Systemic Risk in the Financial System:

Capital Shortfalls under Brexit, the US elections, and the Italian Referendum

May 2017

S&P Global
Market Intelligence

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Abstract

Recent episodes of stress in the financial system fostered a great deal of discussion regarding new supervisory and regulatory tools for financial institutions. The recent introduction of additional capital requirements for Systemically Important Financial Institutions (SIFIs) is an example of concrete measures taken by regulators to mitigate systemic risk.

In order to assist market participants in assessing and tracking systemic risk in the financial system, the V-Lab of the NYU-Stern School of Business developed a quantitative indicator, called SRISK, which estimates the expected capital shortfall faced by a firm in a potential future financial crisis. Conceptually, SRISK is similar to the stress tests that are regularly applied to financial institutions; however, it is based exclusively on publicly available information (market and accounting data) and is quick and inexpensive to compute. Firms with a high capital shortfall in a crisis–that is when capital is low in the financial system–are the ones with the potential to extend the crisis and impact the broader economy.

We use SRISK to quantify the estimated capital shortfalls of financial institutions under three relevant stress events that occurred in 2016: Brexit, the Trump election, and the Italian Referendum. We refer to these events collectively as BRUMPIT.

Robert Engle
Michael Armellino Professor of Finance, 2003 Nobel Laureate in Economics, NYU-Stern School of Business

Cristiano Zazzara
Managing Director, Risk Services, S&P Global Market Intelligence

Systemic Risk in the financial system and measures taken by regulators

The subprime crisis of 2007-2009 highlighted the importance of a relevant risk dimension in financial markets: Systemic Risk.

Over time, the interconnection of financial institutions has increased, generating risk of disruption in a financial system to the point where economic growth and welfare suffer materially[1]. Therefore, it is relevant to monitor financial institutions whose distress or disorderly failure, because of their size, complexity and systemic interconnectedness, is likely to have major impacts on the financial and real sectors of the economy[2]. A quantitative estimate of their capital shortfalls under a future crisis event would help policy makers avoid future bailouts and spillover effects in the financial system.

In response to this challenge, regulators around the world have focused their attention on identifying Systemically Important Financial Institutions (SIFIs) to make sure their capital levels are high enough to absorb this additional risk.

In July 2013, the Financial Stability Board–in consultation with the Basel Committee on Banking Supervision (BCBS) and the International Association of Insurance Supervisors (IAIS), and national authorities–issued lists of Global Systemically Important Banks (G-SIBs) and Global Systemically Important Insurers (G-SIIs) based on accounting–based indicators[3] (the full lists of G-SIBs and G-SIIs are available in Appendix I).

For Banks, the following five indicators, each given a weighting of 20%, were selected to define their Systemic Risk profile:

- **Size** (20%): Total exposures as defined for use in the Basel III leverage ratio
- **Interconnectedness** (20%): Intra-financial assets, Intra-financial system liabilities, and Securities outstanding
- **Substitutability/Financial Institution Infrastructure** (20%): Assets under custody, Payments activity, and Underwritten transactions in debt and equity markets
- **Complexity** (20%): Notional amount of Over-The-Counter (OTC) derivatives, Level 3 Assets, Trading and Available-For-Sale (AFS) Securities
- **Cross-Jurisdictional Activity** (20%): Cross-jurisdictional claims, Cross-jurisdictional liabilities

On March 30, 2017, the BCBS published a consultative document to revise this framework for G-SIBs, including changes to weights, indicators and other requirements. The Committee originally agreed to periodically review this framework for banking institutions to ensure it continues to reflect new systemic risk dimensions not previously anticipated.[4]

For Insurance firms, the following systemic risk indicators (relative weightings in parentheses) were considered to reflect the specific business model of these firms:

- **Size** (5%): Total Assets and Total Revenues
- **Global Activity** (5%): Revenues outside the home country and number of countries
- **Interconnectedness** (49%): Intra-financial assets and liabilities, Reinsurance, and Derivatives, Financial guarantees, and minimum guarantees on variable products
- **Asset Liquidation** (36%): Non-policy holder liabilities and non-insurance revenues, Short term funding, Level 3 assets, Turnover, and Liability Liquidity
- **Substitutability** (5%): Premiums for specific business lines

Since 2013, these lists have been updated annually at year-end, with the recent lists released on November 21, 2016. Additionally, the BCBS and IAIS disclose an annual update of the underlying systemic institutions' risk scores and data[5]. This information will be used to define additional capital requirements for Banks and Insurance firms, which are scheduled to be applied from January 2018 and January 2019, respectively.

The above indicators are useful to identify structural characteristics of firms posing systemic risk and to define a related capital buffer for financial stability purposes. However, since these underlying indicators are backward-looking, they are unable to capture the dynamic and forward-looking nature of systemic risk. It is important to have timely monitoring of the propagation of stress events through the financial system, and the vulnerability of firms to such shocks.

