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Network structure analysis of the Brazilian interbank market☆

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ABSTRACT

In this paper, we provide a detailed analysis of the roles financial institutions play within the Brazilian interbank market using a network-based approach. We present a novel methodology to assess how compliant networks are to being perfect core-periphery structures. The approach is flexible, allowing for the identification of multiple cores in networks. We verify that the interbank network presents a high disassortative mixing pattern, suggesting preferential attachment of highly connected financial institutions to others with few connections. We use the clustering coefficient to assess the substitutability of financial institutions. We find that large banking institutions are counterparties that are easily substitutable in normal times. We uncover that the rich-club effect is strongly present in the community comprising the large banking institutions, as they normally form near-clique structures. Since they play the role of liquidity providers in the interbank market, this interconnectedness effectively endows the network with robustness, as participants that are with liquidity issues can easily substitute counterparties that are liquidity suppliers. This substitutability will likely vanish during periods of stress, increasing systemic risk and the likelihood of cascade failures.

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1. Introduction

The subprime crisis highlighted the important role that money markets play in providing liquidity for the banking system. The lack of liquidity can hamper a financial institution's (FI's) maturity transformation performance. If it funds long-term assets with short-term liabilities, and for some reason, cannot rollover these liabilities, it may be unable to repay its creditors. If those creditors are facing the same liquidity shortage, this scenario may trigger a cascade of repayment failures. Consequently, those FIs under stress may be forced to sell less liquid assets for cash, in order to settle their repayments, suffering losses and worsening their situation. If this process spreads along the financial system, it can trigger a confidence crisis and reduce the ability of the banking system to perform its financial intermediation role, affecting the real sector. Network topology is one of the factors that can favor the propagation described above and, thus, the consequences that follow.

In this work, we intend to characterize the Brazilian interbank network from 2008 to 2014 in terms of complex network measurements, providing economic meaning for these measurements whenever possible. In addition, we present a novel methodology to assess how compliant networks are to being perfect core-periphery structures. To better motivate its introduction, we contrast our methodology to that of Craig and Von Peter (2014) in terms of the relative advantages and shortcomings. Complex networks are a research area that lies at the intersection between graph theory and statistical mechanics, which endows it with a truly multidisciplinary nature (da F. Costa et al., 2005; Silva and Zhao, 2016). As highlighted by Newman (2010), one prominent advantage of employing network-based theory is that it is able to capture topological and structural characteristics of the data relationships. In this work, we take advantage of the characteristics provided by the networked representation of the interbank market to describe it in a structural and systematic way.

Using classical network analysis tools, we find that the degree measures of the interbank market participants show that the most connected FIs are large banks and that non-large banks are less connected than the others, but still participate in the market both as borrowers and lenders. In contrast, non-banks of all sizes are mostly borrowers that have, on average, zero lending relationships.

We use the clustering coefficient network measurement to assess the substitutability of FIs from the viewpoint of the observed network structure. We find that large banks usually possess larger clustering coefficients than non-banks, indicating that they present a relevant non-sparse network structure in their surroundings. In other words, their neighborhood may invest in several other counterparties. Consequently, these large banks are more substitutable than large non-banks. In normal times, banks can fund themselves using roughly any one of the core banks, as they are easily substitutable. However, there is an inherent instability in this substitutability as with the emergence of a crisis or enhancement of asymmetric information. In these cases, substitutability will likely vanish and these core regions within the network will likely suffer from contagion and cascade defaults. These are two sides of the same coin. In normal times, large banks – liquidity providers – can be easily replaced as the network around them is dense. However, if a default is triggered, there is a potential for large increases in systemic risk due to the network topology.

The analysis of the assortativity shows that the network present strong disassortative mixing patterns. This fact indicates a financial system in which highly connected FIs are frequently connected to others with very few connections. The joint analysis of assortativity and degree measures suggests that links between non-banks and banks are far more typical than links among non-banks. In addition, the strong disassortative trace displayed by the Brazilian interbank market suggests the presence of a network with a core-periphery structure. In such kind of network, the peripheral vertices only connect to the core, and the core is allowed to connect to the remainder of the network, acting as intermediators in the interbank borrowing and lending processes. In fact, Lux (2015) shows that the underlying network generating process for interbank markets is better approximated by a core-periphery network generation model than by other classical network formation approaches.

Even though the disassortative pattern shown by the Brazilian interbank market suggests the existence of a core-periphery structure, that network measurement only takes into account the degree correlations between market participants. That is, it does not confirm the existence of a well-defined network core, in which its members are strongly interconnected. We can extract this type of information using another kind of network measure called “rich-club” coefficient. This index verifies the existence of the “rich-club” phenomenon, which refers to the tendency of FIs with several interbank operations to be tightly connected to each