# CRI SYSTEMICALLY IMPORTANT FINANCIAL INSTITUTION (CriSIFI) WHITE PAPER

Credit Research Initiative of the National University of Singapore

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# ABSTRACT

On February 23rd, 2017, the Credit Research Initiative releases its new product CriSIFI the CRI Systemically Important Financial Institution. The 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 it is updated monthly on the CRI website (www.rmicri.org). Viewers can use the CriSIFI to track and monitor the riskiness of each institution to the global financial system over time.

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#### **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. The CriSIFI, using the tendency of firms defaulting together and along with the firms' respective sizes, identifies the banks and insurers that are closely connected with and impose significant risk to the global financial system. Simply put, the CriSIFI identifies the "too big to fail" and "too interconnected to fail" financial institutions.

On the CRI website, the CriSIFI is displayed in ranking tables that are available for each month starting from January 2000. The CriSIFI rankings before March 2017 are back-calculated, while the ones afterwards use information that becomes newly available in each following month. The tables contain 1000-1400 banks and 300-500 insurers, depending on the point in time. A firm with a higher ranking (e.g. 10 is a higher ranking than 20) is likely to impose more risk to the financial system and therefore has a higher systemic importance.

Besides the CriSIFI, viewers can also search the CriSIB (CRI Systemically Important Bank) and CriSII (CRI Systemically Important Insurer) globally, or within 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 ranking 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 the users with special interest in monitoring a particular portfolio. All rankings are available for downloading.

## **METHODOLOGY**

The computation of CriSIFI follows the methodology introduced by Chan-Lau, et al. (2016). The procedure comprises:

 We use the default correlation model of Duan and Miao (2016) to produce a forwardlooking probability of default (PD) total correlation matrix. We then transform it into a partial correlation matrix by applying the CONCORD algorithm. The PDs, simulated at the time of prediction, are 1 month ahead PDs for the 1-year prediction horizon. Instead of using PD correlation, we resort to the partial correlation, which disentangles the direct connection between two parties from many indirect



relationships, to obtain a much clearer network of firms. We use the CONCORD algorithm to regularize the partial correlation matrix, such that it is sparse but no entity therein is completely isolated from others.

2. We create a network centrality indicator based on the regularized partial correlation matrix to measure each firm's systemic importance. Specifically, we denote by  $\mathbf{P}_t$  the partial correlation matrix obtained with the information up to time  $\mathbf{t}$ . Setting its diagonal elements to 0, as there is no interest in analyzing the effects of a firm on itself, we obtain the matrix  $\mathbf{P}_{X,t}$ . To remove the excessive noise in generating month-to-month  $\mathbf{P}_{X,t}$ , we take the 12-month moving average of the matrix to get  $\overline{\mathbf{P}}_{X,t}$  and its absolute value  $|\overline{\mathbf{P}}_{X,t}|$ . Finally, let  $q_i$  be the size of a financial firm (total assets measured in USD) over the total assets of the sample, and  $\mathbf{Q}$  be a diagonal matrix with  $q_i$  as its **i**-th diagonal element.

 $\mathbf{Q}|\mathbf{\overline{P}}_{X,t}|\mathbf{Q}$  is a non-negative matrix. According to 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 a nutshell, CriSIFI is the centrality indicator from the size-weighted partial correlation matrix  $\mathbf{Q}|\mathbf{\overline{P}}_{X,t}|\mathbf{Q}$ , intending to combine the node and edge characteristics of a network. It is a comprehensive measurement of a firm's size and its connectedness with others, or systemic risk by our definition, in the global context.

3. We conduct the local community analyses to generate CriSIFI, CriSIB and CriSII for various global/regional/country samples. That is, for firms in a local community defined by firm type (i.e. bank or insurer), region and/or economy, their rankings in the community are rescaled from their global ranking. For example, the two riskiest Brazilian banks ranked 50 and 200 globally will be ranked 1st and 2nd place in the 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 in a local community.

## **APPLICATIONS**

The CriSIFI can help one compare the systemic risk among the world financials at any point in time. It can also help monitor the evolution of the systemic importance for a financial



institution over time. Some examples are demonstrated below for viewers to consider its potential applications:

 For August 2008, the month before Lehman Brothers' collapse, the following tables show the riskiest banks (Top 30 CriSIB) and insurance companies (Top 30 CriSII). We can see from the table that Lehman imposed a major threat to the world financial system back then. The ranking, in a way, justifies the disastrous impact that Lehman's collapse has brought to the other financial intuitions.