In recent years, various types of systemic risk analytics based on a combination of accounting and market data have been proposed in the market[6]. These tools are very useful to complement the approaches proposed by regulators for capital requirement purposes, such as additional capital buffers for SIFIs and Stress Test analyses.

To get a sense of the magnitude of systemic risk in the financial system and of its evolution over time, we refer to SRISK, a quantitative indicator, developed by the Volatility Institute of the NYU-Stern School of Business, which estimates the capital shortfall of an institution under a crisis event and publishes the result on V-LAB (Volatility Laboratory). SRISK is a valuable indicator to provide insights not only on the direction, but also on the magnitude of stress events.

[1]See European Central Bank (2009)
[2]See Financial Stability Board (2011)
[3]See BCBS (2013) and IAIS (2015)
[4]For more details, see BCBS (2017)
[5]The Office of Financial Research, established by the Dodd-Frank Act to help promote financial stability, created an interactive chart on its website (https://www.financialresearch.gov/gsib-scores-chart/) that uses G-SIBs data to compare banks' systemic scores from the first available date (2013) to the latest one (2015), giving the user the possibility of drilling down to the underlying individual indicators
[6]For a detailed overview of systemic risk quantitative measures, see Office of Financial Research (2012)

What is SRISK and how does it work?[7]

SRISK is a metric that quantifies how much capital a financial institution would need to raise in order to function normally under a crisis event. At the aggregate level, SRISK can be essentially thought of as a stress test on the financial system, where the adverse case scenario is defined as a 40% decrease of the global equity market (this value is adjustable in the V-lab website) over a 6-month time horizon. Assuming that Equity should be at least a fixed percent of assets (k) under stress, the formula for SRISK is as follows:

SRISK = k*Debt-(1-k)*(1-LRMES)*Equity
which can be rewritten as
SRISK = Equity*[k*Leverage+(1-k)*LRMES-1]
where

- **k** = Regulatory capital threshold (this threshold is assumed to be 8% in the US, and 5.5% in Europe[8])
- **Equity** (E) = Market value of equity (market capitalization of the firm)
- **Debt** (D) = Book value of debt
- **Leverage** (LVG) = Market-based leverage ratio, that is (D + E)/E
- **LRMES** (Long Run Marginal Expected Shortfall) = Expected equity loss conditional on the market decline, that is the fractional decrease in market capitalization of the firm under a stressed scenario. This indicator is estimated by V-lab using time varying parameters for Volatility, Beta, and Correlation[9].

Clearly SRISK depends on the size, leverage and interconnectedness or risk of the firm.

The systemic risk tables, updated every week on the V-Lab website (https://vlab.stern.nyu.edu/), provide the SRISK values and also the underlying indicators mentioned above, allowing the users to understand the sources of systemic risk of each firm.

For example, applying the above formula to a firm with **E** = $100 billion, **LVG** = 7, **k** = 8%, and **LRMES** = 70%, would yield a **SRISK** of $20.4 billion. This is the capital shortfall the firm would experience under this stressed scenario[10].

In aggregate, the Capital Shortfall of the financial system is the sum of the individual SRISK values (when they are greater than zero[11]).

Therefore, the contribution of each firm to systemic risk can be calculated as:

$$\text{SRISK\%}_{\text{firm}} = \frac{\text{SRISK}_{\text{firm}}}{\sum \text{SRISK}_{\text{all firms}}}$$

subject to $\text{SRISK}_{\text{firm}} > 0$

This indicator is relevant to assess the concentration of systemic risk in the market. In fact, in several cases, systemic risk is concentrated in a handful of firms, due to their size and interconnected risk with other institutions.

[7]This is a gentle introduction to SRISK to highlight the financial intuition behind it. For full details on the econometric estimations, see Engle and Brownlee (2010), and also Engle (2010, 2012)
[8]This value is also adjustable in the V-Lab website
[9]Technically, LRMES is estimated based on GARCH and DCC (Dynamic Conditional Beta) time series models. For details, see Brownlees, Engle (2016) and Engle (2016)
[10]That is, a 40% decline of the global equity market
[11]When the value of SRISK is negative, a firm doesn't contribute to systemic risk in the financial system

SRISK in action: quantifying the BRUMPIT effect on systemic risk

The second part of 2016 has been full of unexpected events, which put a strain on the stability of international financial markets. The decision of the United Kingdom to leave the European Union, known as Brexit (June 23, 2016), the election of Donald Trump as President of the United States (November 8, 2016), and the "No" outcome of the Referendum in Italy to amend the Constitution (December 4, 2016) generated different reactions in the financial markets, due to the interconnections between financial institutions.

