# Financial Sector Health Since 2007: A Comparative Analysis of the United States, Europe, and Asia

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*This essay uses recent methodology for estimating capital shortfalls of financial institutions during aggregate stress to assess the evolution of financial sector health since 2007 in the United States, Europe, and Asia. Financial sector capital shortfalls reached a peak in the end of 2008 and early 2009 for United States and Europe; however, they declined thereafter steadily only for the United States, with Europe reaching a similar peak in the fall of 2011 during the sovereign crises in the southern periphery. In contrast, the financial sector in Asia had little capital shortfall in 2008–2009 but the shortfall has increased steadily since 2010, notably for China and Japan. These relative patterns can be explained on the basis of the regulatory responses in the United States, the lack thereof in Europe, stagnation in Japan, and the bank-leverage-based fiscal stimulus in China.*

**Keywords:** systemic risk, capital shortfall, financial crises, *SRISK*, deleveraging

How should we assess global financial sector health? Can we provide a comparative analysis of such health across different countries and regions? Where do the future sources of vulnerability in the global financial sector lie?

This article employs recent advances in measurement of the systemic risk of financial firms to answer these questions. In particular, it exploits a theoretically well-founded notion of systemic risk contribution of financial firms—their expected capital shortfall in a crisis—and measures it using publicly available market and balance-sheet data. Using this measure provides a comparative analysis of the health of the global financial sector since early 2007, focusing on similarities and differences between the United States, Europe, and Asia.

The reason for focusing on capital adequacy as a measure of systemic risk is simply that undercapitalized financial sectors lead to significant loss of economic output due to withdrawal of efficient intermediation services and possibly misallocation of resources. In particular, when a large part of the financial sector is funded with fragile, short-term debt (or, conversely, is not funded with adequate equity capital) and is hit by a common shock to its long-term assets, there can be en masse failures of financial firms. In such a scenario, it is not possible for any individual firm to reduce its leverage or risk without significant costs, since other financial firms are attempting to achieve the same outcome. Since deleveraging and risk reduction are privately costly to owners of the financial firms, firms delay such actions, operating as undercapitalized firms that are averse

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I am grateful to Michael Robles of New York University Stern School of Business Volatility Institute for help with the computations and to Michael Barr and two anonymous referees for detailed comments on the first draft. Direct correspondence to: Viral V. Acharya at vacharya@stern.nyu.edu, NYU Stern School of Business, 44 West 4th St., New York, NY, 10016.

to expanding efficiently the provision of intermediation to households and corporations and keen to pursue risky strategies (gambling for resurrection) that offer them some chance of recovering, but at the cost of a greater chance of further stress. If further stress develops, there can be a complete disruption of payments and settlement services, which can cause trade and growth to collapse, as witnessed for several years during the Great Depression as well as in the fall of 2008 during the Great Recession.

The adverse impact of undercapitalized financial sectors on allocation of economic resources has been the focus of an important body of empirical research. Joe Peek and Eric S. Rosengren (2005), Ricardo J. Caballero, Takeo Hoshi, and Anil K. Kashyap (2008), and Hoshi and Kashyap (2010) show for the Japanese banking crisis of the 1990s that banks in the undercapitalized banking sector continued to operate as "zombie banks" that directed credit to nonperforming existing borrowers rather than directing this credit to efficient newer sectors of the economy. This theme has been confirmed again in the European countries following the financial crisis of 2007–2009. The lack of adequate recapitalization and cleaning-up of European banks' balance sheets has prevented an efficient allocation of credit for an extended period of time. Alexander Popov and Neeltje van Horen (2014) report that it has taken European banks much longer to recover in terms of their global syndicated lending than other banks. Viral A. Acharya and Sascha Steffen (2015) demonstrate that undercapitalized European banks put on "carry trades" by using short-term funding to purchase risky government bonds of southern periphery countries of Europe (Greece, Italy, Portugal, and Spain), a bet that did not pay off and resulted in a combined sovereign and banking crisis for Europe in the fall of 2011.

Given these adverse consequences of undercapitalized financial sectors, it is natural to focus on expected capital shortfall of the financial sector as a way of measuring its systemic risk or vulnerability to a future crisis. This article has four sections. In the first, I introduce the measure we employ, *SRISK*, based on the work of Acharya et al. (2010a, 2010b, 2010c) and Acharya, Robert Engle, and Matthew P. Richardson (2012). Next I assess global financial sector health since 2007 using *SRISK* as the measure of systemic risk. In the third section I discuss the divergence observed between the United States, Europe, and Asia, in terms of the evolution of financial sector health since 2007. The last section presents some conclusions.

## *SRISK:* A MEASURE OF FINANCIAL SECTOR HEALTH

Acharya (2009) and Acharya et al. (2010a, 2010b, 2010c) argue that systemic risk should not be described in terms of a financial firm's failure per se but in the context of a firm's overall contribution to systemwide failure. The intuition is that when only an individual financial firm gets distressed—its equity capital becomes low relative to its promised debt or debtlike liabilities—there are minimal economic consequences because healthier financial firms can fill in for the void in intermediation services caused by the failed firm. When capital is low in the aggregate, however, it is not possible for other financial firms to step into the breach. This breakdown in aggregate financial intermediation is the reason there are severe consequences for the broader economy such as a credit crunch and fire sales of assets.

Acharya, Engle, and Richardson (2012) implement this intuition by proposing a measure, called *SRISK*, of the systemic risk contribution of a financial firm; *SRISK* is measured as the expected capital shortfall of a firm in a crisis. In particular, *SRISK* of firm $i$ at time $t$ is defined as the capital that the firm is expected to need (conditional on available information up to time $t-1$) to operate "normally," that is, not face a run by its creditors, if we have another financial crisis. Symbolically it can be defined as

$$SRISK_{i,t} = E_{t\,1}(Capital\ Shortfall_i | Crisis) \qquad (1)$$

Christian Brownlees and Engle (2011; see also Engle 2011) provide the econometrics of estimating *SRISK* by modeling the bivariate daily time series model of equity returns on firm $i$ and on a broad market index using publicly available data. (The results of this analysis are updated weekly and are posted at the New York

University Stern School of Business Volatility Institute website: http://vlab.stern.nyu.edu/welcome/risk. Results are posted both for approximately one hundred U.S. financial firms and for twelve hundred global financial firms.)

