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Contagion in the interbank market and its determinants☆

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ABSTRACT

Carrying out interbank contagion simulations for the German banking sector for the period from the first quarter of 2008 to the second quarter of 2011, we obtain the following results: (i) The system becomes less vulnerable to direct interbank contagion over time. (ii) The loss distribution for each point in time can be condensed into one indicator, the expected number of failures, without much loss of information. (iii) Important determinants of this indicator are the banks' capital, their interbank lending in the system, the loss given default and how equal banks spread their claims among other banks.

1. Introduction

The ongoing financial crisis shows the importance of stress testing exercises in testing the resilience of financial systems given the occurrence of shocks. These results are important for regulatory purposes as a more unstable system has to be regulated more strictly. Furthermore, stress testing is important for bailout decisions: if there is a danger of one financial institution failing, some careful analysis has to be made on the issue of what this would mean for the rest of the financial system. To create meaningful stress testing exercises, one has to think about various channels through which financial distress could spread from one financial institution to another.

In many studies, the interbank market has been identified as one of these channels. To be more precise, the failure of one bank can trigger the failure of its creditor banks due to their direct exposures. This is the case if the write-downs on the exposures to the failed bank cannot be absorbed by the creditor banks' capital buffers. If one of these creditor banks also fails, there could be another round of bank failures. This procedure can lead to several rounds of bank failures and is therefore often denoted as "domino effects". Thus, one obvious stress testing exercise is to investigate how many subsequent bank failures occur as a consequence of direct exposures in the event that one bank fails for some exogenous reason.

Of course, there are other transmission channels of contagion, e.g. due to liquidity problems that result out of asset firesales or refinancing problems because of dried up interbank markets.[2] Further channels of contagion could occur due to information contagion or exposure to common risks.[3] In this paper, however, we exclusively deal with contagion effects due to direct interbank exposures. We concentrate on this channel because we have detailed data about German banks' mutual exposures at our disposal. This enables us to simulate the failure of one of the large and internationally active German banks and to investigate the effects on other German banks that arise from direct interbank linkages.

This analysis can be carried out for all banks in a banking system for a certain point in time. Repeating this exercise for different

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[2] Using data of the Dutch banking sector, van den End and Tabbae (2012) show empirically that in times of crisis, banks increasingly have to use less liquid assets to adjust their balance sheets.

[3] See, for instance, Acharya (2009).

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points in time makes it possible to judge how the stability of the financial system (in terms of the danger of a domino effect) evolves over time.

Our aim is to condense the results of the contagion exercises into one indicator for each point in time and then to investigate its determinants. Investigating the determinants of this indicator can help in three ways: first, determinants derived from theoretical considerations can be empirically validated and their importance can be assessed. Second, the analysis could give regulatory authorities important information on how e.g. a better capitalization of banks would affect (all other parameters kept equal) the stability of the financial system. Third, under the assumption that all interbank markets are similar, one can transfer the results obtained here to interbank markets for which there is no detailed data available.

Our analysis consists of three steps. First, we investigate the danger and the extent of contagion for each point in time from the first quarter of 2008 to the second quarter of 2011. Besides mutual exposures, a very important input variable for the simulations is the loss given default (LGD), i.e. the percentage of the interbank exposure that actually has to be written off in case of default. Thus, a LGD of 0% means that there are no write-downs (e.g. because of good collateral), a LGD of 100% means a complete write-down of the exposures in the event of failure. In most existing studies of contagion in the interbank market, an exogenously given and constant LGD is used. Thus, the outcome of these contagion studies crucially depends on the value of the LGD. We have, however, a unique dataset of actually realized LGD available. Thus, following Memmel et al. (2012) we use a different approach, i.e. we draw randomly from a beta distribution that is fitted to the empirical frequency distribution of our dataset. Hence, our simulations are based on a stochastic instead of a constant LGD. As a robustness check, we then compare these results with results under the assumption of a constant LGD that equals the mean of our dataset. It turns out that for rather stable systems, the assumption of a constant LGD systematically yields a lower number of bank failures than the assumption of a stochastic LGD (and vice versa). We use the cumulative distribution functions of bank failures for each point in time (which can be compared by using the concept of stochastic dominance) as well as the expectation of bank failures as an indicator to investigate how financial stability evolves over time. It turns out that the system becomes less vulnerable to direct domino effects over the time span considered.