In order to assess the impact of these systemic risk effects, we use SRISK to quantify the estimated capital shortfalls of institutions under the above stress events. We refer to these events collectively as BRUMPIT.

The 1st Stress Event of 2016: Brexit

On June 23, 2016, the UK voted to leave the European Union. This "Brexit" decision was a largely unexpected outcome, the impacts of which will have various ramifications.

As reported in Figure 1, the Brexit result had a significant impact on the aggregate systemic risk of UK, US and other European financial systems. This is not surprising, due to the material interconnections between financial institutions in these regions. However, the effect of Brexit appeared to have lasted for a short period, with SRISK values returning to pre-event levels after early-August. This can be attributed to the prompt and coordinated response of the Federal Reserve, the European Central Bank, and the Bank of England, which acted to provide liquidity and to ensure the proper functioning of markets[12]. The apparent recovery is also partly due to the measurement of SRISK in USD since both the Pound and Euro fell over this period.

[12]See Bank for International Settlements (2016)

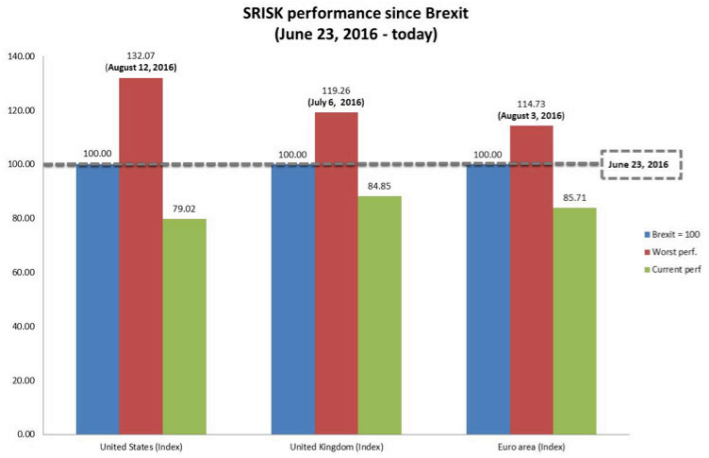

Figure 1–Source: Volatility Lab data (as of April 7, 2017).
*SRISK series were normalized setting values on the Brexit date (June 23, 2016) equal to 100

At the entity level, SRISK values provide interesting insights as well (Table 1). In Europe, at the peak of systemic risk post-Brexit (end-July 2016[13]), Banking institutions reported the highest SRISK values. Of the top 10 contributors, four are UK Banks (Barclays, HSBC, RBS, and Lloyds), three are French (BNP Paribas, the top contributor, Crédit Agricole, and Société Générale), and the others are German (Deutsche Bank), Spanish (Banco Santander), and Italian (Unicredit). It is worth noting the high market-based leverage of Deutsche Bank at the end of July, in the wake of depressed market equity value, is a result of both a failed stress test in the US and a decrease in profitability in Q2 2016.

Systemic Risk Rankings for Jul 28, 2016 ☐ **View changes**

Institution	SRISK%	RNK▲	SRISK ($ m)	LRMES	Beta	Cor	Vol	Lvg
BNP Paribas SA	7.18	1	109,429	70.76	2.41	0.69	51.6	38.21
Deutsche Bank AG	6.63	2	101,123	69.96	2.35	0.69	58.4	105.29
Credit Agricole SA *	5.76	3	87,834	69.64	2.33	0.65	51.6	70.40
Barclays PLC	5.74	4	87,467	82.15	3.37	0.67	82.3	49.89
Societe Generale SA	4.99	5	76,149	78.31	2.99	0.69	65.7	54.90
HSBC Holdings PLC	4.54	6	69,185	49.42	1.33	0.62	31.3	19.30
Royal Bank of Scotland Group PLC	3.85	7	58,721	76.06	2.80	0.62	76.1	40.67
Banco Santander SA	3.79	8	57,743	68.59	2.27	0.67	55.6	23.54
UniCredit SpA	3.28	9	50,077	82.80	3.45	0.63	80.4	64.08
Lloyds Banking Group PLC	3.15	10	48,084	77.55	2.92	0.65	85.2	22.21

Table 1–Source: Volatility Lab, NYU-Stern School of Business (https://vlab.stern.nyu.edu/), April 2017

Looking at changes in SRISK between end-May (just before Brexit) and end-July 2016 (highest aggregate SRISK value for Europe), Lloyds Banking Group was the institution reporting the highest increase in SRISK, being more exposed than other large European financial institutions to the UK economy[14]. What is relevant in this list of ΔSRISK is also the presence of two of the largest international Insurance companies, AXA and Allianz, and of a group with significant banking and insurance activities, ING Groep. This indicates the contribution to systemic risk coming from the Insurance sector: in a prolonged period of low and negative interest rates, Insurers tend to re-risk their investment portfolios to manage the higher sensitivity to interest rate risk of their assets and liabilities[15].