To calculate *SRISK*, we first need to evaluate the losses that an equity holder will face if there is a future crisis. To do this, volatilities and correlations of an individual financial firm's equity return and the global marketwide return are allowed to change over time and simulated for six months into the future many times. Whenever the broad index falls by 40 percent over the next six months, a rather pessimistic scenario that captures the kind of market collapse witnessed during the Great Depression of the 1930s and the Great Recession in 2007–2009, this is viewed as a crisis. For these scenarios, the expected loss of equity value of firm $i$ is called the long-run marginal expected shortfall, or *LRMES*. This is just the average of the fractional returns of the firm's equity in the crisis scenarios.[1]

The capital shortfall can be directly calculated by recognizing that the book value of debt will be relatively unchanged during this six-month period while equity values fall by *LRMES*. We assume a prudential capital ratio, denoted by $k$, of 8 percent (5.5 percent for Europe, to adjust for the differences between accounting standards—the European International Financial Reporting Standards and U.S. Generally Accepted Accounting Principles—in the treatment of netting of derivatives). Then we can define *SRISK*, of firm $i$ at time $t$ as:

$$SRISK_{i,t} = E_{t\,1}((k(Debt + Equity)\ Equity)|Crisis)$$
$$= k\ (Debt_{i,t})\ (1\ k)(1\ LRMES_{i,t})\ Equity_{i,t} \quad (2)$$

where $Equity_{i,t}$ is the market value of equity today, $Debt_{i,t}$ is the notional value of nonequity liabilities today, and $LRMES_{i,t}$ is the long-run marginal expected shortfall of equity return estimated using available information today. This measure of the expected capital shortfall captures many of the characteristics considered important for systemic risk such as size and leverage. These characteristics tend to increase a firm's capital shortfall when there are widespread losses in the financial sector. But a firm's expected capital shortfall also provides an important addition, most notably the comovement of the financial firm's assets with the aggregate market in a crisis.[2]

Before we employ estimates of *SRISK* to provide a comparative analysis of the global financial sector health, a few points are in order.

First, *SRISK* can be considered the capital shortfall for a financial firm estimated using a market-data based "stress test." Stress tests have now become a standard device used by regulators to determine the capital that an institution will need to raise if there is a macroeconomic shock.[3] Regulatory stress tests employ book value of equity capital, estimate

1. In versions of the model where the simulation is not yet implemented on VLAB, *LRMES* is approximated as *1-exp(-18*MES)* where *MES* is the one-day loss expected if market returns are less than –2 percent.

2. In this sense, *SRISK* is based on a notion of systemic risk in which a "tsunami"-type shock hits the global economy rather than a "contagion"-type shock in which an individual financial firm's interconnectedness causes losses elsewhere in the financial system. The latter would, however, also be statistically picked up in a comovement of a financial firm's assets with the aggregate market providing that the contagion does have marketwide impact.

3. Acharya, Engle, and Pierret (2014) summarize the adoption of stress tests by regulators in the United States and the Europe: "An annual supervisory stress test of the financial sector in the United States has become a requirement with the implementation of Dodd-Frank Wall Street Reform and Consumer Protection Act (Pub.L. 111–203, H.R. 4173) of 2010. Macro-prudential stress tests have also been used by U.S. and European regulators to restore market confidence in financial sectors during an economic crisis. As a response to the recent financial crisis, the 2009 U.S. stress test led to a substantial recapitalization of the financial sector in the U.S. In Europe, the 2011 stress test also served as a crisis management tool during the European sovereign debt crisis. The European exercise lacked credibility in this role, however, due largely to the absence of a clear recapitalization plan for banks failing the stress test."

losses using models that map macroeconomic stress into asset losses, and require book values of capital to be sufficiently high based on regulatory risk-weighted assets.[4] In contrast to regulatory stress tests, *SRISK* is based on the market value of equity capital, estimates losses using market-data-based estimate of downside risk of market equity or its vulnerability to a crisis, and requires market values of capital to be sufficiently high relative to the quasi-market value of assets (measured as market value of equity plus the book value of nonequity liabilities). As a result, whereas the regulatory notion of leverage corresponds to risk-weighted assets divided by a measure of book value of equity of a financial firm, the notion of leverage captured in *SRISK* is quasi-market leverage, which is quasi-market value of assets divided by the market value of equity.

Second, as argued by Charles Calomiris and Richard Herring (2013, figures 3 and 4 in particular), an important advantage of using the market value of equity and its exposure to a crisis or aggregate downturn is that market-based signals of financial sector distress have been found to be much better as early-warning signals than regulatory measures of financial sector risk (risk-weighted assets to total assets) and book values of equity. There are several reasons why this might be the case. Book values of equity are readily gamed by management as recognition of nonperforming assets and provisioning against future losses is discretionary; to the extent such practices are anticipated by the market, market values of equity should reflect true equity values more precisely than book values. For this reason, as well as by the very nature of accounting of assets that are not marked to market, market values of equity tend to be more forward looking than book values. Finally, market values of equity may be the relevant metric for prudential purposes as financiers of a financial institution such as wholesale creditors and interbank counterparties should care about the ability of the institution to increase buffers and guard against losses on the financing; an institution whose market value of equity is collapsing to zero is unlikely to be able to raise such buffers, even if its book value is high.

Third, and related to the second point, regulatory risk weights for asset classes are inherently static in nature, whereas the true economic risk of asset classes fluctuates over time. Indeed, combined with shifts in financial leverage, the "risk that risk will change" can be considered an essential cause of financial crises. Acharya, Engle and Pierret (2014) demonstrate that market-based risk assessments of financial firms' balance sheets, in particular using the *SRISK* measure and its components, better captured the actual stress of financial firms in Europe during 2011, relative to the regulatory risk assessments, which relied on static risk weights, notably zero risk weights for risky sovereign bonds of countries in the southern European periphery.

Fourth, since it is based on market data, one limitation of *SRISK* is that it can be computed only for financial firms whose equity is publicly traded. It cannot be computed readily for privately held financial firms. Hence, all assessment of global financial sector health and comparative analysis across countries that follows is subject to this important caveat.