Top 30 CriSIB	Top 30 CriSII		
Credit Agricole SA	Ageas		
Royal Bank of Scotland Group PLC	Aviva PLC		
Barclays PLC	CNP Assurances		
BNP Paribas SA	Legal & General Group PLC		
Deutsche Bank AG	AXA SA		
ING Groep NV	Liberty Group Ltd		
Dexia SA	UNIQA Insurance Group AG		
Lehman Brothers Holdings Inc	Great-West Lifeco Inc		
HSBC Holdings PLC	Lincoln National Corp		
Intesa Sanpaolo SpA	Old Mutual PLC		
HBOS PLC	Zurich Insurance Group AG		
Banco Espanol de Credito SA	Premafin Finanziaria SpA		
Citigroup Inc	QBE Insurance Group Ltd		



Bank of Ireland	Protective Life Corp		
Banca Monte dei Paschi di Siena SpA	Hannover Rueck SE		
Morgan Stanley	Friends Life FPG Ltd		
KBC Group NV	Catlin Group Ltd		
IKB Deutsche Industriebank AG	Assicurazioni Generali SpA		
Lloyds Banking Group PLC	Allianz SE		
Wachovia Corp	China Life Insurance Co Ltd		
Alliance & Leicester PLC	Harel Insurance Investments & Financial Services Ltd		
UBS Group AG	NUERNBERGER Beteiligungs AG		
CIC	Hartford Financial Services Group Inc/The		
Hypo Real Estate Holding AG	Fairfax Financial Holdings Ltd		
Bank of Communications Co Ltd	Genworth Financial Inc		
Banco Espirito Santo SA	FBL Financial Group Inc		
China Merchants Bank Co Ltd	MetLife Inc		
JPMorgan Chase & Co	Liberty Holdings Ltd		
Australia & New Zealand Banking Group Ltd	Societa Cattolica di Assicurazioni SCRL		
Royal Bank of Canada	Wuerttembergische Lebensversicherung AG		

2. The following figures showcase the evolution of the CriSIFI rankings for Lehman Brothers, a US investment bank, and Prudential PLC, a British life insurer. As we can see from the graphs, Lehman's systemic risk rose up as it went closer to its bankruptcy. Prudential has always been ranked among the riskiest financial intuition



in the world. During the global financial crisis, however, its connectedness with others has declined, resulting in a relative lower systemic risk at the time.



3. The following figure is taken from the Global Financial Stability Report, April 2016, published by the IMF. In that report, the 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 1 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 over time life insurers contribute disproportionately higher risk to the global financial system. This is likely because their business lines become increasingly diverse and interconnected with other financial firms over time.



Figure 3.9. Forward-Looking Default Correlation Networks (Percent; over- or underrepresentation of insurers)

Sources: Risk Management Institute 2015; and IMF staff calculations.

Note: Figure shows over- or underrepresentation of life and nonlife insurers, in the top 25, top 50, and top 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 percent 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 (0h and others 2014).

#### **COMPARISON WITH ALTERNATIVE MEASURES**

In this section, we compare the CriSIFI ranking with the following two: the Global Systemically Important Banks (G-SIBs) of the Financial Stability Board (FSB) and the SRISK of the NYU V-Lab. The FSB puts together a list of 28-30 G-SIBs each year from 2011 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 broad market index declines by 40% in 6 months. It ranks the riskiness for around 1,000 financial firms worldwide every month from January 2000 onward.

We use the Spearman rank correlation to compare the similarity across different ranking methods. For example, for the list of G-SIBs published in 2016 (using data up to December



2015), we give rankings from 1 onward to the 30 banks, allowing for ties when some of them fall into the same bucket. For the CriSIFI ranking, we take the list as of December 2015, giving 1-30 to the highest ranked firms and 31 to the rest. We subsequently take the banks that are in both lists, assign a hypothetical G-SIB rank of 31 to all banks outside of the G-SIB list, and compute the Spearman rank correlation with the two sets of rankings. Similarly, we compute the rank correlation between the SRISK and CriSIFI. The following tables demonstrate the rank correlations between the CriSIFI and alternatives using year-end data for a number of years.

	Rank	# of	Rank	# of
	Correlation	companies in	Correlation	companies in
	with SRISK	computing	with FSB G-SIB	computing
		rank		rank
		correlation		correlation w/
		w/ SRISK*		FSB G-SIB
2011	0.45	604	0.49	28
2012	0.41	608	0.42	29
2013	0.43	611	0.14	30
2014	0.42	602	-0.02	30
2015	0.33	584	-0.01	30
2016	0.24	559	NA**	NA

\*The SRISK data are taken from the V-Lab website as of January 2017. The data points are from December of each year.

\*\*The rank correlation with FSB G-SIB is not available in 2016, because the FSB will only release the list of G-SIBs using the 2016 data at the end of 2017.

This table seems to show that the FSB G-SIB has lower or even no correlations with the CriSIFI, suggesting two fundamentally different approaches to systemic risk in applications albeit both attempt to identify "too big to fail" and "too interconnected to fail" financial institutions. SRISK is closer to the CriSIFI, however it does not seem to explore default correlations directly or the network structure fully.



# REFERENCES

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