The decomposition of the change in SRISK into the changes of its main components, ΔSRISK = ΔDEBT + ΔEQUITY + ΔRISK, sheds light on the factors contributing to systemic risk.

Apart from HSBC, whose systemic risk parameters–equity value and risk–improved during the Brexit event window[16], SRISK of all the other European financial institutions increased as a consequence of a decrease in market equity values (ΔEQUITY[17]) and an increase in risk (ΔRISK). Particularly, around 65% of ΔSRISK for these 10 institutions is explained by an increase in risk (market volatility and correlation). After all, two months after Brexit, the uncertainty around the prospects of a contraction of the UK economy coupled with the European Union at risk of survival was at the highest level.

Systemic Risk Rankings for Jul 28, 2016 ☑ **View changes since:** 2016-05-31

Institution	SRISK (t)	SRISK (t - 1)	Δ SRISK▼	Δ(DEBT)	Δ(EQUITY)	Δ(RISK)
Lloyds Banking Group PLC	48,083.7	26,991.0	21,092.6	-2,502.5	8,194.6	15,400.5
BNP Paribas SA	109,429.2	95,775.5	13,653.7	0.0	2,606.6	11,047.1
Barclays PLC	87,467.4	75,582.5	11,884.9	0.0	2,871.0	9,013.9
AXA SA	36,148.3	24,765.9	11,382.4	0.0	3,744.8	7,637.6
Royal Bank of Scotland Group PLC	58,721.1	50,435.8	8,285.3	0.0	3,530.2	4,755.1
Allianz SE	26,528.4	18,682.2	7,846.1	0.0	3,515.0	4,331.1
HSBC Holdings PLC	69,184.8	62,010.9	7,173.9	10,206.0	-1,238.6	-1,793.5
Societe Generale SA	76,149.4	68,979.9	7,169.5	0.0	1,671.8	5,497.6
Banco Santander SA	57,742.8	51,239.4	6,503.4	-881.3	2,574.3	4,810.5
ING Groep NV	39,158.2	32,786.8	6,371.4	0.0	1,650.7	4,720.7

Table 2–Source: Volatility Lab, NYU-Stern School of Business (https://vlab.stern.nyu.edu/), April 2017

[13]In V-Lab, historical SRISK values are available on a monthly basis. Therefore, despite the highest aggregate SRISK for the European financial system was reported on July 6, 2016, we referred to SRISK values at the end of July
[14]An impact of Brexit for the Country could entail lower GDP growth and higher inflation
[15]For an analysis of the impact of low and negative interest rates on various sectors, markets and national economies, see S&P Global (2016)
[16]This is likely attributable to HSBC's international exposure, which makes it less dependent on the UK economy
[17]In terms of contribution to ΔSRISK, an increase in ΔEQUITY means a decrease in market capitalization

On the US front, the composition of financial firms at the peak of SRISK post-Brexit was different from the one seen in Europe (Table 3). In fact, as of end-July, among the top 10 contributors to systemic risk, there were five Banks (Bank of America, Citigroup, JP Morgan, Morgan Stanley, and Goldman Sachs), four Insurance firms (MetLife, Prudential Financial, Lincoln National, and Hartford Financial Services Group), and one Investment Manager (Principal Financial Group). It is interesting to highlight that non-bank institutions reported higher leverage values than banks.

Systemic Risk Rankings for Jul 28, 2016 View changes

Institution	SRISK%	RNK	SRISK ($ m)	LRMES	Beta	Cor	Vol	Lvg
Bank of America Corp	16.38	1	77,775	44.65	1.16	0.63	31.3	13.90
Citigroup Inc	15.64	2	74,251	55.53	1.59	0.79	34.0	13.33
JPMorgan Chase & Co	13.91	3	66,060	48.69	1.31	0.79	26.6	10.41
MetLife Inc	10.31	4	48,943	57.47	1.67	0.80	36.1	18.92
Prudential Financial Inc	8.98	5	42,644	50.40	1.37	0.75	28.5	22.65
Morgan Stanley	7.96	6	37,797	56.37	1.62	0.77	35.0	14.51
Goldman Sachs Group Inc/The	6.88	7	32,659	48.27	1.29	0.78	27.6	12.99
Lincoln National Corp	3.35	8	15,923	64.99	2.05	0.79	43.2	24.10
Principal Financial Group Inc	2.28	9	10,851	53.96	1.52	0.78	32.1	16.33
Hartford Financial Services Group Inc/The	1.76	10	8,353	40.66	1.02	0.63	24.3	14.61

Table 3–Source: Volatility Lab, NYU-Stern School of Business (https://vlab.stern.nyu.edu/), April 2017

The analysis of changes in SRISK over the Brexit event window (Table 4) reveals interesting results.) the top 10 ΔSRISK contributors, there are not only systemic risk firms with significant business activities in the UK (such as JPMorgan and Citigroup), but also other players that moved from negative to positive SRISK values in the aftermath of Brexit (American International Group, Charles Schwab Corp., and PNC Financial Services Group). If, in the case of American International Group, this reaction could be attributable to its significant presence in the UK[18], for the US-focused Charles Schwab Corp. and PNC Financial Services Group their sensitivity to Brexit could be due to second-order effects related to an expected "lower for longer"[19] interest rate environment.