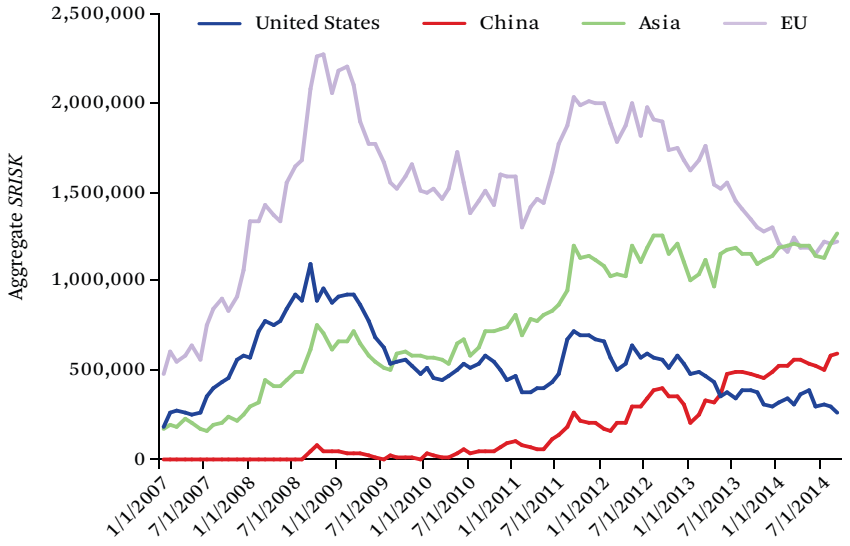
Finally, given the simple formulaic structure for *SRISK*, we can also understand changes in *SRISK* over time as coming from changes in its components, the book value of nonequity liabilities, the market value of equity, and the market value of equity times the *LRMES*, as follows:

$$\begin{aligned} SRISK_i &= SRISK_{i,t} \quad SRISK_{i,t-1} \\ &= Debt_i + Equity_i + Risk_i, \text{ where} \\ Debt_i &= k(Debt_{i,t} \quad Debt_{i,t-1}), \\ Equity_i &= (1-k)(Equity_{i,t} \quad Equity_{i,t-1}), \text{ and} \\ Risk_i &= (1-k)(LRMES_{i,t}Equity_{i,t} \\ &\qquad LRMES_{i,t-1}Equity_{i,t-1}) \end{aligned} \tag{3}$$

where the changes in *Debt*, *Equity*, and *Risk* are measured over the period from $t-1$ to $t$, and

4. Ibid: "The current approach to assessing capital requirements is strongly dependent on the regulatory capital ratios defined under Basel Accords. The capital ratio of a bank is usually defined as the ratio of a measure of its equity to a measure of its assets. A regulatory capital ratio usually employs book value of equity and risk-weighted assets, where individual asset holdings are multiplied by corresponding regulatory 'risk weights.' The

**Figure 1.** International Comparisons of Aggregate *SRISK*, 2007–2014




*Source:* Author's compilation based on data at NYU Stern Volatility Lab (website), "Documentation, Analysis List" (http://vlab.stern.nyu.edu/welcome/risk/).
*Note:* This figure plots the sum of *SRISK* in U.S.$ million for publicly traded financial firms (for inclusion criteria see table A1) in the United States, China, Asia (including China), and Europe. The data are from the period January 1, 2007, to September 30, 2014.

together with the appropriate weights from the *SRISK* formula in equation (2), these changes combine to explain the change in *SRISK* over the period from $t-1$ to $t$.

This decomposition highlights that increases in nonequity liabilities and expected losses in a crisis increase *SRISK* over time whereas increases in market value of equity decrease *SRISK* over time.

## ASSESSING GLOBAL FINANCIAL SECTOR HEALTH USING *SRISK*

In order to operationalize *SRISK* and compare it across countries and regions, NYU Stern VLAB includes all publicly listed financial firms in a country with active trading in common equity that are in the top 10 percent of firms in a year by size (see table A1 for sample size distribution by year). In order to identify firms with capital shortfall, firms with positive *SRISK* are identified. All positive values of *SRISK* for a country or region in a given year are aggregated to obtain the overall *SRISK* for that country or region. In what follows, all references to the current or the present moment refer to October 10, 2014.[5]

Figures 1 to 8 and table 1 summarize our overall findings for aggregate *SRISK* across the three regions: United States, Europe, and Asia, with emphasis on China.

regulatory capital ratios in stress tests help regulators determine which banks fail the test under the stress scenario and what supervisory or recapitalization actions should be undertaken to address this failure."

5. Although this article focuses entirely on *SRISK* that is aggregated at the level of a country or region, prior research has shown that *SRISK* also has the right cross-sectional properties in capturing the systemic risk of individual financial firms. Acharya, Pedersen, Philippon and Richardson (2010a, 2010c) provide such firm-level evidence for 2007–2008 for the United States' financial sector, and Acharya, Engle, and Pierret (2014) provide such evidence for Europe during the period of the sovereign debt crisis in 2011.

Figure 1 plots the aggregate *SRISK* for the three regions and China and is the central figure of this essay.

In the case of the United States, systemic risk appears to have peaked in Fall 2008 and early 2009, with the estimated capital shortfall of the financial sector at over $1 trillion. This is of the order of magnitude of the capital injections and other forms of federal support for the financial sector that were deployed following the collapse of Lehman Brothers, in the form of the Troubled Asset Relief Program (TARP), Federal Deposit Insurance Corporation (FDIC) guarantees, and the Federal Reserve liquidity provision. Since then, the systemic risk appears to have steadily come down since spring 2009, with current levels being as low as in January 2007. The one exception was August 2011, when the systemic risk in the United States rose again around the debt-ceiling political crisis in the United States and the Eurozone sovereign debt and financial sector crisis.