Second, we empirically check whether the information of a whole loss distribution can be sufficiently summarized in a single indicator. Our metric is by how far an indicator can predict whether or not the loss distribution of a given quarter dominates the loss distribution of another quarter, i.e. the comparison of a whole distribution (by using the concept of stochastic dominance) is condensed into a single indicator. In this context, we use the expected number of failures as the indicator. The discriminatory power of this indicator proves to be sufficiently high.

Third, having chosen this indicator, we investigate its determinants. Following the literature on interbank contagion, we suggest four determinants: the capital in the system, the percentage of interbank assets relative to total assets, the loss given default and – as the really systemic measure – the degree of equality in the distribution of bilateral interbank exposures (measured by the entropy of the matrix). We find that the coefficients for the four determinants have the expected sign and are all significant. More important, they can explain more than 80% of the variation of the indicator.

This paper is structured as follows: in Section 2, we provide a short overview of the literature in this field and point out our contribution. Then, in Section 3, we describe the data, explain the contagion algorithm and show our results under the assumption of a constant and a stochastic LGD. In Section 4, we construct an indicator of the stability of the interbank market and, in Section 5, we explore its determinants. Section 6 concludes.

2. Literature

Our paper contributes to three strands of the literature. First, our method for simulating domino effects is similar to the empirical contagion analysis already applied to many countries (see e.g. Upper and Worms (2004) for Germany, Mistrulli (2011) for Italy or van Lelyveld and Liedorp (2006) for the Netherlands). Upper (2011) provides a comprehensive overview of this topic. Our approach, however, differs from this "standard approach" as we do not model the LGD as constant but as stochastic (see Memmel et al. (2012)). To be able to evaluate how the vulnerability of the system to interbank contagion evolves over time, we use a time series of 14 quarters. A similar approach has been used by Degryse and Nguyen (2007). They investigate contagion in the Belgian interbank market over a ten years period ending in 2002. Another related paper in this context is Cont et al. (2010). They use a detailed dataset on exposures in the Brazilian interbank market and investigate by using a contagion exercise on how the stability of the Brazilian banking system evolves from mid 2007 to the end of 2008. Though the basic simulation mechanism of these two papers is similar to ours, there are various differences to our approach (e.g. the design of the shock, the way the loss given default is modeled and the way that the stability of the system is evaluated).

Second, we develop an indicator of the interbank market's resilience. Cont et al. (2010) summarize their simulation results by developing an indicator of the systemic importance of financial institutions for different points in time. Like these authors, we have detailed information on direct interbank exposures. Additionally, we use a dataset on actually realized loss given default (LGD) on the interbank market. Thus, contrary to market-based indicators that are, for example, developed by Acharya et al. (2010), Adrian and Brunnermeier (2011) and Huang et al. (2012), our stability indicator relies on detailed supervisory data.

Third, the aim of this paper is to find out which simple indicators of a financial system help to explain our (more sophisticated) stress testing results. Furthermore, we want to assess the relative importance of these indicators. Simple indicators would be much more convenient for regulators to calculate and interpret compared to more sophisticated ones. In this context, Drehmann and Tarashev (2011) study the effects of simple indicators (such as bank size and interbank lending/borrowing) on the systemic importance of banks. They find that these simple indicators contribute well to the explanation of the more sophisticated systemic risk measures of banks. Degryse and Nguyen (2007) find that a move from a complete structure of claims towards a multiple money center structure within the Belgian banking sector (measured by the share of domestic interbank exposures of large banks to total domestic interbank exposures) as well as its increasing internationalization (measured by the share of total domestic interbank exposures to total interbank exposures) reduced the danger of contagion in the domestic interbank market. Additionally, the banks' capitalization is identified as a crucial determinant of interbank contagion. Cont et al. (2010) find that the size of interbank liabilities as well as some structural features of the interbank network (measured by newly created indicators) have an impact on financial stability.

The selection of the main determinants of our financial stability indicator is based on literature that focuses on theoretical simulations of interbank contagion. In this context, Nier et al. (2007) investigate, among other things, how the variation of banks' capital ratio, the size of banks' interbank exposures as well as banks' connectivity affects the stability of the system. Gai and Kapadia