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Risk management associated with the interbank relationships

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Abstract. *The possibility of systemic crises that could affect most financial markets is at the heart of the researchers concerns and specialists around the world. Thus, regardless of the origin of a financial crisis, it is the responsibility of the regulatory authorities to realize the isolation of the crisis, so that it does not spread to the other banks through the credit channel. The contagion from one bank to another is due to a network of financial contracts which come from three sources: the interbank market, the payment systems and the derivatives market.*

Keywords: risk management, interbank market, financial crisis, derivative financial instruments, payment systems.

JEL Classification: G21, G32.

Introduction

The increasing of non-performing loans in a bank's total investments will lead to an increase of losses, which means that there will be a low level of interest and commission income, thus negatively impacting the volume of profit. At the same time, a bank may decide to develop a development strategy based on the risk minimization goal, assuming a lower but secure profit. In such a situation, the bank will pursue the pursuit of non-dilutive placements in high security directions such as investments in government securities or interbank placements. In this way, the bank will limit the credit access by making more drastic interest rates on the subject of credit, the quality of collateral and of the loan itself. At the same time, the bank will stimulate the growth of time deposits (more expensive but less volatile), thus strengthening its liquidities.

Analysis

The interbank market is a significant element of term structures due to the fact that the shortest terms, overnight rates, are determined on this market and therefore has a strong influence on long-term maturity rates. Also, the interbank market is different from other market segments due to very close relations between participants, specific liquidity identification policies and distinct structures.

According to (Iori et al., 2007), they appreciate that interbank markets are central points of complex institutional networks that connect all financial organizations in the banking system and also in the literature there is a wide range of studies that investigate how movements borrowing costs can relate to specific bank informations, such as its size.

Thus, the level of interest rates on the federal funds market is more in the favor of large banks than small banks as evidenced by (Allen and Saundersi, 1986). In addition, while larger banks buy and sell federal funds directly on a primary market, many smaller banks lend indirectly only through a correspondent of these large banks. As a result, smaller banks generally pay higher federal funding rates or are completely blocked from the market. Due to features such as size and location, smaller banks are constrained in their ability to borrow federal funds, and some evidence according to (Nobili and Picillo, 2011) shows that better capitalized lenders benefited from lower rates, but the effect was not a solid one.

Instead, there are solid evidence that more liquid lenders have benefited from higher rates, in line with recent theories of uncompetitive and predominant behavior on the interbank market, but in our studies (Gabrieli, 2011 a, b) we can see that the Italian market in the period immediately following the bankruptcy of Lehman Brothers, happens the opposite, and the foreign banks in Italy are borrowing at higher rates than the Italian ones. This is because reputation has become significantly more important in order to obtain more advantageous rates, and medium / small banks and even very small banks also lend themselves to relatively higher rates, depending on the importance of the banks to which they are connected. We consider this to be the fact that a predominant position in the banking network after the collapse of Lehman Brothers seems to lead to a "punishment" on

borrowing costs - which is proof of the market discipline imposed by peer-review to any bank regardless of its size.

Since 2001, large banks have a tendency to have a large number of partner banks, as we can also see from (Furfine, 2001a, 2001b) because they do not face an asymmetric market information issue, and their needs funding exceeds what a limited number of banks can offer. We also found that banking relationships have significant effects on borrowing costs as well, and the interest rate charged for federal funds transactions largely reflects the credit risk of the borrowed institution. Thus, banks that have loans, but higher returns, higher capital rates and fewer problematic loans are rewarded with lower interest rates on federal funds.

However, the higher number of partner banks in the interbank market also translates into a greater dependence on each of them, as can be noted in the study by (Liedorp et al., 2010) on bank relations on the interbank market, in which data has been used for a period of 10 years between 1998-2008, illustrating that intensive connectivity across interbank markets can facilitate the spread of problems within individual banks within the interbank system. Thus, banks' risk increases as interbank exposure increases. Also, as a result of this analysis, banks are likely to reduce their risk through loans from stable partners, and the fact that the potential shocks of stability observed on interbank counterparties spread through the interbank market was made more specifically through the debt and liabilities of the affected bank balance sheet to the other banks.

