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CRI Systematically Important Financial Institution (CriSIFI) White Paper

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ABSTRACT

The Credit Research Initiative (CRI) has been publishing the CRI Systemically Important Financial Institutions (CriSIFI) rankings since Aug-2017. CriSIFI is a novel way of assessing and ranking the systemic importance of the exchange-listed banks and insurers around the world. It is available for each month from January 2000 onward, and is updated monthly on the CRI website (www.nuscri.org/en/srt). Viewers can use the CriSIFI to track and monitor the relative systemic importance of each institution to the overall financial system (global or local) over time.

In addition to the rankings that are available on the CRI website, viewers can also use the CriSIFI visualization dashboard (<http://crisifivis.nuscri.org/>) which aims to give viewers a more intuitive and digestible representation of financial network connectedness. The dashboard provides 4 main visualization variants that provide useful analytics for different systemic risk measures, giving viewers the ability to choose the measure of interest for their analysis.

This latest release details two new updates to the CriSIFI methodology. Firstly, the common factor model has been updated in line with wider NUS-CRI developments pertaining to default correlation calculations. This includes an expanded pool of common risk factors and an updated factor model selection-recalibration methodology. Secondly, following the switch in industry classification standards (ICS) from NUS-CRI 2007 to NUS-CRI 2020, an additional 1000 banks and insurers have been included in the ranking, bringing the total number of financial institutions covered to over 3000.¹

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¹ The new results are arguably similar to those in the last release. For instance, the rank correlation for the August 2008 CriSIFI between the two releases is 0.49.

I. OVERVIEW

The global financial crisis during 2007-2009 has highlighted the interconnected nature between the financial institutions. It has also demonstrated the catastrophic impact of a few failures on the global financial system. Using the tendency of firms defaulting together (i.e., their default correlations) and along with the firms' respective sizes, CriSIFI identifies the banks and insurers that are closely connected with, and impose significant risk to, the global financial system. Simply put, the CriSIFI rankings identify financial institutions that are both “too big to fail” and “too connected to fail”.

CriSIFI is displayed on the CRI website in ranking tables that are available for each month starting from January 2000 to present. The CriSIFI rankings till February 2022 are back-calculated, while the rankings since then have used information that has become newly available in each following month. The tables contain around 1,600 banks and 600 insurers worldwide under NUS-CRI 2007 Industry Classification System (ICS), depending on the point in time. Under NUS-CRI 2020 ICS, the number of banks has increased to around 2,500, while the number of insurers in the sample remains relatively unchanged. Both ICSs are available on the website. A firm with a higher ranking (e.g., 10 is a higher ranking than 20) is deemed to impose more risk to the financial system and therefore has a higher systemic importance.

Besides the global CriSIFI rankings available on the website by default, viewers can also search the CriSIB (CRI Systemically Important Bank) and the CriSII (CRI Systemically Important Insurer) rankings globally. Furthermore, viewers can filter financial institutions in a local community defined by region (e.g., North America, Asia-Pacific Developed economies, etc.) and economy (e.g., US, Singapore, etc.). For example, one can view the rankings for all listed banks in the US by selecting “Bank” for firm type, “North America” for region and “United States” for economy. This function aims to help users monitor a particular portfolio. All rankings are available for download.

II. METHODOLOGY

The computation of CriSIFI builds upon the methodology introduced by Chan-Lau et al. (2018)². The procedure comprises of the following three steps:

Step 1: Identifying the PD correlations between entities

The CRI team uses the default correlation model of Duan and Miao (2016)³ to produce a forward-looking Probability of Default (PD) total correlation matrix, which is then transformed into a **partial correlation matrix** by applying the CONCORD algorithm. The use of the partial instead of total correlation matrix reflects a fundamental need to construct a network utilizing direct connections while through the network indirect relationships get revealed. This release adds more macroeconomic credit risk factors as candidates, such as FX and interest rates, in selecting a suitable common factor model to be used to generate default correlations.

The optimal common factors for the model are now chosen using the zero-norm variable selection technique of Duan (2019).⁴ The future PDs, simulated at the time of prediction, are 1-month ahead PDs for the 1-year prediction horizon. These simulated future PDs are the basis for computing the total default correlation matrix. The partial PD correlation, used for the CriSIFI, disentangles the direct connection between two parties from many indirect relationships, to obtain a much clearer network of financial institutions. The CONCORD algorithm regularizes the partial correlation matrix so that it is sparse, i.e., only account for significant correlations, but no entity herein is completely isolated from the others.

² Chan-Lau, J.A., Chuang, C., Duan, J.C. and Sun, W. (2018). "Financial Network and Systemic Risk via Forward-Looking Partial Default Correlations", *National University of Singapore Working Paper*.

