foresight; and in panel C, they have full foresight.

When a stress event is partially or fully anticipated by regulators and market participants, time-varying minima and step limits could generate similar outcomes (see panels B and C). In the case of time-varying minima, regulators impose a gradually increasing add-on in anticipation of a shock event, thereby preventing or mitigating the magnitude of the sudden increase in margins or haircuts immediately following the stress event (see Figures 9b and 9c). In the case of step limits, market participants would increase margins and haircuts (relative to those that they would have set in the absence of step limits) in anticipation of a future stress event (see Figures 9b and 9c). This behaviour is rational: if market participants did not increase margins and haircuts pre-emptively, despite (partially) anticipating the stress event, they would be exposed to excessive counterparty credit risk following the stress event (analogous to the situation illustrated in Figure 9a).

Time-varying minima and step limits would generate different outcomes if regulators and market participants had different expectations regarding the probability of a future stress event. Market participants might have more information regarding future stress probability; step limits would put

the onus on market participants to utilise this private information effectively. In addition, market participants are not subject to the political economy problems which could lead to inaction bias in the case of time-varying minima.

Time-varying minima and step limits also differ in their treatment of unanticipated stress events, which occur when no adequate buffer has been built up (see panel A):

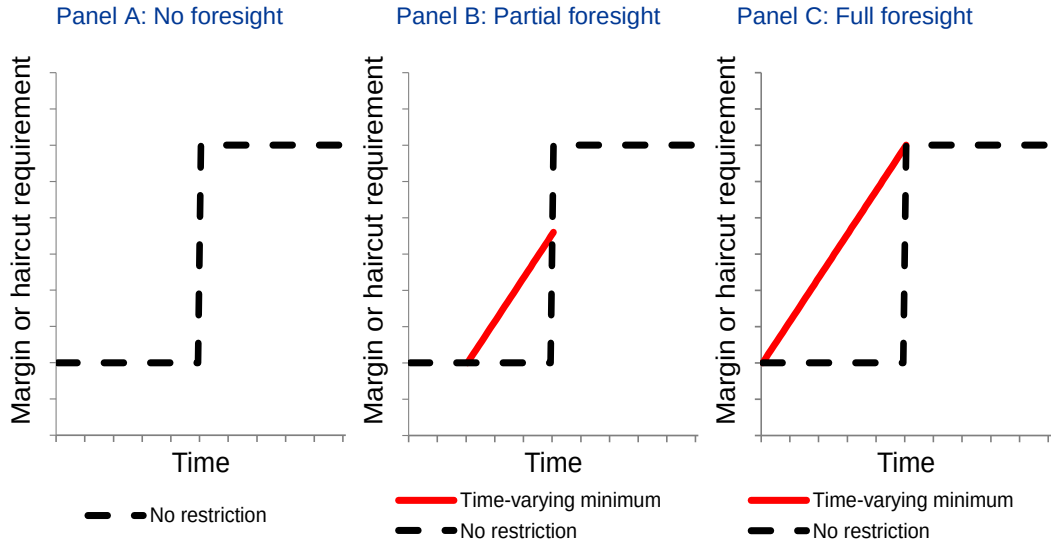
- With time-varying minimum requirements, the sudden increase in margins or haircuts occurs unimpeded: in Figure 9a, the dashed black line increases suddenly, as it would in the absence of any regulation on margins or haircuts. In this scenario, there remains an unmitigated systemic risk of a self-reinforcing illiquidity spiral.
- With step limits, by contrast, the increase in margins or haircuts immediately following the stress event is constrained: margins or haircuts may be increased only gradually to the level preferred by the counterparty (see Figure 9a). In this scenario, the risk of a systemic illiquidity spiral is reduced, but potentially with unintended consequences. Short-term trades that are not centrally cleared may not be rolled over, as counterparties would be prevented from demanding adequate insurance against counterparty credit risk. At the extreme, the repo and derivatives markets could evaporate. At the same time, trades that are centrally cleared would generate excessive credit risk for the central counterparty until the CCP is permitted to increase margins and haircuts to their desired level. Given that CCPs are "super systemic" (Tucker, 2014), this risk transfer could increase overall systemic risk. In light of these potential unintended consequences, the imposition of step limits on increases in margins or haircuts should be considered carefully.[33]

Both time-varying minima and step limits have substantial potential to dampen the risk of illiquidity spirals. Their effectiveness in practice depends on calibration and implementation. Setting minimum margin requirements too high, for example, would partially impede risk-sharing and therefore increase the cost of intermediation (Goodhart et al, 2012). Moreover, a broad application across products and markets is important to limit regulatory arbitrage (Brumm et al, 2015). The same point holds across jurisdictions: in the presence of significant regulatory differences across jurisdictions, activity could shift to regions where regulation is less restrictive. Cooperation across jurisdictions in the implementation of restrictions on margins and haircuts is therefore essential.