Systemic Risk Rankings for Jul 28, 2016 View changes since: 2016-05-31

Institution	SRISK (t)	SRISK (t - 1)	Δ SRISK	Δ(DEBT)	Δ(EQUITY)	Δ(RISK)
JPMorgan Chase & Co	66,060.2	50,698.1	15,362.1	3,201.8	2,332.4	9,827.9
Citigroup Inc	74,250.7	63,181.9	11,068.8	1,083.5	3,512.1	6,473.2
American International Group Inc	2,239.7	-4,461.0	6,700.7	0.0	2,090.9	4,609.8
MetLife Inc	48,943.2	43,250.3	5,692.9	0.0	1,346.4	4,346.5
Bank of New York Mellon Corp/The	6,584.7	2,386.5	4,198.2	-42.5	1,445.6	2,795.1
Bank of America Corp	77,774.8	73,831.7	3,943.0	-254.6	1,595.8	2,601.8
Charles Schwab Corp/The	659.3	-2,802.7	3,462.0	529.2	1,129.2	1,803.6
Wells Fargo & Co	-2,744.5	-6,065.5	3,320.9	2,871.7	7,690.5	-7,241.3
Morgan Stanley	37,797.2	35,333.3	2,463.8	1,710.1	-1,102.5	1,856.2
PNC Financial Services Group Inc/The	1,869.8	-465.0	2,334.8	-1.7	2,012.2	324.3

Table 4–Source: Volatility Lab, NYU-Stern School of Business (https://vlab.stern.nyu.edu/), April 2017

To sum up, despite the increase of systemic risk in the aftermath of the Brexit vote, financial institutions in Europe and the US showed resiliency in reacting to this episode of stress (as reported in Figure 1). However, it takes time for these events to fully play out their effects. In the case of Brexit, there are still economic and geo-political uncertainties that might generate systemic risk in the future.

The 2nd Stress Event of 2016: The Trump election

On November 8, the result of the US elections was in favor of Donald Trump. Again, this was another largely unexpected outcome by market participants.

In Table 5, we report the current SRISK rankings–and the related % contributions to systemic risk–for the top 10 financial institutions in the Americas[20]:

Systemic Risk Rankings for Apr 6, 2017 View changes

Institution	SRISK%	RNK	SRISK ($ m)	LRMES	Beta	Cor	Vol	Lvg
Bank of America Corp	12.15	1	54,104	53.33	1.49	0.59	26.2	9.28
Citigroup Inc	9.54	2	42,481	46.01	1.21	0.58	18.8	10.39
MetLife Inc	8.72	3	38,827	47.41	1.26	0.57	20.2	15.53
Prudential Financial Inc	8.51	4	37,869	49.95	1.35	0.64	19.7	17.06
JPMorgan Chase & Co	6.66	5	29,662	48.29	1.29	0.67	19.3	8.13
Morgan Stanley	6.38	6	28,414	58.07	1.70	0.58	28.4	10.30
Manulife Financial Corp	5.60	7	24,942	50.98	1.40	0.56	20.5	15.70
Banco do Brasil SA	4.34	8	19,337	52.64	1.46	0.40	39.8	14.57
Goldman Sachs Group Inc/The	4.00	9	17,802	48.77	1.31	0.58	21.6	9.27
Power Corp of Canada	3.91	10	17,394	46.05	1.21	0.48	20.7	25.99

Table 5–Source: Volatility Lab, NYU-Stern School of Business (https://vlab.stern.nyu.edu/), April 2017

[18]In 2011, American International Group established in London its European headquarters

[19]See Bank for International Settlements (2016), page 3: "[...] the additional uncertainty created by Brexit was seen as eliciting a distinct response from major central banks: policy rates would stay "lower for longer"."