³ Duan, J.C., and Miao, W. (2016). "Default Correlations and Large-Portfolio Credit Analysis", *Journal of Business and Economic Statistics*, 34(4), 536-546.

⁴ For more implementation details, please refer to the [NUS-CRI Technical Report, Version 2021 Update 1 Addendum 4](#). Previous versions of CriSIFI included all factors (CCIs) in the common factor model without performing any variable selection.

Step 2: Creating a network centrality indicator

The next step involves the creation of a **network centrality indicator**, based on the previously extracted regularized partial correlation matrix, to measure each firm's systemic importance. Let P_t be the partial correlation obtained with the information up to time t . Setting its diagonal elements to 0, e.g. removing the effect of each firm's on itself, yields a matrix denoted $P_{X,t}$. To remove the excessive noise in generating month-to-month $P_{X,t}$, this matrix is converted into $|\bar{P}_{X,t}|$ by taking an absolute value of entries in its 12-month moving average. Finally, let q_i be the relative size of a financial institution (measured by its total assets in USD) over the total assets of the sample, and Q be a diagonal matrix filled with q_i as its i^{th} diagonal element.

$Q|\bar{P}_{X,t}|Q$ is a non-negative matrix. According to the Perron-Frobenius theorem, the eigenvector corresponding to its largest eigenvalue can be made to have all non-negative elements. The i^{th} element in the eigenvector represents the centrality of the i^{th} firm in the network.

In a nutshell, CriSIFI is the centrality indicator from the size-weighted partial correlation matrix $Q|\bar{P}_{X,t}|Q$, intending to combine the node and edge characteristics of a network. It is a comprehensive measurement of a firm's size and connectedness to other firms, or systemic risk by the CRI definition, in the global context.

Step 3: Analyzing local communities

The CRI team conducts local community analysis to generate CriSIFI, CriSIB (for banks) and CriSII (for insurers) for global and various regional/country samples. For firms in a local community defined by a group (i.e., bank or insurer, region and/or economy), those financial institutions are added outside the group but connected to them to define the local community. Their rankings in the community are rescaled from their global rankings. For example, the two riskiest Brazilian banks ranked 50th and 200th globally may be ranked 1st and 2nd place in the local Brazilian banking community. This treatment is to acknowledge the fact that a financial institution is potentially connected with other banks and/or insurers outside of a particular community but in the global system, and this global impact has to be taken into account even when its importance is being assessed from a local-community perspective.

III. APPLICATIONS

CriSIFI can help users compare systemic importance of the world's financial institutions at any point in time. It can also help monitor the evolution of the systemic importance of an individual financial institution over time. Some examples are provided below for viewers to consider its potential applications:

Comparing Systemic Risk among FI at a Point in Time

Table 1 below shows the riskiest banks (Top 30 CriSIB) and insurance companies (Top 30 CriSII) as of August 2008, one month before the collapse of Lehman Brothers. Lehman Brothers, a US investment bank, was ranked the 23rd most systemically important bank in the world at that time. The ranking may, in a way, justify the disastrous impact that Lehman Brothers' bankruptcy has brought to other financial institutions.

Table 1. CRI Top 30 systemically important banks and insurance

As of August 2008, one month before Lehman Brothers' collapse.

Top 30 CriSIB	Top 30 CriSII
1) Deutsche Bank AG	1) Legal & General Group PLC
2) Natwest Group PLC	2) Ageas SA/NV
3) ING Groep NV	3) Premafin Finanziaria SpA
4) Credit Agricole SA	4) Aviva PLC
5) BNP Paribas SA	5) Friends Life FPG Ltd
6) Barclays PLC	6) AXA SA (AXA)
7) Banco Espanol de Credito SA	7) Alleanza Toro SpA
8) Intesa Sanpaolo SpA	8) Allianz SE (Allianz)
9) Societe Generale SA	9) Societa Cattolica di Assicurazioni SC
10) Mitsubishi UFJ Financial Group Inc	10) Harel Insurance Investments &
11) Dexia SA	11) CNP Assurances
12) HBOS PLC	12) Old Mutual PLC
13) UniCredit SpA	13) Fubon Financial Holding Co Ltd
14) Hypo Real Estate Holding AG	14) Migdal Insurance & Financial
15) Alliance & Leicester PLC	15) FBL Financial Group Inc
16) Banca Monte dei Paschi di Siena SpA	16) Liberty Group Ltd
17) IKB Deutsche Industriebank AG	17) UNIQA Insurance Group AG
18) Lloyds Banking Group PLC	18) Sampo Japan Insurance Inc
19) Bank of China Ltd	19) Shin Kong Financial Holding Co Ltd
20) Morgan Stanley	20) Wuestenrot & Wuertembergische
21) KBC Group NV	21) Hannover Rueck SE (Hannover Re)
22) Wachovia Corp	22) Fuji Fire & Marine Insurance Co
23) Lehman Brothers Holdings Inc	23) Milano Assicurazioni SPA
24) Deutsche Postbank AG	24) Nipponkoa Insurance Co Ltd
25) Westpac Banking Corp	25) Tokio Marine Holdings Inc
26) Shizuoka Bank Ltd/The	26) Foyer SA
27) UBS Group AG	27) Generali Deutschland Holding AG
28) Erste Group Bank AG	28) ZUR Shamir Holdings Ltd
29) Santander Bank Polska SA	29) Aioi Nissay Dowa Insurance Co Ltd
30) Bank Polska Kasa Opieki SA	30) MAA Group Bhd