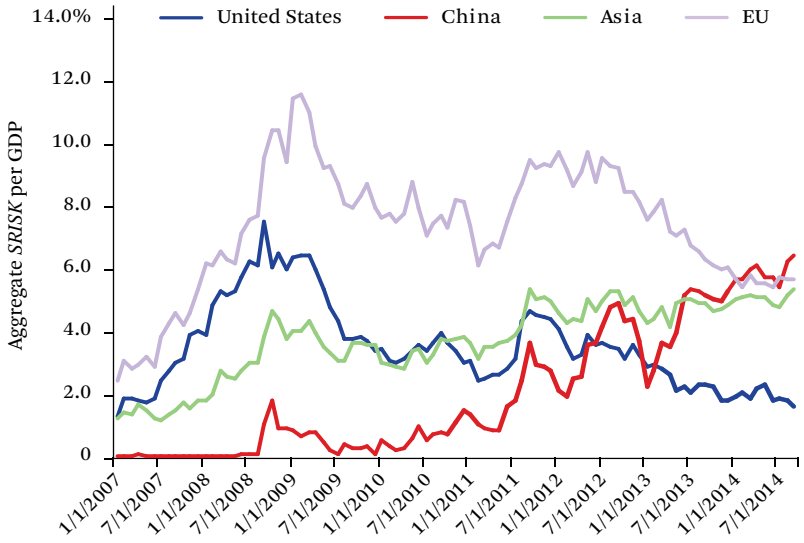
Similar to the United States, the systemic risk of the European financial sector also reaches its peak in the fall of 2008 and early 2009—about $2.25 trillion—but reveals an important difference: it reaches another peak of $2 trillion in August 2011, coincident with the Eurozone sovereign debt crisis. In other words, Europe appears to have witnessed serial episodes of dramatic capital shortfalls in the financial sector. Although systemic risk has come down since this second peak, its current levels remain at more than twice those in January 2007, another striking difference from the United States.

The picture of Asia's systemic risk estimate is, however, quite different than that for the United States and Europe. The estimated capital shortfalls for the Asian financial sector show a steady trend upward all the way from January 2007 to September 2014 with some local peaks but overall having risen by close to $1 trillion, from a quarter trillion to currently around $1.25 trillion. China, which with Japan is the largest financial sector in Asia, mirrors this trend, as shown in the figure. The Chinese financial sector shows little estimated capital shortfall until the middle of 2010, but since then the size of the shortfall has risen meteorically, estimated as of September 2014 at over a half trillion dollars.

One limitation of comparing the absolute values of estimated capital shortfalls is that larger countries generally have larger financial sectors, and all else equal, therefore will have greater absolute values of estimated capital shortfalls in a future crisis. To confirm that inference from figure 1 is not driven by such size differences, figure 2 plots the aggregate *SRISK* for each region that is divided by the region's Gross Domestic Product (GDP). The patterns are essentially the same as in figure 1. In case of the United States, estimated capital shortfalls reach a peak of close to 8 percent of GDP in the fall of 2008 and early 2009, reaching another local peak, 4 percent of GDP, in August 2011, but are currently at less than 2 percent of GDP, as in January 2007. For Europe, the crises of 2008–2009 and fall 2011 appear to have been much worse, with estimated capital needs being close to 12 percent and 10 percent of GDP, respectively, and even as of September 2014, being high, at 6 percent of GDP, relative to the January 2007 level of 2 percent of GDP (as in the case of the United States). This illustrates well that the European financial sector is far less healthy at present than that of the United States, and also relative to itself prior to the global financial crisis of 2007–2008. Finally, for Asia the estimated capital shortfalls have trended steadily upward, from under 2 percent of GDP in January 2007 to close to 6 percent of GDP as of September 2014, and in the case of China, going from zero to over 6 percent of GDP.

Figure 3 helps us understand the diverging patterns of systemic risk for the United States, Europe, and Asia in terms of leveraging or deleveraging of the financial sector, by plotting the aggregate quasi-leverage of the respective financial sectors. It illustrates succinctly that the leverage time series for these financial sectors tracks closely the evolution of the estimated systemic risk of these financial sectors. In other words, the United States financial sector experienced a significant leverage increase until spring 2009, and since then it has been deleveraging at a rapid pace. The European financial sector experienced leverage rises until

**Figure 2.** *SRISK* Normalized by Comparison with GDPs of the United States, China, Asia, and the European Union

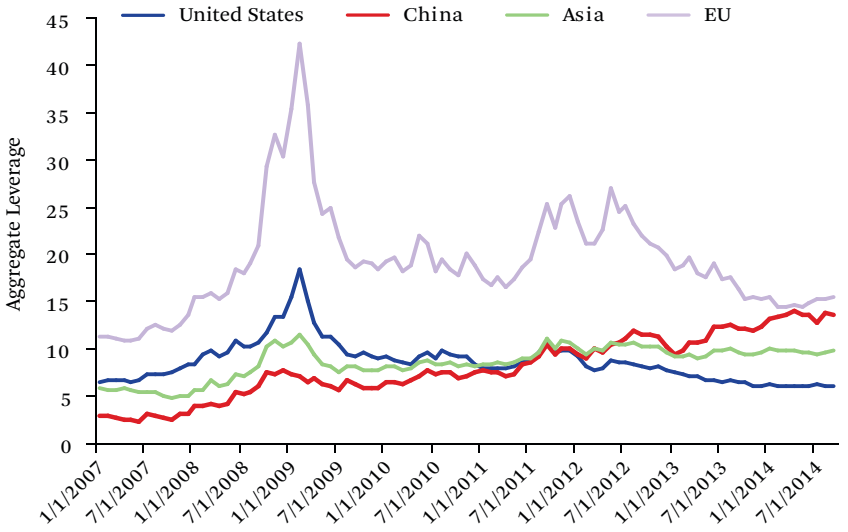



*Source:* Author's compilation based on NYU Stern Volatility Lab, "Documentation, Analysis List" (http://vlab.stern.nyu.edu/welcome/risk/), and Bloomberg.
*Note:* This figure plots the sum of *SRISK* for publicly traded financial firms (for inclusion criteria see table A1) in a given week, scaled by the country's or area's latest GDP figure available that week. Asia includes China. *SRISK* data are from January 1, 2007, to September 30, 2014.

summer 2009 and also in the period close to and leading up to fall 2011, and deleveraging to some extent since then but not to January 2007 levels. In contrast, the Asian and Chinese financial sectors have been ramping up leverage at a steady pace all along from 2007 to September 2014. It is interesting that as of 2016 the leverage in the United States financial sector is down to 5 (that is, five units of assets for one unit of market value of equity), lower than 10 for Asia, and around 15 for China and Europe. Equally interesting, the leverage of the financial sector in Europe has been pervasively greater than that of the financial sectors in the United States and Asia.