[20]It is interesting to see in this list both Banks and Insurance firms, in line with the mentioned proposals on systemic risk by the Financial Stability Board (in consultation with the Basel Committee on Banking Supervision and the International Association of Insurance Supervisors)

How did these institutions react, from a systemic risk standpoint, to Trump's election?
The following table provides insights on the changes in SRISK values over the Trump event window (end-October 2016–April 2017):

Systemic Risk Rankings for Apr 6, 2017 View changes since: 2016-10-31

Institution	SRISK (t)	SRISK (t - 1)	Δ SRISK	Δ(DEBT)	Δ(EQUITY)	Δ(RISK)
Bank of America Corp	54,103.8	53,591.2	512.6	-349.5	-32,568.6	33,430.8
Citigroup Inc	42,480.8	47,850.8	-5,370.1	-1,559.4	-13,482.6	9,672.0
MetLife Inc	38,826.5	38,192.3	634.2	-2,552.8	-3,028.1	6,215.1
Prudential Financial Inc	37,869.0	37,142.7	726.2	-275.0	-4,610.8	5,612.1
JPMorgan Chase & Co	29,662.2	36,993.9	-7,331.7	-2,393.3	-29,983.0	25,044.6
Morgan Stanley	28,414.2	27,695.9	718.4	-1,018.1	-5,929.1	7,665.5
Manulife Financial Corp	24,942.4	26,429.1	-1,486.7	-1,681.7	-2,896.5	3,091.4
Banco do Brasil SA	19,336.5	22,659.5	-3,323.0	-1,699.0	-1,402.9	-221.0
Goldman Sachs Group Inc/The	17,801.6	24,756.5	-6,954.8	-1,577.9	-9,084.6	3,707.7
Power Corp of Canada	17,393.7	17,415.2	-21.4	-225.7	-480.6	684.9

Table 6–Source: Volatility Lab, NYU-Stern School of Business (https://vlab.stern.nyu.edu/), April 2017

Since October 31, 2016 (approximately one week before the US election outcome), Citigroup, Goldman Sachs, JPMorgan, and Manulife Financial have reported a significant decrease of SRISK, due to a greater increase in market capitalization (ΔEQUITY) relative to risk (ΔRISK). Despite other institutions reporting higher SRISK values, all of the top 10 SRISK contributors recorded a significant positive performance, in terms of equity market values, in response to the prospects of deregulation, increase of interest rates, government spending, and tax reform announced by the US administration, of which large financial institutions would be the potential beneficiaries. But an increase in a firm's market capitalization is not enough to reduce its SRISK value, unless it is greater than the effect of changes in Accounting Debt and Risk (this latter being a function of the firm's equity volatility, the beta and correlation of the firm's equity with the broad market index). In fact, looking at the column of ΔRISK (Table 6), all firms' risk values have increased since Trump's election.[21] The betas of these financial firms have increased as correlations increased, while overall global market volatility declined. The uncertainty around the future US economic plans has not yet increased market volatility. However, heightened optimism and increased risk-taking after the election boosted Banks' trading revenues in the last quarter of 2016. This could explain why JPMorgan reported the largest decrease in SRISK among the top 10 contributors in the Americas.[22]

When shortening the horizon to a 1-month period after the event, the impact on SRISK values appears rather different (Table 7). It is, in fact, evident that the negative impact in terms of systemic risk reported by Banks in Latin America is likely due to the announced changes in the US trade agreements: seven of the ten largest ΔSRISK contributors are from this region, and 50% of them are from Brazil, a country whose economy has been significantly struggling in recent years. Particularly, Banco Bradesco and Itau Unibanco Holding reported a capital shortfall under this stress event of approximately $10 and 8.7 billion respectively, moving from negative to positive SRISK values (as a result of a combination of a decrease in market capitalization and an increase in risk).

Systemic Risk Rankings for Nov 29, 2016 View changes since: 2016-10-31

Institution	SRISK (t)	SRISK (t - 1)	Δ SRISK	Δ(DEBT)	Δ(EQUITY)	Δ(RISK)
Banco Bradesco SA	10,516.8	-1,175.2	11,692.0	3,164.9	3,391.7	5,135.4
Itau Unibanco Holding SA	8,712.5	-2,685.1	11,397.6	-328.5	3,893.8	7,832.3
Banco do Brasil SA	25,273.1	22,659.5	2,613.6	-451.5	912.0	2,153.1
Bank of Nova Scotia/The	14,206.2	12,936.8	1,269.4	0.0	-1,005.5	2,274.9
Banco de Bogota SA	-446.7	-1,318.9	872.2	0.0	111.6	760.7
Citigroup Inc	48,565.3	47,850.8	714.4	0.0	-10,735.7	11,450.1
Porto Seguro SA	-705.9	-1,136.2	430.4	6.9	163.0	260.4
Capital One Financial Corp	3,860.0	3,465.9	394.2	0.0	-1,341.9	1,736.0
Itau CorpBanca	638.7	265.7	372.9	0.0	317.1	55.8
BR Malls Participacoes SA	-518.5	-842.4	323.9	-5.3	215.4	113.8

Table 7–Source: Volatility Lab, NYU-Stern School of Business (https://vlab.stern.nyu.edu/), April 2017

However, as reported in Table 8, as of April 2017, this increased effect of SRISK for Latin American institutions is less evident: Banco Bradesco is still the largest contributor in terms of ΔSRISK, whereas Itau Unibanco, despite the increase in SRISK (third largest value), is currently reporting a negative SRISK value. Both these banks significantly reduced their SRISK values since their peaks reached at the end of November 2016 (almost 3 weeks after the Trump election).

