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Systemic loops and liquidity regulation☆

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ABSTRACT

Banks are typically exposed to spirals between liquidity scarcity and solvency risk. We build a network model of optimizing banks featuring contagion on both sides of balance sheets: runs on short term liabilities and banks' liquidity hoarding induce liquidity freezes; fire sale externalities and interconnected debt defaults produce asset risk. We use the model, which is calibrated to European data via simulated method of moments, to study the effects of phase-in increases of liquidity coverage ratios. Interestingly we find that the systemic risk profile of the system is not improved and might even deteriorate. Based on those insights we propose an alternative approach: differential (across banks) application of coverage ratios based on a systemic importance ranking help to mitigate the externalities and deliver a much more stable system.

1. Introduction

Systemic risk is usually associated with *contagion*. Indeed, contagion is a key ingredient in explaining how a small shock can lead to large system-wide losses (i.e. how systemic risk emerges). Contagion itself is a multifaceted phenomenon as it can occur on both the liability and asset sides of banks' balance sheets. But in order to properly account for how systemic risk can arise, contagion is not enough: *amplification* is also needed. Amplification mechanisms are critical in deepening contagion effects and in particular in generating self-reinforcing dynamics. Understanding how contagion arises through its various channels and how it gets endogenously amplified is paramount for crisis prevention. At the current juncture prudential regulation is undertaking two main avenues. Equity requirements are meant to control and prevent the spread of losses on banks' asset side. Liquidity requirements, newly introduced in Basel III and subsequent regulations (CRD IV and CRR), aim at mitigating the impact of liquidity freezes. A unified theory of contagion and its interaction with amplification mechanisms is not yet available, although many recent and prominent contributions have examined in depth various individual channels of contagion. We move a step forward in this direction by providing a unified model that captures the interplay between these channels, in the context of a micro-founded framework with a meaningful role for regulation. We focus on the newly adopted liquidity regulation, which has been motivated by the widespread observation that banks' solvency crises are often the result of liquidity freezes (namely distress on the banks' liability side).

To build a theory of contagion it is essential to endeavour toward a model with interlinkages. We do so by building a banking network model which features interlinkages on both the asset and the liability side of banks' balance sheets. In our model banks optimally solve portfolio decisions (choosing both interbank lending and borrowing, liquid and non-liquid assets, and short term liabilities) subject to equity and liquidity requirements. Banks trade

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in interbank and non-liquid asset markets. They enter the first to insure against liquidity shortages,[1] but once inside they are also exposed to risks of debt default. In both markets prices are determined endogenously and fire sale externalities materialize in the non-liquid asset market. Those endogenous clearing processes together with banks' optimizing decisions contribute to determine the contagion channels in our model as described below.

Banks' short term funding comes from interbank borrowing and short term liabilities.[2] Liquidity is *scarce* in our model for two reasons. First, banks are risk averse and therefore tend to hoard liquidity in the face of shocks. Second, short term funding is obtained by resorting to external investors who assess the quality of their asset investment based on information about banks' returns. When news of non-performing banks' assets arrive, an information coordination problem among depositors of the bank takes place. Specifically, through an underlying global game mechanism (along the lines of Morris and Shin, 2003 or Carlsson and van Damme, 1993), if returns fall below a certain threshold investors run the bank. Because of interbank freezes or investors' runs, banks might experience liquidity shortages. The latter typically lead to banks' solvency crises: as postulated in Diamond and Rajan (2005) (among others) illiquid banks quickly turn into insolvent banks as liquidity shortage forces project liquidations. The ensuing asset losses render illiquid banks also insolvent. In turn insolvency of some banks puts further strains on other banks. It is those links and the feedback loops between liquidity and solvency that motivated policy makers to consider liquidity requirements so central in the design of the most recent regulatory architecture. Notice that interbank markets in our framework play a dual role: on the one side banks, experiencing liquidity shortage, enter the interbank market for insurance motives and to mitigate the impact of runs on short term liabilities; on the other side, interbank lending exposes banks to default risk. The impact of liquidity shortage on systemic risk in our model will always result from the balance between those two effects.