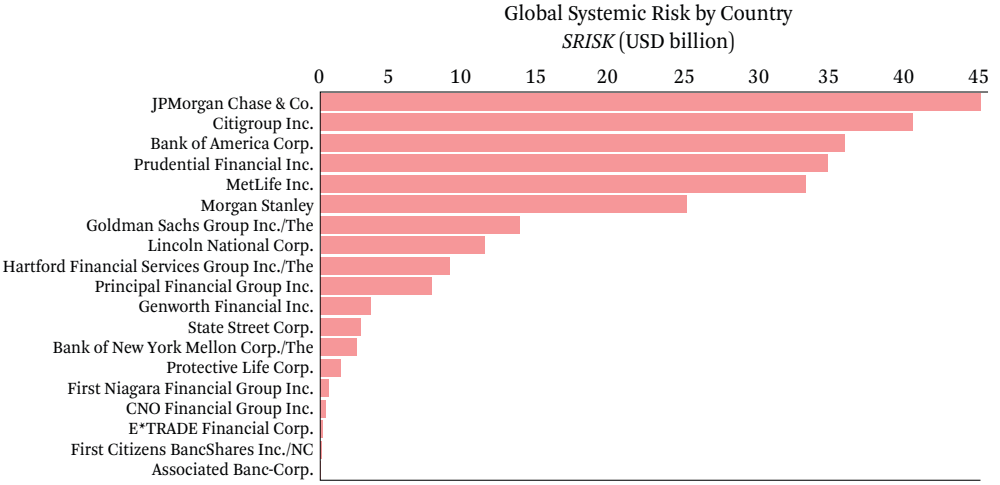
Figure 4 illustrates that in the case of the United States, the top three banks account for over half of the total capital shortfall of $250 billion, reflecting the increasing concentration in the financial sector owing in part to the acquisitions structured during 2007–2008 to resolve distressed financial firms. Interestingly, the top ten contributors include five insurance firms, whose systemic risk is increasingly coming under scrutiny, notably at the Financial Stability Oversight Council (FSOC) put in place by the Dodd-Frank Act in the United States to identify and prevent the emergence of systemic risk. Even though the insurance sector has a relatively stable liability structure compared to the banking sector, recent empirical evidence has suggested that life insurance firms in the United States have been "reaching for yield" (Becker and Ivashina 2015) by looking for highest-risk (and therefore, highest-yield) assets within a regulatory risk bucket; have been reducing statutory capital requirements by engaging in "shadow insurance," which transfers liability risks to captive reinsurance firms economically linked to the parent insurance firms (Koijen and Yogo 2016); and have been expanding their asset base of sub-investment-grade structured products in residential real estate mortgages while simultaneously shrinking their pool of investment-grade products in this asset class (Becker and Opp 2014). These changes appear to have been priced in by the market in terms of the greater

**Figure 3.** International Comparison of Aggregate Leverage (United States, China, Asia, European Union)



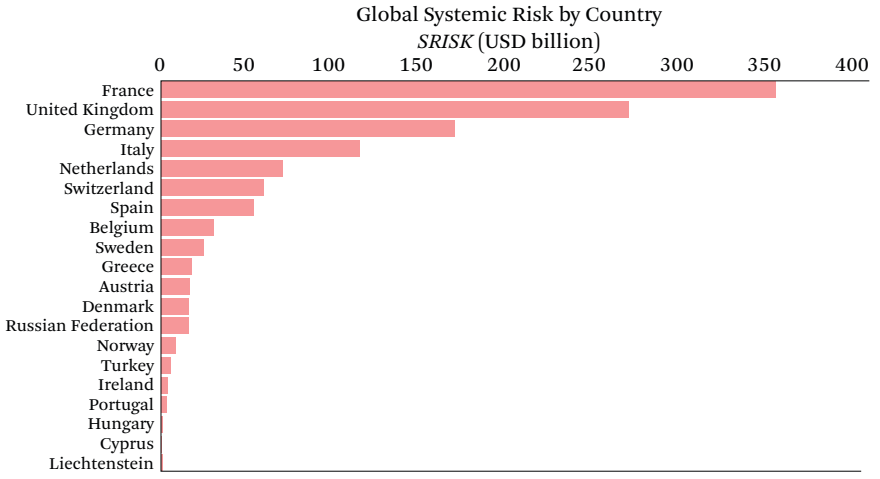

*Source:* Author's compilation based on NYU Stern Volatility Lab, "Documentation, Analysis List" (http://vlab.stern.nyu.edu/welcome/risk/).
*Note:* This figure plots the aggregate (quasi-) leverage for publicly traded financial firms (for inclusion criteria see table A1). Quasi-leverage of a financial firm is its quasi-market assets (market value of equity plus book value of nonequity liabilities) divided by the market value of equity. Quasi-leverage of financial firms in a region is weighted by the market value of equity of financial firms to obtain the aggregate quasi-leverage. The leverage data are from January 1, 2007, to September 30, 2014.

**Figure 4.** *SRISK* for Top Nineteen Publicly Traded U.S. Financial Firms (U.S.$ Million) as of October 10, 2014



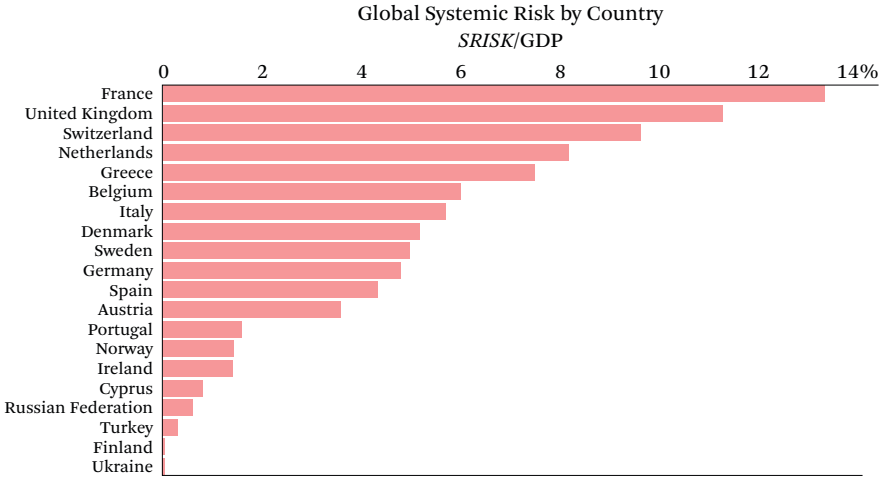

*Source:* NYU Stern Volatility Lab, "Documentation, Analysis List" (http://vlab.stern.nyu.edu/welcome/risk/).
*Note:* For inclusion criteria of firms, see table A1. The *SRISK* data are from NYU Stern Volatility Lab (vlab.stern.nyu.edu/welcome/risk).

