Supervision of Complex Banking Networks

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The global financial crisis of 2008, triggered by the collapse of Lehman Brothers, highlighted a banking system that was widely exposed to systemic risk. The minimization of the systemic risk via a close and detailed monitoring of the entire banking network became a priority.

complex networks banking supervision monitoring optimization

1. Introduction

The global financial crisis of 2008, also known as the subprime mortgage crisis, is classified as the world's worst crisis since the Great Depression of 1930. The initial collapse of Lehman Brothers triggered a cascading effect of failures, thus exposing the high systemic risk embedded in a highly interrelated and interdependent banking network. Systemic risk in a banking system is defined as the risk of destabilization of the whole system, caused by the failure of a single or a small set of banking institutions. The collapse of Lehman Brothers threatened the viability of many other large financial institutions. The ones that eventually survived received significant subsidies (through bailout programs) under the Troubled Assets Relief Program (TARP) implemented by the government. The same was not true for a set of smaller institutions that were left to collapse.

Historically, following each banking crisis, a series of acts were introduced aiming to stabilize the banking system and avoid a future reoccurrence of a crisis. The Banking Act of 1933, commonly known as the Glass–Steagall Act, was signed by President Franklin Roosevelt as an attempt to restore confidence in the U.S banking system. The bill was designed to reform the banking system by imposing a dichotomy between commercial and investment banking in order to reduce risk. It also intended to allow for a safer and more effective use of banks' assets, to regulate interbank control, and prevent banks from conducting speculative operations. This boosted disintermediation, which is the practice of financing directly from capital markets without the intermediation of banks, thus reducing the banks' share in total financing. As a result, banking institutions pursued the abolishment of the Glass–Steagall Act, and several decades later, the U.S Congress passed the Gramm–Leach–Bliley Act of 1999, which was signed into law by President Clinton. The Gramm–Leach–Bliley Act waved the preexisting barriers in financial markets; hence, banking institutions were again free to engage in security trading and insurance contracts that helped them increase their market share. This newly gained freedom, and the inevitable fierce competition with non-banking institutions, led to the rapid development in the markets of new and diverse financial instruments. In effect, the liberalization of the banking sector led to a significant increase in systemic risk, as banks have since been exposed to investment and other types of risk. Many analysts believe that the 2008 financial crisis is directly linked to the imposition of the Gramm–Leach–Bliley Act. The lack of separation between commercial and investment banking activities, allows financial institutions to be involved in security trading, not only for their customers, but also for themselves, a practice that exposes common depositors to high market risk.

After the 2008 financial crisis, the Obama administration enacted the Dodd–Frank Wall Street Reform and Consumer Protection Act in 2010, in an attempt to minimize systemic risk, enforce financial sector's transparency and accountability, and implement rules for consumers' protection; however, the provisions of the Dodd–Frank Act did not include the strict separation between commercial and investment banking, and thus, it cannot fully minimize such risk in the banking sector.

It is essential for the regulators to swiftly pinpoint incidents of bank distress. A prompt identification of instances of increased systemic risk can help minimize the policy reaction time. This can help minimize the contagion and defuse the propagation of a potential financial crisis; thus, an effective and continuous monitoring of financial institutions is necessary for the maintenance of a solvent and stable banking system. Increased supervision and strict regulation of the banking system is also required by the new Basel Accord (Basel III) by the Basel Committee on Banking Supervision, introduced in the U.S. in 2013, and implemented in 2018. Recently, Durana Pavol et al. (2021) revealed the impact of bankruptcy risk on the level of earnings management in the life cycle stages.

According to the new Basel Accord framework, the regulatory authorities are responsible for: (a) implementing extensive supervision of the banking system, and (b) mitigating the effects of possible crises and limiting contagion. A significant concern, apart from finding the appropriate monitoring tools, is the appointment of such a regulatory authority. A great deal of research supports the idea that supervision of the entire banking system should be vested to a single authority. Vives (2001) and Blinder (2010) support the idea that a single authority can (a) establish credible systems, (b) achieve economies of scale, and (c) reach financial stability by taking advantage of the economies of scale between the Lender of Last Resort (LOLR) facility, supervision, and monetary policy. Boyer and Ponce (2012) support the idea that a single supervisory authority preserves a more effective supervision of the banking system than the one achieved by multiple authorities. Following the idea that a single authority can competently optimize the supervision of the entire banking system by providing a timely and efficient intervention, in October 2012, E.U. leaders decided to assign the supervision of the whole European banking network to a single authority, the ECB.

