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A stable systemic risk ranking in China's banking sector: Based on principal component analysis☆

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HIGHLIGHTS

- We compare five popular systemic risk rankings for the Chinese banking sector.
- We find that PCA based on five popular methods provides a reliable risk ranking.
- PCA combined systemic risk ranking is mainly based on fundamentals for Chinese banking sector.
- Our results implicate that the PCA model provides a stable ranking for banking supervision.

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ABSTRACT

In this paper, we compare five popular systemic risk rankings, and apply principal component analysis (PCA) model to provide a stable systemic risk ranking for the Chinese banking sector. Our empirical results indicate that five methods suggest vastly different systemic risk rankings for the same bank, while the combined systemic risk measure based on PCA provides a reliable ranking. Furthermore, according to factor loadings of the first component, PCA combined ranking is mainly based on fundamentals instead of market price data. We clearly find that price-based rankings are not as practical a method as fundamentals-based ones. This PCA combined ranking directly shows systemic risk contributions of each bank for banking supervision purpose and reminds banks to prevent and cope with the financial crisis in advance.

1. Introduction

The International Monetary Fund (IMF, 2016) claims that continued and extensive Chinese financial reforms will support the growth and stability of China and the global economy.[1] China has attempted to or been an indispensable part of the world economy with many achievements in its monetary and financial system, especially with respect to the progress of reforming

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[1] The International Monetary Fund Annual Report, 2016, see at http://www.imf.org/external/pubs/ft/ar/2016/eng/sdr.htm.

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its banking system. According to the 2016 list of global systemically important banks (G-SIBs),[2] Chinese banks including Industrial and Commercial Bank of China (ICBC), China Construction Bank (CCB), Bank of China (BOC) and Agricultural Bank of China (ABC), are all in the top five banks by Tier 1 capital worldwide. Numerous literature pay specific attention to the banking sector as banks, which are the primary backstop providers of liquidity in the economy and issuers of federally guaranteed deposits to households, are critical to stability (see, e.g., [1–4]). With the rise of China, the stability of the Chinese banking sector is gradually becoming essential for global financial markets. Therefore, how to measure systemic risk properly in Chinese banking system is an inevitable issue not only for China, but also for global financial systems.

Ever since the outbreak of global financial crisis, many methods have been used to measure systemic risk of the institutions in financial sector, such as leverage ratio (short as LVG, [5,6]), SRISK [7,8], Value at Risk (short as VaR, [9,10]), ΔCoVaR [11,12], and capital assets pricing model beta times market capitalization (short as CAPM-$\beta\times$MV, [13,14]). However, these methods can hardly be used for supervision purpose because of their weak theoretical foundation and inherently volatile in rankings [15].

In this paper, we focus on providing a robust combined ranking by applying principal components analysis (PCA) to combine five prominent systemic risk rankings of financial institutions. Our work would also prefer to consider the absence of research in systemic risk during the post-crisis era. Following Nucera et al. [15], we apply five popular methods (LVG, VaR, SRISK, ΔCoVaR, and beta $\times$ size) to analyze the systemic risk rankings of China's banking sector, using the PCA method as the indicators, such as leverage ratio, provide fundamental information on the riskiness of individual banks (IOSCO, 2011). The indicators based on market data, such as VaR and ΔCoVaR, contribute market risk to the combination, and different measures contain rich information concerning systemic risk. Therefore, we combine these five popular systemic risk measurement rankings in our study by applying the PCA model, which contains sufficient information and generates a reliable systemic risk ranking. PCA is a standard tool in multivariate variable analysis to reduce the number of dimensions, while retaining the data's information. Using the PCA method, we can consider both the fundamental information and the price-based information simultaneously, analyze the systemic risk contribution of banks directly, and identify the top systemically risky banks, which is more reliable and convincing. Therefore, the method prompts banks to prevent and cope with the financial crisis beforehand, which is valuable for supervision purposes. In addition, important original variables that are the major contributors to the first few components can be identified through the PCA method.

We focus on three main empirical results in this paper. First, we apply five popular methods to analyze the systemic risk rankings of sixteen listed Chinese banks between September 2010 and October 2016 and it turns out that there are vastly different systemic risk rankings for the same bank. From the result of comparing stabilities of different rankings, we also notice that approaches of different basis deviate substantially when using a sample of Chinese banking market. Second, when we investigate rank volatility and state transition matrix of our five input methods and two combined rankings, it is not surprising to find a more concentrated diagonal line that reveals a stable ranking PCA model offers. Besides, the matrix also offer evidence that methods rely on market data are not practical as fundamental-based systemic risk measures. Third, we use principal component analysis to offer a reliable ranking to obtain a combined ranking that is less affected by model risk and estimation uncertainty for both regulators and market participants. The results of China's banking data are not the same as the previous study. Nucera et al. [15] focus on the mature market and study the systemic risk of banks in developed countries, while this paper examines the systemic risk in China. On the other hand, in comparison to Huang et al. [16], we employ five systemic risk measures and the PCA model to provide a comprehensive analysis of the Chinese banking system, rather than only employing the CoVaR, MES, systemic impact index (SII), and vulnerability index (VI).

Our paper makes several contributions to academic literature on systemic risk ranking of the Chinese banking system. First, we employ five methods to measure the systemic risk of the banking sector in China. As a unique part of the global economy, China plays an important role in global financial stability, particularly in its banking sector. In addition, as there is limited evidence on emerging markets, the samples from China are representative of the developing countries. We then compute standardized monthly rankings for different banks, and describe the time-series evolution and the cross-sectional of each ranking criterion. More importantly, we find that the price-based rankings (such as VaR and ΔCoVaR) are not practical methods in comparison to the fundamentals (such as LVG, SRISK, and CAPM-$\beta\times$MV) in China, as market data provides limited information on systemic risk.

Second, to the best of our knowledge, this is the first attempt to use principal components methodology to measure systemic risk ranking within banking system in China. We use principal component analysis (PCA) to obtain a reliable combined systemic risk ranking for supervision purpose in practice. More specifically, in this article, five popular systemic risk measurements (SRMs) are employed to obtain a standardized ranking (between 0 and 1) for each bank. We then apply PCA model to analyze five kinds of scaled rankings to obtain the CR1, which contains more than 60% information that the five SRMs provide. The CR1 is a linear combination of five systemic risk rankings. It can not only reduce the number of dimensions, but also retain as much information as possible. Our paper clearly finds that this combined ranking is mainly based on fundamentals instead of market price data, which cautions us to pay more attention to the operation of financial enterprises.

The remainder of the article is organized as follows. In Section 2, we introduce the related literature. Then, we focus on data and main methodology in Section 3. Section 4 discusses the empirical findings and conducts further analysis. We conclude in Section 5.

[2] The Financial Stability Board (FSB), in consultation with Basel Committee on Banking Supervision (BCBS) and national authorities, has identified the 2016 list of global systemically important banks (G-SIBs), using end-2015 data and the updated assessment methodology published by the BCBS in July 2013. See at http://www.fsb.org/wp-content/uploads/2016-list-of-global-systemically-important-banks-G-SIBs.pdf.

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