**Figure 5.** *SRISK* Calculated for Top Twenty European Countries (U.S.$ Billions), as of October 10, 2014




*Source:* NYU Stern Volatility Lab, "Documentation, Analysis List" (http://vlab.stern.nyu.edu/welcome/risk/).
*Note:* For inclusion criteria see table A1.

**Figure 6.** Sum of *SRISK* for Publicly Traded Financial Firms Normalized by GDP for Top Twenty Country-Level Values in Europe, as of October 10, 2014

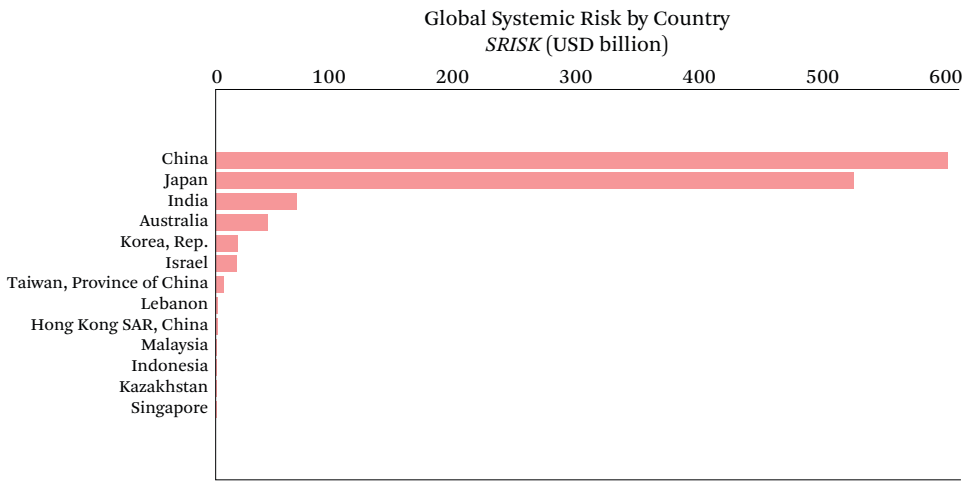



*Source:* NYU Stern Volatility Lab, "Documentation, Analysis List" (http://vlab.stern.nyu.edu/welcome/risk/).
*Note:* For inclusion criteria see table A1) in a country, scaled by the country's latest GDP figure available as of October 10, 2014. The *SRISK* data are from NYU Stern Volatility Lab (vlab.stern.nyu.edu/welcome/risk). The country GDP data are from Bloomberg.

economic risk and leverage of the life insurance sector.

Similarly, figures 5 and 6 help us understand the country-level contributors to current systemic risk assessment in Europe. In terms of absolute contributions to the estimated capital shortfalls (figure 5), France leads the way at $350 billion, over a fourth of the current shortfall estimate for Europe. Even on a percentage-of-GDP basis (figure 6), France

**Figure 7.** *SRISK* in Asia




*Source:* NYU Stern Volatility Lab, "Documentation, Analysis List" (http://vlab.stern.nyu.edu/welcome/risk/).

*Note:* This figure plots the top thirteen country-level values in Asia, including Australia and New Zealand, of the sum of *SRISK* in U.S.$ billion for publicly traded financial firms (for inclusion criteria see table A1) in a country as of October 10, 2014.

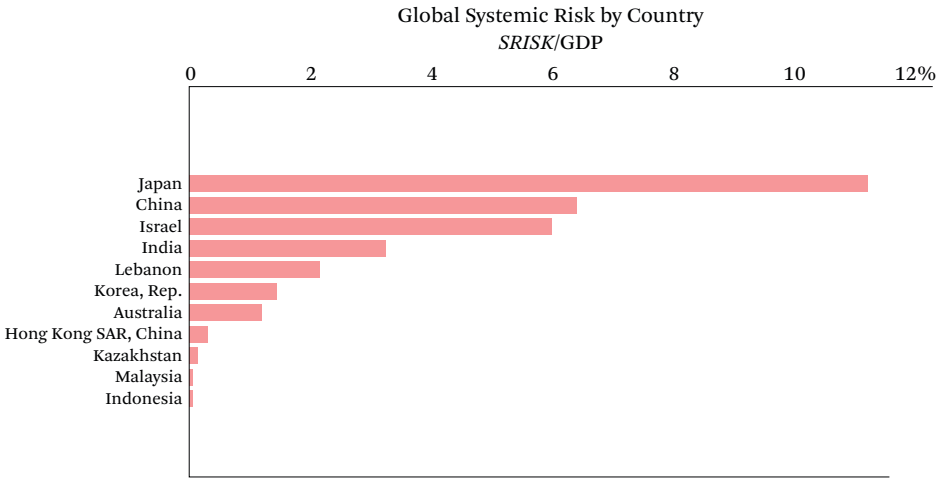
leads the way with its estimated capital shortfall being around 13 percent of its GDP, a rather sizable fraction of GDP to put aside to recapitalize the banking sector, should future stress require public injections of capital. Whereas Switzerland and United Kingdom are expected to rank high on a percentage-of-GDP basis, given the relatively large balance sheets of their financial sectors compared to the national balance sheets, France's topping this list is somewhat surprising and highlights the relative undercapitalization of its banking sector in terms of its quasi-market leverage. Notably, although Germany ranks high in terms of absolute size of estimated capital shortfalls, on a percentage-of-GDP basis it looks much healthier than France.

Figures 7 and 8 help us understand countries that contribute to the systemic risk in Asia at the present date, 2016. China and Japan together constitute most of the estimated capital shortfall in Asia (figure 7). On a percentage-of-GDP basis, however, Japan is substantially higher, with an over 11 percent shortfall relative to GDP, whereas China is somewhat smaller, at over 6 percent.

Finally, notwithstanding that China's systemic risk relative to its GDP appears to be manageable, particularly given its vast reserves, it is intriguing to speculate what explains its dramatic rise seen in figures 1 and 2, from being practically zero to now being half a trillion dollars, or 6 percent of GDP. Table 1 provides an intuitive understanding of this rise by breaking down change in *SRISK* between the end of 2009 and October 10, 2014, for the highest *SRISK* contributors in the Chinese financial sector, into its three components—$\Delta Debt$, $\Delta Equity$, $\Delta Risk$—as explained in the concluding remarks of the first section of this article.