However, in the case of small banks acting as borrowers, as a result of the research carried out by (Cocco et al., 2003) on the Portuguese interbank market between 1997 and 2001, a particular feature is that they are more prone to rely on loan relationships than larger banks. Therefore, smaller banks are trying to avoid the disadvantage of monitoring by their larger peer bank. We have also found that banks tend to lend to banks with which they have a close relationship when they face a greater imbalance in their reserve account. Also, when market liquidity was low, fund borrowers often relied on loans from banks with which they had a close relationship.

In this way, these relationships allow banks to secure themselves against the risk of financial collapse. This result is important because it suggests that the fragmented nature of the market allows banks to establish relationships, promote financial stability, but with very different results than those that could appear on a centralized market that was not affected by shocks.

According to (Filipović and Trolle, 2012), interbank risk is defined as the risk of direct or indirect losses from interbank money market borrowings. In my opinion, interbank risk is the risk assumed by a bank when another bank that has given it a credit goes bankrupt and can not refund the loan.

The 2007-2008 financial crisis has highlighted the importance of interbank markets for the distribution of liquidity among banks and for lending to non-bank financial institutions. Following the failure of Lehman Brothers, the interest rates between unsecured and secured interbank loans became large and volatile, as evidenced by the (Afonso et al., 2011) and (Cassola et al., 2010). Thus, central banks reacted with a combination of key policy interest

rate cuts, quantitative easing, and adjustments of liquidity management personnel. Because quantitative easing has caused interest rates on the market significantly lower than target rates and some central banks such as the US Federal Reserve and the Bank of Japan have begun to pay interest on bank reserves to maintain market rates close to the target rate and to promote efficiency and stability in the banking sector. However, in the days immediately following the bankruptcy of Lehman Brothers, the market became more sensitive to the characteristics of banks, especially to the amounts borrowed by lenders, but also to the cost of overnight funds. As a result, large banks, with high percentages of bad loans, recorded drastic reductions in daily loan amounts and borrowed from several counterparties in the days after Lehman Brothers bankruptcy.

However, since September 16, 2008, with the announcement of the AIG rescue plan, the trend has reversed, and the spreads for the largest banks have been drastically reduced. We interpret the return to pre-crisis spreads as an effect of government support for systemic banks, but this does not apply to small banks that have continued to face larger spreads. This reversal supports the idea that counterparty risk concerns have been the focus of the federal funds market as rates have returned to normal levels as soon as government interventions have reduced fears about counterparty risk.

In spite of these political interventions, the ability of interbank markets to reallocate liquidity in the banking sector remained undervalue and interest rates persisted as we can deduce from the research conducted by (Angelini et al., 2010) and (Taylor and Williams, 2009). But besides these, an essential role is played by the liquidity contagion (contagion through lack of liquidity) between the top financial banking institutions caused by the 2007-2008 credit crisis, highlighting the importance of identifying causality, equilibrium relations, and structural breaks on the short-term interbank market. If interest rates and spreads are moving independently in the long run, they are said to follow a random move, and rates and spreads are unpredictable. However, if rates and spreads are interconnected and move in a synchronized way, we obtain essential information on the spread of liquidity shocks on the interbank market. In addition, by thoroughly analyzing the interaction of money market spreads before and during a financial crisis, we can understand how structural fractures affect equilibrium relations and what are the implications for the smooth functioning of the interbank market in terms of preventing liquidity crises and their forecast.

The interbank contagion is the result of two risks: firstly, the risk that at least one component of the system is hit by a shock (the probability of a shock) and, on the other hand, the risk of spreading this shock through the system (the potential impact of shock, and in some circumstances, according to the literature, the bankruptcy of a single bank can lead to a domino effect in the entire banking system. This happens when the failure of interbank obligations by the bankruptcy bank threatens the ability of its creditor banks to meet their obligations to their interbank creditors. Under these conditions, contagion occurs mechanically through direct interconnections between banks.