Systemic Risk Rankings for Apr 6, 2017 View changes since: 2016-10-31

Institution	SRISK (t)	SRISK (t - 1)	Δ SRISK	Δ(DEBT)	Δ(EQUITY)	Δ(RISK)
Banco Bradesco SA	4,187.1	-1,175.2	5,362.4	2,916.5	404.3	2,041.5
Capital One Financial Corp	6,017.4	3,465.9	2,551.5	1,013.7	-1,204.5	2,742.3
Itau Unibanco Holding SA	-803.5	-2,685.1	1,881.6	353.2	-417.6	1,946.0
Regions Financial Corp	2,056.9	493.9	1,563.0	119.4	-1,958.8	3,402.4
KeyCorp	1,613.7	611.5	1,002.2	32.5	-1,832.4	2,802.1
Prudential Financial Inc	37,869.0	37,142.7	726.2	-275.0	-4,610.8	5,612.1
Principal Financial Group Inc	9,260.4	8,540.2	720.2	-158.6	-1,199.8	2,078.7
Morgan Stanley	28,414.2	27,695.9	718.4	-1,018.1	-5,929.1	7,665.5
Fifth Third Bancorp	1,348.4	654.2	694.2	-42.4	-1,213.0	1,949.6
Huntington Bancshares Inc/OH	779.2	123.4	655.8	1,836.7	-3,086.7	1,905.8

Table 8–Source: Volatility Lab, NYU-Stern School of Business (https://vlab.stern.nyu.edu/), April 2017

[21]With the exception of Banco do Brasil, which remained almost unchanged from a risk standpoint

[22]In a recent conference call with investors, the CEO of JPMorgan said: "The fixed-income market is going to go up, and needs for [currencies] is going up, and the needs for hedging is going up". Decambre, Mark. "J.P. Morgan results hint at bank renaissance in Trump era." MarketWatch. N.p., 13 Jan. 2017. Web. <http://www.marketwatch.com/story/jp-morgan-results-hint-at-bank-renaissance-in-trump-era-2017-01-13>

Our analysis showed this stress event did not increase systemic risk in the US and the rest of the Americas, although there was evidence of short-term effects on Latin American financial firms. Indeed, the aggregate capital shortfall in the region decreased from $488.845 to $445.132 billion between October 31, 2016 and April 7, 2017. However, the proposed reductions in regulatory requirements could have a long-term effect on increasing financial risk even though the short run effect is a reduction in SRISK. These effects in the US financial system need to be properly monitored.

The 3rd Stress Event of 2016: The Italian Referendum

On December 4, the Italian Referendum defeat raised questions about Italy's membership in the Euro area, generating fears of systemic risk for the Italian Banking system, already weighed down by a sluggish domestic economic environment. Italy is a bank-centric market, where lending represents the bulk of corporates' financing needs. Thus, a banking crisis would have a direct impact on the real economy via the credit channel, with the risk of propagation in the global market.

Since the event date, the SRISK indicator for the Italian financial system has reported the worst performance (+6%) on December 11th, with an aggregate Capital Shortfall of $147.486 billion. SRISK then improved to return to pre-event levels, currently reaching a value of $95.541 billion (as of April 7, 2017).

At the firm level (Table 9), on December 30th, the top five SRISK contributors (around 80% of the Italian Systemic Risk) were Unicredit, Intesa, Assicurazioni Generali, Banca Monte dei Paschi di Siena, and Banco BPM. It is worth noting the very high leverage of Banca Monte dei Paschi di Siena, as a confirmation of its troubled financial situation. The bank was the only institution that failed the recent stress test (July 2016) carried out by the European Banking Authority.

