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Systemic risk and heterogeneous leverage in banking networks ☆

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HIGHLIGHTS

- The systemic risk depends on the leverage dispersion across banks in a network.
- Heterogeneous leverage has implications in a banking network.
- The systemic risk implications of bank specific characteristics are explored.
- The relative significance of different types of borrowers is illustrated.
- A policy experiment related to the surcharge requirements is conducted.

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ABSTRACT

This study probes systemic risk implications of leverage heterogeneity in banking networks. We show that the presence of heterogeneous leverages drastically changes the systemic effects of defaults and the nature of the contagion in interbank markets. Using financial leverage data from the US banking system, through simulations, we analyze the systemic significance of different types of borrowers, the evolution of the network, the consequences of interbank market size and the impact of market segmentation. Our study is related to the recent Basel III regulations on systemic risk and the treatment of the Global Systemically Important Banks (GSIBs). We also assess the extent to which the recent capital surcharges on GSIBs may curb financial fragility. We show the effectiveness of surcharge policy for the most-levered banks vis-a-vis uniform capital injection.

1. Introduction

The global financial crisis of 2008 paved the way for a thorough consideration of systemic effects of bank defaults. Recent financial regulations, such as Basel III, placed special emphasis on the mitigation of systemic risk. In an interbank network, an idiosyncratic shock hitting a bank may spread via borrowing–lending linkages and may thereby impair the stability of the whole system. Bank balance sheets and network positions, and the connectivity of the network are crucial aspects of financial stability. In this paper, through simulations of banking networks, we study the systemic risk implications of leverage heterogeneity. We show that introducing leverage heterogeneity significantly changes systemic risk measures,

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and reveals the significance of bank specific characteristics. We use financial leverage data of the US banking system from[1] to observe relative systemic significance of the biggest and the most-connected borrowers, the evolution of the network after a shock, systemic consequences of interbank market size and the impacts of market segmentation. We then discuss the potential implications of our results as they relate to Basel III regulations on systemic risk and to the treatment of the GSIBs. Our approach is useful for assessing to the extent to which recent capital surcharges on GSIBs may reduce the financial fragility in the banking system. We show that the surcharge for the most-levered banks reduces the total systemic risk.

Broadly, there are two strands of literature focusing on the implications and measurement of systemic risk. The first strand mainly relies on market based indicators to measure systemic risk, however these indicators do not allow for a detailed analysis of potential contagion effects or inference of risk prior to a crisis. Using a macroeconomic framework and employing data from the 2008 financial crisis, He and Krishnamurthy [1] provide evidence to support this observation.

The second strand uses network approach. There are several measures of systemic importance and systemic risk contributions of individual nodes, following the seminal papers of Erdos–Renyi [2], Bonancich [3] and Borgatti [4]. Recently, relying on earlier work on network topology, Soramaki and Cook [5] develop algorithms to identify the systemic importance of nodes in a network. Paltalidis et al. [6] model systemic risk using the Maximum Entropy approach for Eurozone. Kuzubaş et al. [7] compare the relative performance of risk measures, using interbank network data for 2001 Turkish banking crisis and observe the evolution of the network during the crisis. In another recent paper, Minoiu and Reyes [8] analyze the global interbank network, using a large dataset; they observe that the density of the global banking network as defined by these flows is pro-cyclical and find that country connectedness in the network tends to rise before crises and then to fall in their aftermath. Our results are in line with this finding. Hale et al. [9] examine the composition and drivers of cross-border banking and show that on-balance sheet syndicated loan exposures, which account for one third of total cross-border loan exposures, increased during 2008 financial crisis due to large drawdowns on credit lines growth before the crisis. Saltoglu and Yenilmez [10] discuss the role of connectivity in banking networks and its implications for systemic risk. There are several studies applying a network based analysis of systemic risk to different banking networks e.g. Ref. [11] for the US market, Benitez et al. (2014) for Mexican banking system, Puhr et al. [12] for the Austrian interbank market, and Caldarelli et al. [13] for the Italian overnight money market. Cont et al. [14] analyze how balance sheet sizes and network structure affect the systemic risk contribution of the institutions. They provide specific policy implications, targeting the most contagious banks in the system. Iyer and Pedró [15] conduct an econometric analysis of data from a natural experiment and conclude that a policy targeting the systemic risk should decrease excessive exposure of single institutions and limit the effect of shocks. Most of these studies, including that of Gai et al. [16], find that interbank networks consist of several central players and many institutions that are less connected. That is, links across banks in interbank borrowing and lending markets are not distributed evenly. In line with this evidence, we use geometric distribution in our study to form banking networks with a small number of central players, and many less-connected ones.

Simulation based studies investigate the role of interbank linkages in absorption and amplification of risk. Iori et al. [17] suggest that interbank market stabilizes the system for homogeneous banks case, whereas its role remains ambiguous in systems with heterogeneous banks. Gai et al. [16] offer policy recommendations for different network structures. Jo [18] extends Chan-Lau's [19] network analysis linking liquidity and solvency risks, and discusses how they are related to Basel III requirements. Haldane [20] discusses the role of concentration in risk amplification, and argues that interconnections among financial institutions may serve as shock amplifiers or absorbers, depending upon the degree of connectivity. We will discover this "knife-edge" property of the network in our analyses. Eisenberg and Noe [21] and Diamond and Dybvig [22] are network models including market dynamics. Eisenberg and Noe [21] reveal the existence and uniqueness of clearance vector for financial system in *fictitious default algorithm*, while Diamond and Dybvig [22] examine the effects of a bank run associated with policy issues. We employ a similar algorithm in our model. Gleeson et al. [23] propose a method for calculating the expected size of contagion cascades in the network, based the Nier et al. [24] and Gai and Kapadia [25]. Our theoretical framework adapt several features from these two models. Bluhm et al. [26] incorporate market equilibrium into a heterogeneous banking network, focusing on the microfoundation, including optimal portfolio decisions along with liquidity and capital constraints.

Despite a large body of literature on the linkages between the leverage and systemic risk, most of the existing network models mentioned above have been built on homogeneous leverages. On the other hand, Adrian and Shin [27,28], Danielsson et al. [29,30], and Brunnermeier (2009) reveal the importance of financial leverage in systemic risk. Thurner [31] shows that higher leverage gives rise to higher volatility in prices in the financial markets, and hence higher risk. Moreover, small random events, that are harmless at low levels of leverage, may have a severe effect on the system in the case of relatively high leverage. Brunnermeier and Sannikov [32], in a macroeconomic model, illustrate the relationship between high leverage positions and a more unstable system. Ramadan [33], employing a cross-sectional data analysis, concludes that leverage is a significant factor for risk, no matter which method is used in estimation. These findings give rise to the question about the role of leverage differentials in network analysis of banking systems.

Our paper contributes to this literature by using networks tool to analyze systemic risk in the case of heterogeneous leverages. We investigate systemic consequences of leverage differentials across banks. Our main concerns are fragility

[1] Forbes, Dec 22, 2014. "Full List: America's Best and Worst Banks". Forbes has published the data for 100 largest publicly traded banks in US. See forbes.com/sites/kurtbadenhausen/2014/12/22.