[33] The systemic importance of CCPs underscores the importance of designing a credible resolution framework for CCPs (Cœuré, 2014; Duffie, 2015). Central banks could also consider extending access to lender of last resort facilities to CCPs (see EMIR, recital 71). Granting CCPs access to central bank liquidity could reduce the risk that a CCP would contribute to a system-wide illiquidity spiral by fire-selling collateral in the event of a default by a clearing member, albeit at the potential cost of greater moral hazard. In November 2014, the Bank of England announced that CCPs operating in UK markets may apply for participation in the sterling monetary framework, including the Bank of England's discount window.

Figure 9

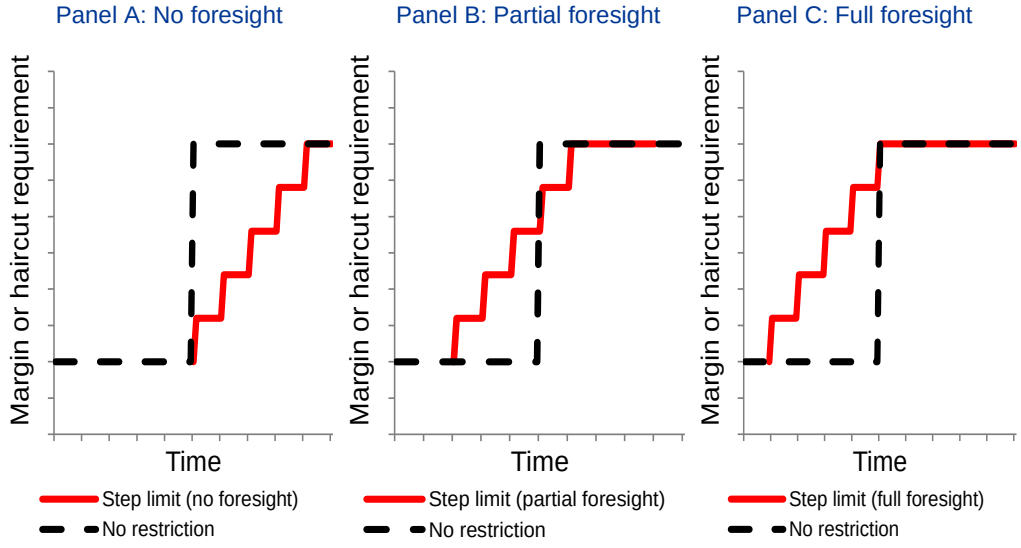
Time-varying minimum margins or haircuts



Source: ESRB.

Figure 10

Step limits on the change in margins or haircuts



Source: ESRB.

Part C: Information disclosure

The policy objective is to mitigate negative information spillovers, and thus to prevent negative externalities at times of systemic financial stress.

Policymakers could utilise their information advantage over market participants to reduce noise and uncertainty. This policy is particularly beneficial at times of stress, when uncertainty can cause market liquidity to deteriorate rapidly. In this sense, generous and credible information disclosure can help to limit indirect contagion and potentially prevent a materialisation of systemic risk. As Lo (2013) writes:

"Policymakers would do well to focus more on clear, accurate, timely, and regular communication with the public throughout periods of significant turmoil, irrespective of the cause. Only through such trusted communication can fear be successfully managed, and ultimately, eliminated. If active management of fear involves greater communication and transparency, a prerequisite is the collection and dissemination of information regarding systemic risk."