But besides direct contagion, according to his analysis (Bandt and Hartmann, 2000), we also find indirect contagion. Direct contagion comes from direct financial links between banks, such as credit risk exposures. In turn, indirect contagion is the result of expectations

of a bank's health and rapid recovery capacity after the difficulties of the entire sector. Instead, banks' exposure to similar events (such as asset price fluctuations) can by definition not lead to direct contamination. Obviously, although these two channels of contagion can work separately, direct contagion and indirect contagion are not mutually exclusive and can even reinforce each other. For example, a bank failure can lead to further bank failures through direct links and may even lead to other bankruptcies, even if depositors only require the existence of links between banks.

The theory shows that the extent to which a crisis in the banking system spreads is closely linked to the structure of interbank connections, but according to (Allen, Gale, 2000) the structure of the interbank market presents three types of interbank structures:

- the structure of the full interbank market - the one in which banks are symmetrically connected to all other banks;
- the structure of the incomplete interbank market - where banks are only connected to neighboring banks;
- the structure of the incomplete interbank market disconnected - two disconnected markets co-exist.

According to this study, the full structures of the interbank market are less susceptible to contagion than the incomplete structures of the same markets, because within the full structure of the interbank market, the impact of a financial crisis in a single bank is absorbed by a larger number of banks.

Small shocks, which initially affect only a few institutions or a particular region of the economy, spread through contagion to the rest of the financial sector and then infect the entire economy as a whole. When a region suffers a banking crisis, the other regions suffer a loss because their claims on the affected region are falling (devalues). If this spreading effect is strong enough, it can cause a crisis in the adjacent regions. In extreme cases, the crisis shifts from one region to another and becomes a contagion. Incomplete information may create another channel for contagion. If a region's shock serves as a signal predicting a shock in another region, then a crisis in a region can create a self-fulfilling crisis in another region.

(Freixas et al., 2000) introduced the fourth structure called the "central bank" (the central bank) - which is symmetrically connected to all other banks and the other banks are not connected to each other. This explains that in some situations the bankruptcy of a bank connected to the money center will not trigger the bankruptcy of the money center, but the bankruptcy of the money center itself may trigger the bankruptcy of interconnected banks.

Under normal circumstances, a system of interbank credit lines reduces the cost of holding liquid assets. However, the combination of interbank credit and the payment system make the banking system prone to speculative actions, even if all banks are solid. If depositors from a home bank wish to move to other banks for deposits, considering that there will be insufficient resources for their consumption at that bank, the best answer is to withdraw deposits from the home bank. But this triggers the early liquidation of deposits from the home bank, which will make other depositors of the same bank do the same.

The structure of financial flows affects the stability of the banking system in terms of solvency shocks. On the one hand, interbank connections increase the system's "resilience" to resist the insolvency of a particular bank, as some of the bank's portfolio losses are transferred to other banks through interbank agreements. On the other hand, this cross-passive network may allow an insolvent bank to continue to operate through the implicit subsidy generated by interbank credit lines, weakening the incentives to close down inefficient banks.

In the literature, the testing of financial contagion through interbank relations during periods of crisis is very difficult to achieve due to the lack of detailed data and the impossibility of recording the transmission of shocks as a result of the extensive network of interbank links. But besides the lack of detailed data on interbank exposures, another major obstacle is the lack of bankruptcy of systemically important banks, as regulators always resort to rescuing these banks in order not to generate major contagion through interbank relations.

(Goodhart and Schoenmaker, 1995) highlighted the preference of the monetary authorities in all developed countries to save those large banks as a result of the risk of systemic contagion. This vision is also reflected in the Federal Reserve Chairman Ben Bernanke's speech in October 2008 in the context of the financial crisis, saying: "The Federal Reserve will work closely and actively with the Treasury and other authorities to reduce systemic risk."

The main finding is that larger interbank exposure generates large withdrawals of deposits. After controlling the fundamental banking principles and the macroeconomic climate, it is highlighted that banks with high levels of exposure to the bankrupt bank face a low deposit growth, as are banks with less robust bank fundamentals. While the effect of high exposure levels on deposit growth is negative, this does not necessarily mean that banks with high exposure levels suffer major withdrawals of deposits, as evidenced by some financial contagion theories.