2. Supervision of Complex Banking Networks

Systemic risk is spread through the multiple interrelations between financial institutions in a banking network. A simple, concise, and efficient way to model this system is by using a complex network representation; each bank is represented by a node and the interrelation between two banks is represented by an edge linking them. The theory of complex networks provides a set of tools that are able to examine the structure of economic networks. Mantegna (1999) and Hill (1999) were the first to apply complex networks in economic systems. More specifically, Mantegna (1999) uses the MST in his attempt to study the hierarchical structure of the New York Stock Exchange, whereas Hill (1999) compared price levels across countries using the same methodology. Some closely related papers to Mantegna (1999) and Hill (1999), are Tumminello et al. (2007), Bonanno et al. (2004), Lyocsa et al. (2012), Tabak et al. (2010), Onnela et al. (2004), Kumar and Deo (2012), and Sandoval (2012). The application of complex networks in economics, and particularly, in banking, has grown expeditiously during the last few years. There are several studies that examine the risk of contagion.

The seminal paper of Allen and Douglas (2000) investigates the cascading effect of a banking crisis on a network of regions or economic sectors. The authors showed that two cases are resilient to a liquidity shock: (a) the case of a complete interbank market (i.e., a market where every bank is connected to all the other banks in the network) and (b) an incomplete interbank market with a low degree of interconnectedness. Conversely, in the case of an incomplete interbank market with a high degree of interconnectedness, the liquidity shock may spread to the whole network. Similar conclusions are drawn from the studies of Leitner (2005) and Gai and Kapadia (2010), where the results revealed that as the network becomes denser, systemic risk drops, and the influence of an institution's default is negligible as the losses of the failed institution will be spread and engrossed from the rest of the institutions in the network.

Several studies analyze the topology of real-word economic and financial networks. Their aim is to explore the roots of systemic risk and how this risk spreads in a banking network. The studies of Fagiolo et al. (2009), Inaoka et al. (2004), Iori et al. (2006), Iori et al. (2008), Nacher and Akutsu (2012), Huang et al. (2008) and Angelini et al. (1996) draw the conclusion that the structure of banking networks is characterized as scale-free and core periphery. The distinct feature of these two structures is that all networks are formed from a small number of hub banks, whereas the rest of the banks are periphery banks. Hub banks are highly interconnected, whereas, on the other hand, periphery banks are not. In these networks, the hub banks determine the system's robustness. If the hub banks are not affected by a shock in the economy, then the system is not exposed to systemic risk and the network remains healthy. On the contrary, if a hub bank suffers a shock, the crisis may be directly spread to a large part of the network, thus increasing the risk of a system failure. The only way to stop the contagion in such a case, is by supporting the hub banks with sufficient funds.

In order to examine the origins of systemic risk in depth, a number of papers analyze the topology of real word networks in an effort to identify their features. Minoiu and Reyes (2011), analyze the topology of the global banking network, formed of financial flows during and after periods of financial stress. The findings show that a number of structural breaks in the network indicate the waves of capital flows before and after crises. A network's centrality falls at the beginning of and after a debt crisis. In the study of Tabak et al. (2014), the authors introduce the directed clustering coefficient as a measure of systemic risk in complex networks. The results reveal that the network is not exposed to systemic risk, and more specifically, the clustering coefficient and domestic interest rates reveal negative correlation; as interest rates increase, the banks decrease their exposure to the system. Thurner et al. (2003), examine the impact of a network's structure on the wealth of the economy, concluding that a highly connected network is more stable since it is not exposed to large wealth changes. Hoggarth et al. (2002) assesses the impact of a banking crisis in developed and emerging countries. The study concludes that developed countries experience larger losses on average during crisis periods compared with emerging countries. Kuzubas et al. (2014) use centrality measures such as betweenness centrality, closeness centrality, and Bonacich's centrality, in order to assess the network's connectivity and identify the systemically important institutions. The results reveal that the centrality measures are adequate for the identification and the observance of systemically important financial institutions.

Furthermore, there are studies using the balance sheet-based technique to explore and evaluate the interrelations of banking institutions and their level of influence in the overall banking system. These studies test the influence of credit relations in different banking systems. Their aim is to explore how mutual claims between banks can affect the propagation of contagion. Upper and Worms (2004) study the German banking system, Cocco et al. (2009) analyze the Portuguese banking system, Wells (2004) explores the U.K. interbank market, Boss et al. (2004) study the Austrian interbank market, Furfine (2003) studies the U.S. banking system, Degryse and Nguyen (2004) tests the Belgian interbank market, and Sheldon and Maurer (1998) study the Swiss banking system. The results of the above studies overlap with one another, and they reveal that the default of a single institution is not capable of triggering the collapse of the entire system, though it is able to influence a quite small part of the network. All studies reach the same conclusion: banking systems are robust even if a single institution fails. Finally, Chan-Lau (2010) also uses a balance sheet-based approach to examine whether the financial crisis of 2008, which was triggered by an institution's failure and spread to the largest part of the world, was the aftermath of the institutions' interbank exposure and their externalities with too-connected-to-fail institutions. The results reveal that when shocks in the network jeopardize banks' solvency, they can be characterized as sources of financial contagion worldwide.

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