Authorities can choose the level of granularity, complexity, frequency and publication lag of the information disclosure in order to reap the benefits of information disclosure while minimising potential costs (Landier and Thesmar, 2011). These costs arise when:

- the information innovation exacerbates the asymmetry in market participants' knowledge, as processing the information is costly (Pagano and Volpin, 2010);
- market participants place too much emphasis on public information rather their own privately produced information, and therefore overreact to the disclosure of information (Morris and Shin, 2002);
- predatory traders use the information to trigger and exacerbate fire sales of marketable securities (Brunnermeier and Pedersen, 2005);
- market participants subject to the disclosure requirement manipulate the disclosed information to their own advantage (Holmström and Milgrom, 1991);
- the information innovation reveals bad fundamental news without any remedy, such as adequate capital and liquidity buffers and a credible resolution regime (Vives, 2014).

The effectiveness of this policy depends on the credibility of the competent authority. Ad hoc disclosure of information could suffer from credibility problems, since market participants may suspect that the newly released information has been selectively disclosed. To solve this credibility problem, authorities should aim to build credibility over time by committing to regular disclosure of information. Regularly disclosed information is also likely to be of higher quality. Examples of high-quality regular information disclosure in the US include the call reports for banks and 13Fs for asset managers and life insurers.

Once credibility is established, authorities could consider targeted information disclosure to alleviate specific market concerns at times of stress. The alleviation of market concerns regarding euro area banks' asset quality following the ECB's disclosure of information as part of its comprehensive assessment is an example of how targeted information disclosure can be successful. To formalise the process of information disclosure, the proposed policy would require the following steps to be taken by the relevant authority. A competent authority with a macroprudential oversight function would be particularly well-suited to this task given its mandate to identify and monitor sources of systemic risk across institutions, markets and market infrastructure.

- First, identify the most important channels of (direct and indirect) contagion, which may manifest themselves alone or in combination. Identifying contagion channels would help policymakers to focus their attention on the potential "weak spots" and "reinforcing mechanisms" in the financial system that could lead to direct and, in particular, indirect contagion.
- Second, gather data and information on various forms of interconnectedness (direct and indirect links), including various forms of institutions, market segments and market infrastructures. In order for policymakers to have an information advantage, there would need to be broad-based, regular and systematic data collection. Beyond understanding direct links through exposures, it would be essential to explore and uncover possible indirect links, for example through exposure concentrations, correlated exposures or various mechanisms that could magnify the market price channel[34]
- Third, create a framework for the comprehensive monitoring of systemic risk. Combining the evolution of interconnectedness with the level of financial stress, and taking into account potential channels of contagion, would facilitate the effective monitoring of systemic risk.

Based on the above steps, policymakers would have an information advantage relative to markets that could be used to mitigate information asymmetries, and potentially to prevent episodes of systemic financial stress, in line with the objectives of macroprudential authorities. Steps 1 to 3 are also necessary conditions for effective application of the macroprudential measures under parts A and B of this section. Effective policy action requires robust informational and analytical support.

[34] Competent authorities could also consider whether they have enough policy tools available to limit the formation of "excessive" interconnectedness (e.g. through exposure limits).

Section 4
Concluding remarks

This paper explores a framework for identifying and managing indirect contagion. Indirect contagion is the spreading of financial shocks through channels other than the direct contractual relations of financial actors. Indirect contagion almost defines systemic risk – a mechanism through which market failures spread far and wide across the global financial system. A proper understanding of indirect contagion is therefore essential to effective systemic risk management.

The paper has identified two classes of mechanisms that are present in indirect contagion: a price channel and an information channel. Prices transmit shocks to otherwise unrelated parties in the financial system when they hold correlated securities. Information – or a lack of accurate information – leads to defensive behaviour by market participants, which amplifies the impact of negative shocks.

The first important observation is that, since indirect contagion is the spreading of market failures through the financial system, existing reforms aimed at making both individual actors and the system as a whole stronger will also contribute to containing indirect contagion.

In addition, the paper discusses three possible policy innovations which could help authorities to effectively and efficiently contain indirect contagion: the macro-prudential use of time-varying and cross-sectional liquidity regulation; restrictions on margins and haircuts; and principles of the effective use of authorities' informational advantage.

The financial crisis has instigated important regulatory reforms designed to make the global financial system more robust. These reforms are being implemented; it will take some time before a comprehensive evaluation of their effects will be possible. The process of developing tools for authorities to enable them to predict, understand, and manage financial crises is well underway, and this paper explores a possible framework for dealing with one of the most challenging aspects of crises.

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