Journal of Financial Stability 9 (2013) 168–184

Contents lists available at SciVerse ScienceDirect

Journal of Financial Stability

journal homepage: www.elsevier.com/locate/jfstabil

A network analysis of global banking: 1978–2010☆

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ARTICLE INFO

Article history:
Received 8 March 2012
Received in revised form 31 August 2012
Accepted 6 March 2013
Available online 15 March 2013

JEL classification:
F21
F36
F49
G15
G19

Keywords:
Cross-border banking
Network analysis
Financial interconnectedness
Banking crises
Sovereign debt crises

ABSTRACT

We analyze the global banking network using data on cross-border banking flows for 184 countries during 1978–2010. We find that the density of the global banking network defined by these flows is pro-cyclical, expanding and contracting with the global cycle of capital flows. We also find that country connectedness in the network tends to rise before banking and debt crises and to fall in their aftermath. Despite a historically unique build-up in aggregate flows prior to the global financial crisis, network density in 2007 was comparable to earlier peaks. This suggests that factors other than connectedness, such as the location of the initial shock to the core of the network, have contributed to the severity of the crisis. The global financial crisis stands out as an unusually large perturbation to the global banking network, with indicators of network density in 2008 reaching all-time lows.

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1. Introduction

Following the seminal work of Allen and Gale (2000), a growing literature argues that the structure of financial networks matters for how they react to shocks. Higher connectedness, a basic property of financial networks, carries both benefits and risks. On the one hand, it can improve risk sharing by more easily absorbing shocks when they occur. On the other hand, it can lead to contagion because shocks can reach further out in the web of relationships. We contribute to this literature by taking the first step in assessing how the global banking system reacts to negative shocks––that is, by describing its structure and assessing how it evolves over time. To this end we use network analysis, a powerful methodological toolkit for modeling interactions between economic agents.[1]

We explore the properties of the global banking network (henceforth 'GBN') over the past three decades and its dynamics around periods of financial stress. To this aim, we use a range of binary and weighted network indicators that capture the importance of countries in the network and the degree of connectedness in the network as a whole. Our data represent cross-border (bilateral) financial flows intermediated by national banking systems

☆ Part of this work was undertaken while Javier A. Reyes was a Visiting Scholar at the IMF Institute. We thank the Bank of International Settlements (BIS) for providing us with confidential data on BIS bilateral locational banking statistics. We thank two anonymous referees and the editor of the journal, Stefano Battiston, Charlie Brummit, Mario Eboli, Giorgio Fagiolo, Patrick Imam, Tümer Kapan, Swapan-Kumar Pradhan, Marc Quintyn, Stefano Schiavo, and participants at the Joint DNB-EBC Conference on Banking and the Globalization of Finance (Amsterdam, May 2011), 9th INFINITI Conference on International Finance "Institutions, Actors and International Finance" (Dublin, June 2011), 17th International Conference on Computing in Economics and Finance organized by the Society for Computational Economics (San Francisco, June 2011), George Mason University Department of Computational Social Sciences seminar, and IMF seminars for useful comments and discussions. We are grateful to Ian Cooper, Patrick McGuire, and Mahvash S. Qureshi for extensive comments on previous versions of the paper, and to Eugen Tereanu for his contribution in the early stages of this project. The views expressed in this paper are those of the authors and do not necessarily reflect those of the IMF or IMF policy. All remaining errors are our own.

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[1] For reviews of network theory applications in economics and finance, see Nagurney (2003) and Allen and Babus (2009). Allen et al. (2009) review the literature that uses network theory to study financial crises.

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http://dx.doi.org/10.1016/j.jfs.2013.03.001

and was confidentially provided by the Bank of International Settlements (BIS). These flows define a global banking network with a core–periphery structure. Unlike many studies of financial linkages, we use flows rather than exposures because they are more likely to reflect liquidity conditions in international markets and provide variation that is particularly informative of how the GBN changes during financial crises.

We find that network density is pro-cyclical as it tends to expand and contract with the global cycle of private capital flows. In particular, network indicators have structural breaks that broadly identify two waves of capital flows, respectively, leading up to the 1997–1998 East Asian crisis and the 2008–2009 global financial crisis. The empirical distributions of network indicators tend to change shape over time, especially for borrowers in the network's periphery, but they underpin relatively stable country rankings in terms of connectedness. Before each major crisis, a new set of periphery countries rises to the top of connectedness rankings, only to be replaced by another set of countries before the following crisis. Using regression analysis we show that financial connectedness both in the core and periphery tends to rise prior to banking and debt crises, and falls in their aftermath – a result that complements the literature on post-crisis access to international capital markets. Furthermore, countries in the network's periphery fail to recover in terms of connectedness in the five years following a financial crisis.