Specifically, we note that the impact of exposure to deposit withdrawals is higher for banks (i) with a lower capital level, (ii) smaller sizes, and (iii) classified as weak by the regulator authorities. These results suggest that the magnitude of contagion is lower for banks with stronger fundamentals. This, in turn, implies that the weaker fundamentals of the banking system amplify the impact of interbank contagion.

(Degrysea and Nguyen, 2007) exploits a unique set of data on the Belgian interbank exposure series to study the determinants of interbank contagion. In the author's simulations, they tracked the consequences of non allocation (part) of interbank lending on other banks' equity, including any other domino effects. The exercise provides insights into the potential impact of "stress" situations on the Belgian financial system, which may be representative of many other small countries due to the high degree of internationalization of its interbank market, the economic significance of its large banks and similarities, in its market structure interbank.

We found out that the risk of contagion due to internal interbank malfunctions varies considerably over time and thus: increased over the period 1993-1997, decreased

subsequently and again decreased to a very low level towards to the end of the sampling period (end of 2002). This is important because existing studies focus on one point in time. The results of this research show that the structure of the interbank market, the global capitalization of banks and the degree of internationalization are important in explaining the behavior of the time series of contagion.

Interbank exposures between Belgian banks currently represent only 15% of total Belgian interbank exposure, suggesting that the potential risk of contagion from foreign interbank exposures is more important. We believe that the failure of some foreign banks could have a significant effect on the assets of Belgian banks.

Existing methodologies imply a fixed LGD (Lost Given Default). When we endogenize (we analyze and develop the LGD bankruptcy loss), we note not only that LGD interacts with other determinants of contagion, such as the market structure, but also that the effects of contagion are more important when transversal variations of LGD are introduced, than those with the corresponding LGD average.

The simulations follow successively the impact of the failure of each Belgian bank in the N and each foreign bank in M for a loss, due to bankruptcy (LGD). It is estimated that the initial failure would cause an additional failure when the exposure of a bank to bankrupt banks is large enough to compensate for the capital and it is assumed that a bank fails if its exposure to a bankrupt bank (i.e. its loss) is higher than the tier 1 capital, and if more than two banks are bankrupt, the third bank will fail as well, if its exposures to the two banks are higher than the tier 1 capital.

(Lelyvelda and Liedorp, 2004), scenario analysis is done using the interbank lending matrix, assuming that all banks are also bankrupting due to exogenous shocks. It can be noticed that a bankruptcy does not always imply that the bankrupt counterparty loses the total amount of exposure because the sale of a (part of) the assets of the bankruptcy bank can offer compensation.

Therefore, several loss rates (25%, 50%, 75% and 100%) were used to assess the strength of banks, and even temporary losses may have direct and immediate consequences for the bank's liquidity position, and therefore, for its solvency.

As in the case of the Dutch interbank system, the methodology used by (Upper and Worms, 2004) assesses the impact on the Belgian financial system, the unexpected failure of each bank correspondent of the Belgian banks. The contagion test uses a matrix of the type ($N \times (N + M)$) of bilateral interbank exposures to study the crisis propagation mechanisms. Thus, the matrix of bilateral exposures summarizes the interbank exposures of Belgian banks to the other Belgian banks ($N - 1$) and to foreign banks M.

Research findings highlight some specific regulatory issues. First, although the risk of contagion is currently low - analysis shows that contagion is a low frequency event - and interbank exposures at certain times may constitute a devastating contagion channel. This type of event is particularly relevant for banking supervisors. Given that contagion risk evolves over time, the supervisory practices should not include only frequent monitoring of large interbank exposures, but also a regular assessment of the structure of the interbank

market. However, the risk of interbank contagion should not be monitored in isolation and independently of other risks.

Secondly, surveillance efforts to control propagation processes will be more effective if they focus on large banks. In addition, although small banks can trigger some limited contagion effects, they do not cause a systemic crisis, if large banks are resistant. Analysis of the different propagation channels will allow surveillance authorities to differentiate the effects of non-systemic contamination from real systemic crises.

