Journal of Financial Stability 25 (2016) 179–192

Contents lists available at ScienceDirect

Journal of Financial Stability

journal homepage: www.elsevier.com/locate/jfstabil

Capital requirements, liquidity and financial stability: The case of Brazil☆

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ARTICLE INFO

Article history:
Received 30 December 2014
Received in revised form 9 July 2015
Accepted 6 October 2015
Available online 19 October 2015

JEL classification:
C63
G21
G28
G32

Keywords:
Financial stability
Capital requirements
Risk attribution
Fire sales

ABSTRACT

This paper simulates the effects of credit risk, changes in capital requirements and price shocks on the Brazilian banking system. We perform the analysis within the context of a model that integrates data on bilateral exposures in the interbank market with information about the liquidity profile of each financial institution. Asset prices in the model are determined endogenously as a function of the total volume of fire sales, thus creating the possibility that marking to market may trigger new rounds of fire sales and downward asset price spirals. The simulation results show that the Brazilian banking system is robust, as relatively large increases in the NPL ratio lead to only modest losses in the system. We also compute the contribution of each financial institution to systemic losses under severe shocks and find that contributions from medium-sized banks can be significant. However, if shocks become more severe, only large banks will contribute significantly to systemic losses.

1. Introduction

In this paper, we study the reactions of a banking system subject to regulatory constraints under a variety of shocks using a model that allows for the interaction of solvency and market liquidity issues. We use an agent-based network model that represents a network of banks mutually exposed, which also have claims and obligations towards agents that are external to the network.

Our model has the framework proposed by Cifuentes et al. (2005). In their model, each bank updates the market value of its assets and may realize losses due to the delinquency of its debtors and to assets fire sales, if they occur. When there are losses, they reflect directly on the bank's capital, which may fall below the regulatory minimum. In that case, they assume that banks restore compliance with capital requirements through risky assets fire sales. These fire sales lower the price of the assets being sold, following an exponential function with an exponent proportional to the share of the assets that are being sold. Decreased prices in markets in which fire sales have occurred affect simultaneously all banks that hold them, amplifying the original losses, given that these assets are marked to market.

Kok and Schepens (2013) find evidence that during crises, undercapitalized banks primarily react to deviations deleveraging, as their leeway to adjust balance sheets, specially raising capital, is more limited.[1] Taking into account this finding, we consider in our model an unfavorable scenario, in which asset prices are falling and banks prefer selling risky assets for restoring their compliance, as these constitute the basis for capital requirement computation. The assets are sold outside the network. Our model is also related to a model presented in Gauthier et al. (2012), and, similarly to that model, follows David and Lehar (2011), who incorporate liquidation costs in the solvency assessment of banks. However, our model differs from the above ones in what follows. In the models presented in Cifuentes et al. (2005) and Gauthier et al. (2012), the illiquid asset is marked to market. Our model, in turn, has two categories of illiquid assets, related to their accounting features: the assets

☆ The author thanks Emanuel Werner Kohlscheen, João Blanco Barroso and two anonymous referees for their constructive comments. Any remaining errors are the sole responsibility of the author. This paper presents the author's personal opinions and does not necessarily reflect the views of the Central Bank of Brazil.

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[1] In normal times, banks prefer to increase equity levels or reshuffle risk-weighted assets, without changing asset holdings (see Francis and Osborne (2012) and Kok and Schepens (2013)).

http://dx.doi.org/10.1016/j.jfs.2015.10.001
1572-3089/

from the trading portfolio (TP assets henceforth), that are equivalent to the illiquid asset in the models in Cifuentes et al. (2005) and Gauthier et al. (2012), and the available for sale assets (AFS assets henceforth), that are not marked to market. Following the international accounting standards, we compute profits or losses only when these assets are sold. In our model, adding this category of assets is essential because treating these assets as marked-to-market ones would produce highly overestimated losses. The other differences from the previous models are the functional form of the price decay functions, the debt seniority structure and the inclusion of the bank network assets in the computation of default costs.

The way banks react to adverse conditions may cause externalities to other banks within the network through three channels. The first is a direct contagion channel, operating through direct exposures between banks and the other two are indirect contagion channels, operating through asset prices. One of these channels affects marked-to-market assets: when their prices change, the banks that own them have to mark them to market. The other channel affects available for sale assets when they are sold at their market prices. These mechanisms amplify the impact from shocks on banks, creating the possibility that a modest shock produces important effects. In addition to this, the shock amplification due to fire sales caused by the need of continuous compliance with legal capital requirements provides evidence of the procyclicality of this prudential tool. In other words, in times in which banks are weakened by losses, the need to comply with capital requirements may well amplify vulnerabilities instead of mitigating them.