The top four banks in the list in table 1 are the largest state-owned commercial banks in China. Together they account for over half of the estimated capital shortfall for China. However, all these banks had negative *SRISK* at the end of 2009, that is, they in fact had a capital surplus. What is remarkable in table 1 is that almost all of the change in *SRISK* can be attributed to the increase in debt liabilities ($\Delta Debt$) for these banks. Indeed, while their debt liabilities have increased, equity valuations have suffered so that the increase in *SRISK* is also due to declines in equity (positive $\Delta Equity$). Interestingly, their downside risk on per dollar of

**Figure 8.** *SRISK* in Asia Normalized by GDP




*Source:* NYU Stern Volatility Lab, "Documentation, Analysis List" (http://vlab.stern.nyu.edu/welcome/risk/).

*Note:* This figure plots for the top eleven country-level values in Asia, including Australia and New Zealand, the sum of *SRISK* for publicly traded financial firms (for inclusion criteria see table A1) in a country, scaled by the country's latest GDP figure available (from Bloomberg) as of October 10, 2014. The *SRISK* data are from NYU Stern Volatility Lab (vlab.stern.nyu.edu/welcome/risk).

equity basis has improved, so that the risk contribution ($\Delta Risk$) is negative. Together, this suggests massive financial leveraging of the largest banks in China from 2010 to September 2014, which has increased the systemic risk of the financial sector to nontrivial levels—way beyond that of the United States on percentage-of-GDP basis.

## WHAT EXPLAINS THE DIVERGENCE IN EVOLUTION OF GLOBAL FINANCIAL SECTOR HEALTH SINCE 2007?

In summary, the financial sector capital shortfalls reached a peak in the end of 2008 and early 2009 for the United States and Europe; however, they declined thereafter steadily only for the United States, with Europe reaching a similar peak again in the fall of 2011 during the sovereign debt crises in the southern periphery of Europe. In contrast, the financial sector in Asia had little capital shortfall in 2008–2009, but the shortfall has increased steadily since 2010, notably for China and Japan. What explains these relative patterns? I shall argue briefly that these patterns can be explained on the basis of the regulatory responses in the United States, the lack thereof in Europe, economic stagnation in Japan, and the bank-leverage-based fiscal stimulus in China.

Following the collapse of Lehman Brothers, the United States put in place first a substantial rescue package in the form of TARP recapitalization of the financial sector up to $750 billion, FDIC deposit and loan guarantee programs, and the Federal Reserve's liquidity support of the financial sector as well as markets at large, in addition to the government conservatorship of the mortgage agencies, Fannie Mae and Freddie Mac. While these measures were not adequate to calm the volatility in markets, which remained substantially high even in early 2009, the stress-test-based recapitalization in spring 2009 (the Supervisory Capital Assessment Program, SCAP) ensured that banks injected $200 billion more capital into the balance sheets (required capital raising by regulators was $75 billion). These measures calmed fears about the health of the financial sector in the United States. Following this, the Dodd-Frank Act was enacted in 2010 and various measures were put in place to rein in systemic risk, again notably an annual stress

**Table 1.** Decomposition of Change in *SRISK*

| Institution | *SRISK* (*t*) | *SRISK* (*t* – 1) | Δ*SRISK* | Δ*Debt* | Δ*Equity* | Δ*Risk* |
|---|---|---|---|---|---|---|
| Bank of China Ltd. | 105,580.9 | –4,396.9 | 109,977.8 | 90,325.2 | 20,038.1 | –385.5 |
| China Construction Bank Corp. | 84,956.1 | –12,500.5 | 97,456.6 | 90,456.5 | 15,262.1 | –8,261.9 |
| Industrial and Commercial Bank of China Ltd. | 77,991.2 | –71,501.9 | 149,493.1 | 114,137.7 | 48,781.9 | –13,426.4 |
| Bank of Communications Co. Ltd. | 44,484.7 | –678.7 | 45,163.4 | 38,475.8 | 6,314.8 | 372.7 |
| China CITIC Bank Corp. Ltd. | 33,828.5 | –3,342.2 | 37,170.7 | 32,863.6 | 5,290.3 | –983.2 |
| China Merchants Bank Co. Ltd. | 29,608.3 | –14,607.5 | 44,215.8 | 38,062.1 | 5,430.3 | 723.4 |
| Shanghai Pudong Development Bank | 25,899.8 | –4,037.5 | 29,937.3 | 29,607.2 | –1,414.7 | 1,744.8 |
| Industrial Bank Co. Ltd. | 24,856.8 | –8,643.1 | 33,499.9 | 33,119.3 | –1,822.7 | 2,203.2 |
| China Minsheng Banking Corp. Ltd. | 17,584.8 | –4,891.7 | 22,476.5 | 27,422.5 | –6,765.6 | 1,819.6 |
| Huaxia Bank Co. Ltd. | 11,742.1 | 2,068.4 | 9,673.7 | 12,193.5 | –2,690.4 | 170.6 |

*Source:* Author's compilation, based on the *SRISK* data and its component changes from NYU Stern Volatility Lab (vlab.stern.nyu.edu/welcome/risk).
*Note:* Table 1 shows the change in *SRISK* between the beginning of 2010 (*t* – 1) and October 10, 2014 (*t*) in U.S.$ billion for publicly traded financial firms (for inclusion criteria see table A1) in China with the top ten values of *SRISK* as of October 10, 2014. The change in *SRISK* is broken down further into change due to changes in book value of nonequity liabilities ("Debt"), in market value of equity ("Equity"), and in market value of equity times *LRMES*, the measure of downside beta of the firm's equity to a global market correction of –40 percent ("Risk").

test of the systemically important financial institutions (SIFIs) identified by the newly created Financial Stability Oversight Council (FSOC). All of these measures have ensured substantial deleveraging of the United States financial sector balance sheets, as seen in figures 1 to 3, to the point that they appear to be among the healthiest in the global economy at present.