Monitoring the Evolution of the Systemic Importance of a FI

Figure 1a and 1b below display the evolution of the CriSIFI rankings for Lehman Brothers and Prudential PLC, a British life insurer. Leading up to the global financial crisis, their systemic risk has significantly increased.

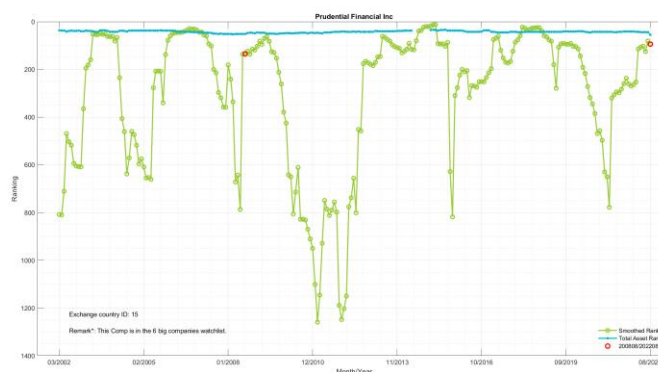
Fig 1a. CriSIFI ranking of Lehman Brothers Holdings Inc.

Compared to its size (Total asset). From January 2000 to August 2008.



Fig 1b. CriSIFI ranking of Prudential PLC.

Compared to its size (Total asset). From January 2000 to March 2018.



Evaluating the Systemic Importance of a Portfolio of FIs

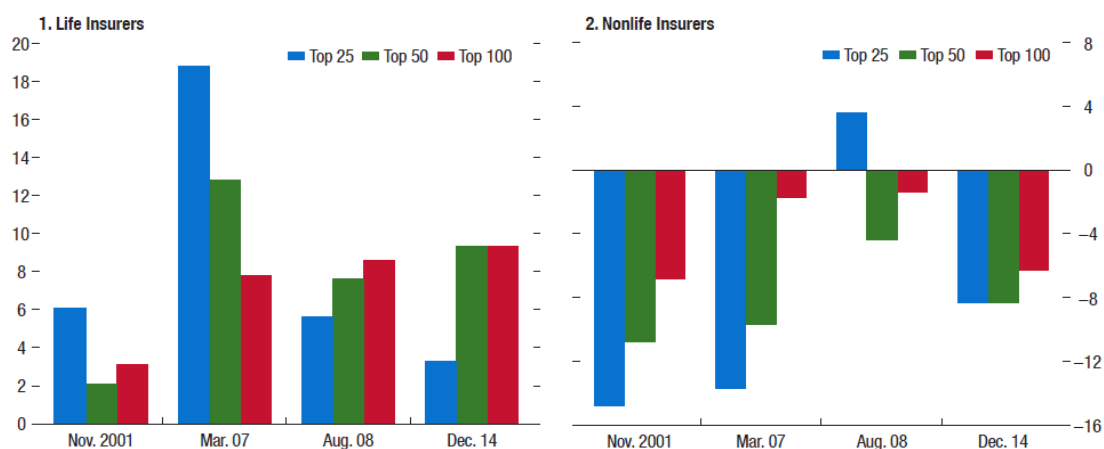
Figure 2 below is taken from the IMF Global Financial Stability report (2016).⁵ In that report, IMF economists evaluated the systemic importance of the global insurance companies, using a similar, but simpler, measure than CriSIFI. Specifically, from the regularized partial correlation matrix obtained from Step II in the Methodology section of this white paper, they counted the number of linkages, or non-zero partial correlations, between each firm and the others in the global system. They found that life insurers contribute disproportionately higher risk to the global financial system over time. This is likely due to their business lines' becoming increasingly diverse and interconnected with other financial institutions as time passes.

Fig 2. Forward-looking default correlation networks

Percent over/under representation of insurers.

Sources: Risk Management Institute (2015) and IMF staff calculations.