The model does not take into account banks' behavioral reactions to shocks. Rather, the behavior of banks follows rules or constraints imposed by the regulator. This is one of the reasons given by Borio and Drehmann (2009) and Borio et al. (2014) for not using a given model as an early warning indicator. However, this type of model can be useful because economic agents make decisions constrained by rules defined by regulation or even by themselves. It is common that banks themselves define rules to follow. One example for this is the maintenance of leverage by financial intermediaries, as studied in Adrian and Shin (2010). Concerned with the effects of the interaction between regulator-proposed rules and banks' behavioral rules, we study the need of compliance with capital requirements and find that it induces procyclicality, in line with Adrian and Shin (2010). A procyclical system amplifies a shock by providing a reinforcing feedback. This mechanism allows that small increases in shocks applied to these systems produce large increases in losses. This is the knife-edge property to which the literature refers (for instance, see Gai and Kapadia (2010) and Hałaj and Kok (2013)). Specifically in the case of capital requirements, a rule intended to keep individual banks safe may produce harmful effects on the system due to externalities.

We propose this model as a framework for systemic risk assessment or stress testing with three main features: (1) integration of solvency and market liquidity issues, (2) three channels of shock transmission, and (3) adequate treatment of the different accounting characteristics of the banks' assets.

We use this model to analyze the Brazilian banking system in December 2013. We apply three types of shocks: a parallel increase in NPL ratios, a drop in asset prices, and individual banks' idiosyncratic defaults. Given that the interbank exposures are relatively small, we find that for this banking system, the prices shock transmission channels are much more relevant than the direct exposures channel. We also find that, for lower intensity shocks, the TP assets price channel is the strongest, and for higher intensity shocks, the AFS assets price channel is the strongest. This finding is conditional to the portfolio sizes proportion: AFS assets portfolio is much larger that TP assets'. We also find that the TP assets price channel is at the root of losses amplification. This happens because the mark-to-market procedure transmits losses to most of the banks of the system, leading many of them to lose compliance and fire sell TP assets, lowering their price even more. Analyzing individual banks contribution to losses in a scenario of a simultaneous increase in NPL ratios of 10 p.p., we find that the four banks that contribute the most are relevant due to a combination of a lower capital ratio and the share of its stock of TP assets in the banking system's stock. We perform an analysis that compares the cost of protecting banks from losing compliance and the systemic losses that this protection prevents. This analysis can be used to support bailout decision making and finds that it would be worth to protect only a few medium and small-sized banks. We finally analyze the robustness of the model with respect to price decay ratios and find that higher price decays lead this banking system into a region in which the knife-edge property is remarkable. We note that this increased sensitivity of prices with respect to the quantities sold is characteristic of crises turmoil. Finally, according to the rules of this model, the reason for the increasing amplification of additional losses in response to shock increases is the presence of big banks among those affected by the shocks, as they need to sell comparatively higher amounts of assets to become compliant.

The present paper contributes with the literature in the following ways: (1) it proposes a model with an additional contagion channel, through AFS illiquid assets, (2) it presents analyses for different plausible scenarios of shocks in credit, market conditions and idiosyncratic shocks, and (3) it investigates vulnerability sources for this banking system according to the process modeled.

The remainder of the paper is structured as follows: the next section presents a literature review, the following, the model we employ, Section 4 presents the data we use, in Section 5, we test the Brazilian banking system under different types of shocks, in Section 6, we assess the individual banks contributions to losses, in Section 7, we perform a robustness check with respect to different prices decay rates, and in Section 8, we make closing remarks.

2. Literature

This paper investigates the financial stability of a network of banks with overlapping portfolios, allowing for the integration of solvency and market liquidity issues. Among the earlier papers studying financial networks, we cite Freixas et al. (2000) and Allen and Gale (2000). The first paper models the systemic risk that arises in a network of banks subject to liquidity needs that stem from depositors' uncertainties, while the second studies how the network structure of a stylized banking system affects its final equilibrium after a liquidity preference shock. Our solvency assessment process is based on the Eisenberg and Noe (2001)'s seminal paper. That paper proposes a clearing algorithm for a generic financial network that always has a solution and sets the conditions for a unique solution. This algorithm is used in financial stability studies in interbank networks and national payment systems. In this vein, Upper and Worms (2004) analyze the German banking system, Cocco et al. (2005), the Portuguese interbank market, Van Lelyveld and Liedorp (2006), the Dutch banking sector and Degryse and Nguyen (2007), the Belgian banking sector. Elsinger et al. (2006) analyze the Austrian banking system, combining the banks' exposure to default cascades with their exposures to macroeconomic risk factors. There are other papers that present models integrating risks from different sources or propagation mechanisms. Alessandri et al. (2009) describe a framework for assessing systemic risk, allowing for macro credit risk, interest income risk, market risk, network interactions, and asset-side feedback effects, using it to make projections for the United Kingdom's banking system. Barnhill and Schumacher (2011) propose a model that integrates systemic liquidity and solvency risks taking into account their correlations, and apply it to a set of banks in the U.S.. Finally, van den End and Tabbae (2012)