Third, the failure of some large foreign banks to meet their obligations has the potential to trigger significant domino effects in Belgium. This suggests that it is important for regulators to monitor cross-border interbank systemic risk sources. However, national regulatory authorities have no control over these banks. Therefore, promoting international regulatory cooperation is essential. Thus European initiatives such as the European Banking Supervisors' Committee or the bilateral or multilateral memorandums of understanding agreed by the regulatory authorities in different countries, are significant advances.

An important role on the interbank market is represented by interbank deposits and the relationship between the volume of deposits of the bankrupt bank, of its counterparties and its withdrawals of deposits. This is also being analyzed by (Lyer and Peydro, 2010) that exploits an idiosyncratic shock and suddenly triggered by the failure of a large bank, in order to provide accurate data on interbank exposures to test financial contagion due to the interbank links. Firstly, we find solid evidence that banks with a higher interbank exposure to the bankrupt bank are experiencing greater withdrawals of deposits and, at the same time, the effect of exposure to deposits withdrawals is nonlinear.

Secondly, we find out two main implications of the contagion: the magnitude of interbank contagion is higher for weaker banks, and the interbank links between surviving banks (beyond ties to bankrupt banks) are the ones that propagate the shock.

The results of this research have important policy implications for both prudential regulation and crisis management. Because interbank links are causing shocks, regulators and banks can develop risk management systems to reduce excessive exposure to single institutions and to limit destabilizing effects that might arise from idiosyncratic shocks. Another potential solution could be that the bank's capital requirements take into account the risk of concentration of large single exposures, taking into account the costs of supplying limited cash. Alternatively, there could be limits on the extent to which banks can rely on interbank market financing to meet their liquidity needs, especially if they are large banks.

Equally important in the evolution of contagion is the structure of the links between the financial institutions participating in the electronic interbank market - e-MID (the only electronic market for interbank deposits in the euro area and the USA) studied by (Temizsov et al., 2014) in attempt to establish a link between the interest rate and the stability of banking relationships and to explore how this link has evolved in the last period of the financial turmoil by identifying the determinants of their spreading.

The dataset used for this paper was based on a series of e-MID interbank electronic market data from June 15, 2006 to December 7, 2009, with detailed information on each transaction; time, transaction volume, maturity, interbank rate, transaction (buy/sell) and bank code that acts as the victim and aggressor, but also the size of both sides. The interest rate is expressed as an annual rate and the transaction volume is provided in millions of euros. The e-MID market includes contracts with maturities between one day and one year.

Although benchmarks are not correlated with bank sizes, smaller banks get better interest rates when establishing relationships with banks of similar size categories. Therefore, there is no clear evidence that benchmarks can explain the interbank spread for larger banks. In addition, (Eross et al., 2016), they look for a methodological analysis of short-term interest rates and interest spreads to determine the causality of linear interdependencies, equilibrium relations and structural changes on the short-term interbank market. The ultimate goal is to highlight whether liquidity shocks spread on the short-term interbank market and whether these shocks can disrupt long-term equilibrium relationships.

The data set is built using the daily historical spread between the US LIBOR rate and the overnight rate of the OIS swap index (LIBOR-OIS), the three-month spread of US-Germany bonds (USGer3M) and the price the three-month floating rate swap rate on the Fixed and Floating OIS (EUSWEC) exchange rate. The data cover the period from January 1, 2002 to December 31, 2015, including the previous and post-crisis periods, with the possibility of structural break-through in time series.

The dynamic forecasts indicated the presence of at least one structural pause; thus, the magnitude of shocks that translate into structural breaks is large and rare and, consequently, long-term relationships that temporarily decompose. The structural breakdown observed on the short-term interbank market on August 9, 2007 is the same with BNP Paribas' announcement that some of its mortgage-backed assets could not be valued. The uncertainty has increased and this is due to the lack of imminent liquidity developed in the money market, which was, in essence, the beginning of the 2007-08 financial crisis. Therefore, this study shows clear evidence of early warning signals, as well as structural liquidity shocks, that can be detected before the financial crisis.