Figure shows over or under representation of life and nonlife insurer, in the top 25, 50, and 100 firms included in the forward-looking default correlation network. For example, a 5 percent value for the top 100 indicates that there are 5% more insurance firms among the top 100 than justified by their sample share. Total sample size ranges between 1,263 and 1,679 firms, including 310 to 410 insurers. Owing to the large number of firms, a regularization adjustment was required to generate fully connected networks, where no firm is an orphan.



⁵ International Monetary Fund (2016). "Global Financial Stability Report, April 2016: Potent Policies for a Successful Normalization", IMF reports.

IV. COMPARISON WITH ALTERNATIVE MEASURES

In this section, the CriSIFI ranking is compared with the following two systemic importance measures: [1] the Global Systemically Important Banks (G-SIBs) of the Financial Stability Board (FSB) and [2] the SRISK of the NYU V-Lab. The FSB puts together a list of 28-30 G-SIB each year from 2011 onward and requires them to hold higher but different loss absorbency ratios, depending on the risk buckets they are in. The SRISK measures the amount of capital a financial institution needs if the economy is in crisis, i.e., the amount of each financial institution's capital shortfall if the broad market index declines by 40% in 6 months. It ranks the riskiness for around 1,000 financial institutions worldwide every month from January 2000 onward.

The Spearman rank correlation is used to compare the similarity across different ranking methods. For example, for the list of G-SIB published in 2016 (using data up to December 2015), rankings from 1 onward to the 30 banks are assigned, allowing for ties when some of them fall into the same bucket. For the CriSIFI ranking, the list as of December 2015 is taken, giving 1-30 to the highest ranked firms and 31 to the rest. Subsequently, the Spearman rank correlation (on the two sets of rankings) is computed on the banks that are common in both lists. The rank correlation between the SRISK and CriSIFI is computed in a similar way. Table 2 below shows the rank correlations between CriSIFI and alternatives using year-end data for a number of years based on this latest release.

Table 2. Rank correlations between CriSIFI and alternative measures

Comparison studies performed from 2011 to 2021.

	Rank Correlation with SRISK	# companies in computing rank correlation w/ SRISK*	Rank Correlation with FSB G-SIB	# companies in computing rank correlation w/ FSB G-SIB
2011	0.39	686	0.20	27
2012	0.33	694	0.38	29
2013	0.32	704	0.30	29
2014	0.28	722	0.32	30
2015	0.12	731	0.14	30
2016	0.12	730	0.32	30
2017	0.20	732	0.26	29
2018	0.19	745	0.27	30
2019	0.08	738	0.27	30
2020	0.17	723	0.36	30
2021	0.21	724	0.25	29

* The SRISK data are taken from the V-Lab website as of December 2022. The data points are from December each year.

This table shows that the FSB G-SIB rankings has a low correlation with the CriSIFI rankings, suggesting two fundamentally different approaches to measuring systemic importance, albeit both measures attempt to identify “too big to fail” and “too connected to fail” financial institutions. SRISK also has low correlation with CriSIFI rankings, however this is not surprising as given a closer examination of the SRISK methodology, it relies on equity return correlations instead of default correlations. Neither does it utilize a network structure built through partial correlations.

ABOUT THE CREDIT RESEARCH INITIATIVE

The Credit Research Initiative (CRI) was launched by Professor Jin-Chuan Duan in July 2009 at the Risk Management Institute of the National University of Singapore. CRI has since moved under the umbrella of the Asian Institute of Digital Finance (AIDF) from 2021. Aiming at “Transforming Big Data into Smart Data”, CRI covers over 85,000 public firms and produces daily updated Probabilities of Default (1-month to 5-year horizon), Actuarial Spreads (1-year to 5-year contract) and Probability of Default implied Ratings on over 45,000 currently active, exchange-listed firms in 134 economies. CRI also maintains a historical time series on over 40,000 firms who are inactive due to bankruptcy, corporate consolidation or delisting for other reasons. In addition, CRI produces and maintains the Corporate Vulnerability Indices (CVI), which measure credit risk in economies, regions and special portfolios.

CRI also converts smart data to actionable data to meet the demand for customized usage and offers bespoke credit risk solutions, leveraging on its expertise in credit risk analytics. A concrete example is our development of the BuDA (Bottom-up Default Analysis) toolkit in collaboration with the IMF. BuDA is an automated analytic tool based on the CRI PD system, enabling IMF economists to conduct scenario analyses for the macro-financial linkage.

The CRI publishes Weekly Credit Brief and Semi-Annual Credit Summary, highlighting key credit-related events, offering insights based on the CRI PDs of the entities involved, and providing useful statistics on credit risk of economies and sectors.

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