Our analysis also reveals that total cross-border banking flows experienced a historically unique build-up in the run-up to the global financial crisis, rising several-fold compared to their long-term average. However, this rise was not matched by similar developments in connectedness. In 2007, connectivity and clustering, two of the measures we use to assess network density, reached levels comparable to earlier peaks. Despite the seemingly benign pre-crisis level of network density, the 2008–2009 episode stands out as an unusually large perturbation to the GBN, with a number of indicators plunging to historical lows. We hypothesize that the unusually large pre-crisis banking flows coupled with the initial shock hitting the core of the network created the conditions for a "perfect storm." Our results also present a puzzle. During the 2008–2009 crisis, aggregate flows decreased to levels close to their long-term average while network density fell to 30 percent below its lowest level over the sample period. Hence there is an asymmetry in the behavior of aggregate flows and connectedness, with the former experiencing a more pronounced boom but a less pronounced bust than the latter.

Our paper is closely related to studies that employ network analysis to describe the architecture of financial flows among institutions or countries and to assess the resilience of financial systems to shocks.[2] Hale (2012) constructs a global network of lending and borrowing relationships using data on bank participation in syndicated loans during 1980–2010. This network has become more tightly connected over time and more asymmetric, with the distributions of network indicators becoming increasingly skewed.[3] While Hale's network is more granular than ours, our studies are similar in that both our networks focus on flows rather than exposures. Using a BIS cross-country dataset similar to ours, Hattori and Suda (2007) analyze the global network of banking exposures over 1985–2006 and document a long-term trend toward higher financial connectedness.[4] Kubelec and Sa (2012) document similar findings using data on cross-country exposures for asset classes such as foreign direct investment and portfolio investment. Chinazzi et al. (2013) focus on changes in network topology around the 2008–2009 crisis using cross-country equity and debt exposures. They find that network density declined, asymmetry increased, and investments from periphery countries fell. Like Hale (2012) and Chinazzi et al. (2013), our results show that the GBN changes markedly during times of financial stress and that the 2008–2009 crisis stands out as an unusually large perturbation to the network.

The theoretical literature on financial networks provides a rationale for documenting the topological properties of real-world networks by showing that different network structures react differently to shocks. In their seminal contribution, Allen and Gale (2000) assess resilience to shocks in a stylized four-bank network and show that complete networks, in which every bank is connected to every other bank, are more resilient due to risk sharing. By contrast, incomplete networks, in which every bank is connected with fewer than all banks, are more fragile as less connected banks have difficulty diffusing the shocks.[5] The literature spurred by the global financial crisis has focused rather on the positive link between connectedness and instability. For instance, Battiston et al. (2012a) study connectivity and systemic risk in a model of the economy as a credit network. In their setup, higher connectivity allows for improved risk sharing but it also leads to a mechanism of trend reinforcement. When an economic agent suffers a negative shock her trade partners react by making her conditions even harder; hence financial fragility feeds on itself. Battiston et al. (2012b) relate credit risk diversification to systemic risk under different structures of the credit market, and identify conditions under which systemic risk increases with network density.

There is also a large and fast-growing simulations-based literature on the resilience of financial systems to shocks (see Upper, 2011 for a review). Nier et al. (2007) document a non-monotonic effect of connectedness in a bank network on contagious defaults: at small levels of connectivity, a small increase in connectivity raises the likelihood of contagion; in more connected networks, higher connectivity improves the ability of the financial system to absorb shocks. Gai and Kapadia (2010) show that although the likelihood of contagion in arbitrary financial networks may be low, when it occurs it can be widespread. They also suggest that similar aggregate shocks can have different impacts on the financial system depending on the importance of the affected nodes in the network. Martinez-Jaramillo et al. (2010) analyze contagion that emerges in an interbank network after one or more financial institutions' balance sheets are weakened by a random shock. They show that in order to assess financial sector stability it is important to know not only the network topology, but also the distribution of the initial shocks, the size of the losses, and the correlation of defaults.

Financial networks have also been prominent in recent models of panic during financial crises, in which the focus is on the role of macroeconomic complexity in the sense of a very complicated environment in which economic agents operate. Many observers believe that the complexity of this environment is at least partly responsible for the severity and global reach of the

[2] Recent contributions include, e.g., Garratt et al. (2011), Hale (2012), Kubelec and Sa (2012), Hattori and Suda (2007), Von Peter (2007) on the global financial architecture; Degryse et al. (2010), Gai et al. (2011), Gai and Kapadia (2010), and Georg (2011) on resilience to shocks; and Iori et al. (2008) and Soramaki et al. (2007) on the dynamics of interbank markets.

[3] This increased skewness may be associated with increased fragility (Sachs, 2010).

[4] Hattori and Suda (2007) use the BIS bilateral consolidated banking statistics, which are fit for analyzing the global balance sheet of banks. By contrast, the locational statistics that we use are better suited for examining geographical patterns. See BIS (2009) for a comparison of the BIS locational vs. consolidated statistics.

[5] In the same setup Leitner (2005) shows that financial linkages are desirable even if they act as conduits for contagion, because they can motivate banks to bail each other out if they can coordinate to do so when contagion arises.

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