In contrast to the United States, the regulatory response in Europe to the financial sector meltdown of 2007–2008 was half-baked. While the governments and central banks were quick to assist the ailing financial sector with asset and liability guarantees as well as liquidity injection, there was no substantial recapitalization of the financial sector, on a scale similar to the TARP was for the United States financial sector. This lack of recapitalization, in presence of massive guarantees, meant that the financial sector had poor incentives during the recovery phase. Many undercapitalized banks invested in risky assets to rebuild equity capital, in the process transferring risks to the government, by undertaking "carry trades" on southern periphery sovereign debt funded with retail and wholesale deposits (Acharya and Steffen 2015). This created a rather unfortunate nexus between financial and sovereign credit risks in the Eurozone, bringing about twin crises in the fall of 2011, the deteriorating macroeconomic and financial health of Spain and Italy (Acharya 2014). This nexus of sovereign and financial sector credit risks—first, the undercapitalized financial sector taking leveraged exposures to risky sovereigns, and second, further distress of risky sovereigns inflicting collateral damage on the financial sector—appears to have had significant real consequences. Acharya et al. (2014) show that even relatively large borrowers in Europe whose lead banks have been from the southern periphery countries have been hoarding cash and cutting back investment and employment, behaving as though they are financially constrained. This effect is not seen for borrowers whose lead banks are from the core European countries, where the banks are relatively better capitalized.

Regulators did not put a stop to the carry-trade strategies and the undercapitalization of banks that had led to them. In fact the strategies were encouraged by regulators who conducted stress tests that had little bite when compared to the SCAP exercise of the United States. As Acharya, Robert Engle, and Diane Pierret (2014) document, the European stress tests granted zero risk weights to risky southern periphery sovereign debt so that effectively not much capital was raised by banks in response; in fact, the worst banks in terms of risks were found to require the least capital in the stress tests. Furthermore, Acharya, Engle and Pierret show that assumptions regarding the net losses, that is, gross losses minus future profits, were primarily driven by future profits by the end of the stress scenario (typically in eight to nine quarters), rather than by losses up to the worst point in the stress scenario (typically the first few quarters of the stress test horizon). This discretionary choice by the regulators also implied that banks that were making the most losses by the worst point in the stress scenario were designated as well capitalized.

Acharya and Steffen (2014) document that the pattern was hardly different with the Asset Quality Review and Comprehensive Assessment of the European Central Bank in 2014. Indeed, the underlying issue here is likely political: revising sovereign risk weights to nonzero levels might require support of national governments, revisions that might be partly seen as lacking in credibility in a future economic convergence within the Eurozone. Without a Eurozone-level arrangement to inject capital and provide deposit insurance to banks, designating large banks as undercapitalized may require national taxpayer injections that would only add to their countries' sovereign debts.

Nevertheless, there is some overall improvement in the health of the financial sector relative to condition in the fall of 2011, as a result of the extraordinary liquidity injection and promises to purchase securities from the market provided by the European Central Bank, starting in December 2011.

Finally, the case of Asia can be explained by the continuing economic malaise in Japan since the regulatory failure in the 1990s to recapitalize the banking sector, and in China by

the debt-based stimulus to ensure high growth rates in the short run even as the global economy suffered in the wake of the crisis of 2007–2008. In the case of Japan, leverage of the financial sector remains high or is increasing in spite of continued macroeconomic weakness. This explains the continuing rise of systemic risk in Japan since 2007.

In contrast to Japan, the Chinese case is relatively straightforward. Since the global financial and economic crisis of 2007–2008, Chinese state-owned banks have leveraged massively, including off-balance-sheet liabilities (not captured in *SRISK* analysis), to fund real estate and infrastructure projects, many of which are at unsustainable price levels and have resulted in high nonperforming rates. From 2008 to 2013, total credit outstanding in the Chinese economy grew from 125 percent to 240 percent of GDP. Much of this increase came about from stimulus expenditures undertaken since 2008 by local municipal governments. These local governments, being prohibited from raising debt directly, set up special-purpose financing vehicles that raised debt from shadow banks ("trusts") in China to invest in infrastructure and real estate development. The local government debt is backed mainly by revenues from land sales, but with house prices inevitably slowing down in the past few years from their astronomical previous growth, the shadow banks—many of which are implicitly supported by parent state-owned banks—are exposed to significant losses. This situation has created the possibility of runs as well as undercapitalized banks.

China appears to have time and resources—large quantity of reserves and a high domestic savings rate—and it exercises tight control of its banks and housing markets. Still, the question is whether—like the United States in post-Lehman era—China will take tough recapitalization decisions for its banks before its own crisis comes to fruition, or whether, like Japan in the 1990s and Europe since the Great Recession, it will let undercapitalized banks continue to operate as zombie banks engaged in the misallocation of economic resources.

## CONCLUSION

In this essay I used recently developed methodology to estimate capital shortfalls of financial institutions during aggregate stress to assess the evolution of financial sector health since 2007 in the United States, Europe, and Asia. Financial sector capital shortfalls reached a peak at the end of 2008 and in early 2009 for the United States and Europe. After that, however, they decline steadily only in the United States. Europe reached a similar peak again in the fall of 2011 during the southern periphery sovereign crises. In contrast, the financial sector in Asia had little capital shortfall in 2008–2009, but the shortfall has increased steadily since 2010, notably for China and Japan. The regulatory responses in these regions explain these differing patterns: Were distressed banking sectors recapitalized or were they allowed to remain under-capitalized? The United States did not waste its crisis, and its banking sector appears to be the best-capitalized of the lot. Europe has already wasted two opportunities—two crises—to strengthen its banking sector. Japan has not yet fully recovered from consequences of its zombie-banking policy of the 1990s. And China is potentially heading into a debt-fueled banking crisis, largely from its fiscal stimulus policies since 2008. Economic outcomes in these regions appear to be mirroring the health of their financial sectors as measured by capital adequacy against future stress.

## APPENDIX

**Table A1.** Number of Total Firms per Region

| Year | United States | China | Asia | European Union |
|---|---|---|---|---|
| 2007 | 155 | 30 | 336 | 353 |
| 2008 | 159 | 39 | 373 | 389 |
| 2009 | 148 | 52 | 409 | 395 |
| 2010 | 148 | 58 | 429 | 397 |
| 2011 | 156 | 66 | 453 | 405 |
| 2012 | 157 | 70 | 458 | 404 |
| 2013 | 156 | 70 | 457 | 394 |
| 2014 | 153 | 70 | 451 | 385 |

*Source:* Author's compilation.
*Note:* Publicly listed financial firms in each country with active trading in common equity that are also in the top 10 percent of financial firms by size (market equity).

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