Designing Resilient Financial Systems

CARLOS RAMIREZ*

July 18, 2017

The question of how resilient are modern banking and financial systems has received considerable attention since the recent financial crisis. Yet, the literature provides limited theoretical guidance on what a policymaker should do to improve the resilience of a highly interconnected financial system, reflecting the fact that the policymaker is fundamentally uncertain about how capital losses propagate among related companies during times of economic stress. This paper fills this gap by developing a framework to study the behavior of such a policymaker.

I show that under some conditions such a policymaker can significantly improve the resilience of a financial system by imposing restrictions, e.g. capital or liquidity requirements, on a relatively small fraction of companies in the economy. These restrictions aim to allow companies to absorb capital losses while continuing to meet obligations to counterparties in times of economic stress. The fraction of companies restricted depends on the nature of the uncertainty faced by the policymaker and the ease of implementing restrictions

To address the aforementioned gap, I develop a probabilistic model that is motivated by a financial system in which companies are highly interconnected via credit relationships and counterparty risk is uninsurable. Within the model, systemic failures occur due to contagion; during times of economic stress, the distress of one company may cause distress to the company's counterparties, which, in turn, may cause distress to the counterparties' counterparties, and so on. The uncertainty faced by the policymaker is summarized by the fact that she is fundamentally uncertain about the underlying connectivity structure of the financial system that allows company-specific shocks to propagate and potentially cause systemic failures during times of economic stress.

I first analyze the behavior of the policymaker if she can almost perfectly forecast the underlying connectivity structure of the financial system in stressful conditions. For tractability,

*Board of Governors of the Federal Reserve System. This article represents the view of the author, and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or other members of its staff. E-mail: carlos.ramirez@frb.gov.

I focus on two policies. First, the policymaker imposes ex-ante restrictions on a fraction of randomly chosen companies. Second, the policymaker focuses on the set of companies that, with high probability, will be highly connected in times of economic stress. More concretely, the policymaker imposes ex-ante restrictions on a fraction of companies in such a set. Using results from percolation theory, e.g. Cohen et al. (2000, 2001), I determine the values of those fractions as a function of the underlying connectivity structure of the financial system and the costs of implementing restrictions. I show that in some cases, it is almost impossible to improve the resilience of a financial system when companies are selected at random. However, if restrictions are imposed on the set of companies that, with high probability, will be highly connected in times of economic stress, the resilience of a financial system can always be improved. The intuition underlying this result is that when the connectivity structure heavily depends on a few companies, improving the resilience of these companies improves the resilience of the whole financial system, whereas improving the resilience of companies at random does not necessarily decrease the likelihood of systemic failures.

I then analyze what happens when the policymaker is fundamentally uncertain about the underlying connectivity structure of the financial system in stressful conditions. In particular, I explore how the fraction of companies the policymaker imposes restrictions to varies with: (a) the uncertainty faced by the policymaker, and (b) how easily restrictions can be implemented. I show that under some conditions small changes in uncertainty introduce large changes in such fraction. I then show that the impact of implementation costs on the value of this fraction depends critically on the nature of uncertainty faced by the policymaker.

The first set of results provides a theoretical foundation of regulation that seeks to enhance standards of highly interconnected financial companies, such as the Dodd-Frank Act. The second set of results highlight the fact that optimal regulation heavily depends on the nature of uncertainty faced by the policymaker.

This paper contributes to a growing body of work that focuses on the relationship between the underlying structure of a financial system and the likelihood of systemic failures, e.g., Freixas et al. (2000), Allen and Gale (2000), Eisenberg and Noe (2001), Dasgupta (2004), Leitner (2005), Gai et al. (2011), Allen et al. (2012), Georg (2013), Amini et al. (2013), Eboli (2013), Elliott et al. (2014), Cabrales et al. (2014), Glasserman and Young (2015), Acemoglu et al. (2015), Castiglionesi et al. (2017). Unlike these papers, my paper provides guidance on what a policymaker should do to improve the resilience of a financial system when she is fundamentally uncertain about how distress propagates among related companies during times of economic stress.

REFERENCES

Acemoglu, Daron, Asuman Ozdaglar, and Alireza Tahbaz-Salehi, 2015, Systemic risk and stability in financial networks, *American Economic Review* 105, 564–608.

Allen, Franklin, Ana Babus, and Elena Carletti, 2012, Asset commonality, debt maturity and systemic risk, *Journal of Financial Economics* 104, 519–534.

Allen, Franklin, and Douglas Gale, 2000, Financial contagion, *Journal of Political Economy* 108, 1–33.

Amini, Hamed, Rama Cont, and Andreea Minca, 2013, Resilience to contagion in financial networks, *Mathematical Finance* .

Cabrales, Antonio, Piero Gottardi, and Fernando Vega-Redondo, 2014, Risk sharing and contagion in networks, *CESifo Working Paper* .

Castiglionesi, Fabio, Fabio Feriozzi, and Guido Lorenzoni, 2017, Financial integration and liquidity crises, *Forthcoming Management Science* .

Cohen, Reuven, Keren Erez, Daniel ben Avraham, and Shlomo Havlin, 2000, Resilience of the internet to random breakdowns, *Phys. Rev. Lett.* 85, 4626–4628.

Cohen, Reuven, Keren Erez, Daniel ben Avraham, and Shlomo Havlin, 2001, Breakdown of the internet under intentional attack, *Physical Review Letters* 86, 3682–3685.

Dasgupta, Amil, 2004, Financial contagion through capital connections: A model of the origin and spread of bank panics, *Journal of the European Economics Association* 2, 1049–1084.

Eboli, Mario, 2013, A flow network analysis of direct balance-sheet contagion in financial networks, *Kiel Working Paper* .

Eisenberg, Larry, and Thomas Noe, 2001, Systemic risk in financial systems, *Management Science* 47, 236–249.

Elliott, Matthew, Benjamin Golub, and Matthew Jackson, 2014, Financial networks and contagion, *American Economic Review* 104, 3115–3153.

Freixas, Xavier, Bruno M. Parigi, and Jean-Charles Rochet, 2000, Systemic risk, interbank relations, and liquidity provision by the central bank, *Journal of Money, Credit and Banking* 32, 611–638.

Gai, Prasanna, Andrew Haldane, and Sujit Kapadia, 2011, Complexity, concentration and contagion, *Journal of Monetary Economics* 58, 453–470.

Georg, Co-Pierre, 2013, The effect of the interbank network structure on contagion and common shocks, *Journal of Banking and Finance* 37, 2216–2228.

Glasserman, Paul, and H. Peyton Young, 2015, How likely is contagion in financial networks?, *Journal of Banking and Finance* 50, 383–399.

Leitner, Yaron, 2005, Financial networks: Contagion, commitment, and private sector bailouts, *Journal of Finance* 60, 2925–2953.