Our model also features a rich structure for contagion on the asset side. Both interbank lending and investment in non-liquid assets carry some risk on returns. The interbank market features direct network linkages thereby creating a direct channel for loss propagation. Defaulting banks impose losses on their creditors, who might in turn be unable to honour their debts thereby amplifying the network externalities. On the other side returns on non-liquid assets are heterogenous across banks[3] and are subject to shocks. When an adverse shock materializes banks engage into fire sales of non-liquid assets in order to fulfill regulatory requirements. Market prices fall endogenously due to the readjustment triggered by the tâtonnement mechanism. The ensuing fall in asset prices produces accounting losses on all exposed banks (pecuniary externalities).

Notice that the model features systemic feedback loops arising from the endogenous interaction of contagion on both sides of the balance sheet. Feedback loops in turn induce amplification effects. On the one side, liquidity shortage (due to interbank debt defaults or to investors' bank runs) force banks to liquidate assets and to engage into fire sales. Hence liquidity shortage triggers contagion on the asset side. On the other side, when banks' asset returns fall due to accounting losses, news of the bad performance reach investors, who might then run the bank. In this case asset risk feeds back onto liquidity risk. Past literature on banking networks (see Caccioli et al., 2014 or Glasserman and Young, 2014) pointed out that a single contagion channel can hardly explain systemic banking crises. The two side contagion channels coupled with the feedback loops just described allows our model to produce realistic banking panics: this also makes the model suitable for the study of crises prevention policies, such as liquidity requirements.

The model is calibrated to the network of large European banks presented in Alves et al. (2013). Calibration of the policy parameters is done based on regulatory requirements. The rest is instead obtained through a method of simulated moments: parameters are chosen so as to match some empirical targets. This strategy contributes to the realism and the empirical validity of the model.

We use quantitative simulations to conduct policy analysis. Prior to that we verify whether our model matches a number of banking network statistics: and indeed it does it remarkably well. Also based on this we judge it well suited for the analysis of prudential regulation. Specifically we simulate the model in response to shocks and to a gradual introduction (phase-in) of the liquidity coverage ratio (LCR hereafter). We find that a phased-in increase of the LCR produces undesired negative consequences in the dynamic of systemic risk.[4] In the initial steps of the phase-in arrangement systemic risk presents a mild reduction, but in the last step this is reversed, providing no net gain overall. The reason for this is twofold. First, under high LCR the insurance benefits of interbank trading fade away and leave space only to contagion channels. Second, an LCR requirement which is equal for all banks has distortive effects when applied to institutions which are otherwise very diverse in their exposures and balance sheet structures. Liquidity ratios have beneficial effects by limiting interbank leverage and the exposure to non-liquid assets of large banks (those with high returns on assets). This limits the scope for loss propagation through network and fire sale externalities. However their introduction has detrimental effects by creating unnecessary liquidity shortages also on banks which were only mildly exposed to contagion risk. The detrimental effects tend to out-weigh the beneficial ones in the process of phase-in.

Motivated by this finding we conduct a second policy experiment which focuses on the cross-section dimension of liquidity regulation by incorporating a macro-prudential element into an otherwise flat micro-prudential requirement. We increase liquidity requirements for systemically important banks,[5] while at the same time reducing them for the others, in a "liquidity-neutral" way (i.e. required liquidity stays the same as in the benchmark model with no macro-prudential requirements). This alternative approach is actually effective in reducing systemic risk monotonically. The differential regulation helps in maximizing the beneficial effects and minimizing the detrimental ones. Systemically important banks are in fact forced to raise internal liquidity buffers and to reduce their exposure to interbank and non-liquid asset markets, thereby reducing the likelihood of contagion. This mitigates the propagation of contagion. The other banks are instead able to free up liquidity thereby compensating for the shortage induced by the introduction of the LCR on systemically important banks. Overall this manoeuvre helps to restore the function of liquidity insurance in the interbank market.

The rest of the paper is structured as follows. The next section provides a literature review. Section 3 describes the model.

[1] Trading partners in the interbank market are matched based on an entropy algorithm, which spreads trading relationships as evenly as possible. See Upper (2011) for a methodological overview and Upper and Worms (2004) for an early application to the interbank contagion literature.

[2] We will occasionally use the term deposits for simplicity, although those are meant to be non-insurable short term liabilities, as is the vast majority of banks' outside short-term funding.

[3] This captures the fact that banks have different performing investment opportunities, either because of luck or because of their monitoring abilities.

[4] Systemic risk is computed as the percentage of assets lost following a shock, over total assets of the system.

[5] These banks are identified based on the methodology proposed by the Basel Committee on Banking Supervision (BCBS) to identify systemically important financial institutions (SIFIs).