Large banks are able to adjust their credit position at better rates and even improve them gradually, as it happened between 2007 and 2009, thus highlighting the impact of the change in monetary policy rates on the functioning of the uncolateralized interbank markets, as also follows from the analysis by (Vollmer and Wiese, 2015). The modeling of pricing on interbank markets is a result of a bilateral negotiation process, which is consistent with the fact that interbank transactions are usually conducted as over-the-counter transactions. We note that without the permanent facilities of the central bank, an interbank loan will only be granted if the lender's asset is not too risky, as an increase in risk could lead to a collapse of interbank lending. If the central bank offers only a marginal lending facility and interbank lending will only take place for marginally lending rates, high enough, a decrease in the marginal lending rate significantly reduces the chances of an interbank lending.

As a result, many central banks moved their liquidity framework from a corridor to a floor-type system and reduced the operational objective to the deposit ratio, which in turn decreased significantly during the financial crisis. This change in the liquidity supply framework was justified as "a means to help offset the impaired functioning of the money market," according to the European Central Bank in 2010. The purpose of such a system is to allow the central bank to provide at the same time, excessive liquidity (to prevent market stress), if necessary to stabilize the economy. Although money and credit easing could help restore interbank markets, the ECB's analysis suggests that the increase in the deposit rate may not be a too significant advantage. The main result obtained in this research suggests that an increase in the deposit rate will never lead to an increase in interbank credits, except for rare conditions that are met - stabilization is not met inflationary pressures, by rising interest rates will lead to a reduction in interbank lending, a greater need for quantitative and qualitative relaxation, and a subsequent burst of central bank balance sheets.

Conclusion

The price of a federal loan reflects, in large part, the credit risk of the borrowed institution. In particular, banks with higher profitability, with fewer troubled loans and higher capital rates pay lower interest rates on overnight loans. This suggests that banks can distinguish credit risk between their counterparts, as well as the price of loan contracts.

A bank with a high probability of bankruptcy generally can not attract overnight unsecured funds, regardless of price. However, the finding that less healthy banks are charged with higher interest rates than their perfectly healthy counterparts, highlights the risk assumed by the credit of sick banks, with at least three implications:

- first, banks can and monitor their present risk in their interbank transactions, and proposals to include some sort of interbank tracking in traditional regulation and supervision have given some empirical credibility;
- second, the magnitude of the differential price found on the overnight money market is economically significant;
- third, fixing the price for credit risk at the maturity of the overnight loan suggests that if something similar to the Calomiris plan (1998) applied using a subordinate debt of 10 years, it could be necessary a fairly wide range of admissible interest rates, if the credit risk and the maturity of the overnight loan have a significantly positive correlation.

We have found that banks tend to borrow and borrow itself from banks with which they have a close relationship when the imbalance in their reserve account is higher. In this way, the relationships allow banks to ensure against the risk of lack of funds or funds excess during the period of application of reserve requirements. It is also noticed that when market liquidity was low, debtors of funds were often based on loans from banks with which they had a close relationship.

Immediately after Lehman Brothers bankruptcy, we see that the overnight interbank market becomes sensitive to the specific features of banks, not only in terms of borrowed amounts, but also in the cost of funds. We find clear differences between large and small banks in terms of access to credit: so large banks have low daily loans after Lehman Brothers

bankruptcy and borrow from fewer counterparties. Assuming that very short-term banks do not change their demand for liquidity, this is a possible effect of restricting loans. Instead, smaller banks managed to raise the amount borrowed from the interbank market and even managed to add new counterparties during the crisis.

Only the weakest ROA banks (banking profitability relative to total assets) have accessed the Federal Reserve Window after Lehman Brothers bankruptcy. It is reasonable to suppose that these are banks that have been restricted to federal funds by the credit market, since private banks were not willing to lend them. Although it is difficult to assess whether this means that the interbank markets functioned effectively during the 2007-2008 financial crisis, but it is reassuring that we do not see that performing banks have to turn to discounts again. Such a finding would have been extremely alarming evidence of malfunctioning in the federal funds market.

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