Systemic Risk Rankings for Dec 29, 2016 **View changes**

Institution	SRISK%	RNK	SRISK ($ m)	LRMES	Beta	Cor	Vol	Lvg
UniCredit SpA	36.16	1	46,062	72.79	2.55	0.44	60.1	52.69
Intesa Sanpaolo SpA	17.38	2	22,138	50.12	1.36	0.45	29.6	19.49
Assicurazioni Generali SpA	14.88	3	18,953	50.93	1.39	0.47	29.3	24.26
Banca Monte dei Paschi di Siena SpA	7.13	4	9,081	37.21	0.91	0.43	126.3	368.89
Banco BPM SpA	4.85	5	6,176	56.21	1.62	0.29	56.6	64.64
Unione di Banche Italiane SpA	3.90	6	4,967	42.55	1.09	0.17	136.2	44.45
EXOR NV	3.39	7	4,321	53.03	1.48	0.12	174.4	16.61
Unipol Gruppo Finanziario SpA	2.97	8	3,784	42.98	1.10	0.36	29.3	37.35

Table 9–Source: Volatility Lab, NYU-Stern School of Business (https://vlab.stern.nyu.edu/), April 2017

In terms of changes in SRISK values over a 1-month event window (Table 10), all the largest financial institutions improved their systemic risk profiles (that is, they reported negative ΔSRISK values), with the exception of Banca Monte dei Paschi di Siena, due to its high level of default risk. As of April 2017, Banca Monte dei Paschi di Siena is no longer in the current SRISK list (Table 11), since it was suspended from trading on December 23rd, 2016, following the decision by the Italian Government to bail out the bank at the end of December (after it failed to raise €5 billion on the market). It is worth noting that the €8.8 billion Capital Shortfall estimated by the ECB is in line with the one predicted by SRISK on December 30th, which was $9.080 billion (equivalent to €8.575 billion at current exchange rates).

Systemic Risk Rankings for Dec 29, 2016 **View changes since:** 2016-11-30

Institution	SRISK (t)	SRISK (t - 1)	Δ SRISK	Δ(DEBT)	Δ(EQUITY)	Δ(RISK)
UniCredit SpA	46,062.2	46,500.2	-438.1	0.0	-1,300.4	862.3
Intesa Sanpaolo SpA	22,138.1	28,291.4	-6,153.3	0.0	-2,232.0	-3,921.3
Assicurazioni Generali SpA	18,952.6	22,225.3	-3,272.6	0.0	-1,480.0	-1,792.6
Banca Monte dei Paschi di Siena SpA	9,080.6	8,879.8	200.8	0.0	132.9	67.9
Banco BPM SpA	6,175.8	6,455.9	-280.0	0.0	-109.5	-170.6
Unione di Banche Italiane SpA	4,967.4	5,168.1	-200.7	0.0	-283.6	82.9
EXOR NV	4,320.6	4,676.4	-355.8	0.0	-125.7	-230.1
Unipol Gruppo Finanziario SpA	3,783.7	4,147.9	-364.2	0.0	-186.6	-177.6
BPER Banca	2,312.3	3,015.3	-703.0	0.0	-230.9	-472.1
Banca Popolare di Milano Scarl	1,996.2	2,250.1	-253.8	0.0	-95.8	-158.1

Table 10–Source: Volatility Lab, NYU-Stern School of Business (https://vlab.stern.nyu.edu/), April 2017

The current list of top 10 SRISK contributors (Table 11) remains almost unaltered, with the presence of seven banks, two insurance companies, and one financial institution. However, the three largest SRISK contributors, Unicredit, Intesa, and Assicurazioni Generali, now make up approxmately 74% of the total systemic risk in Italy, compared to 68% as of December 30, 2016. Unicredit, the top SRISK contributor, is the only Italian institution in the Financial Stability Board's list of Systemically Important Financial Institutions (Appendix I).

Systemic Risk Rankings for Apr 6, 2017 ☐ **View changes**

Institution	SRISK%	RNK	SRISK ($ m)	LRMES	Beta	Cor	Vol	Lvg
UniCredit SpA	38.75	1	37,024	54.60	1.55	0.43	27.1	28.99
Intesa Sanpaolo SpA	18.11	2	17,302	45.51	1.19	0.39	22.6	17.72
Assicurazioni Generali SpA	17.18	3	16,409	44.95	1.17	0.41	20.7	23.04
Banco BPM SpA	5.01	4	4,788	61.28	1.86	0.37	40.5	27.81
Unione di Banche Italiane SpA	4.20	5	4,012	41.49	1.05	0.17	135.0	31.41
EXOR NV	3.87	6	3,701	54.82	1.56	0.13	171.5	14.24
Unipol Gruppo Finanziario SpA	3.60	7	3,439	48.24	1.29	0.41	24.6	31.43
BPER Banca	2.30	8	2,197	43.51	1.12	0.28	32.6	27.77
Banca Carige SpA	1.29	9	1,235	28.05	0.64	0.11	30.1	111.34
Banca Popolare di Sondrio SCARL	1.26	10	1,203	45.77	1.20	0.40	23.6	24.33

Table 11–Source: Volatility Lab, NYU-Stern School of Business (https://vlab.stern.nyu.edu/), April 2017

In sum, apart from the Banca Monte dei Paschi di Siena case, the Italian referendum appeared to be a non-event in terms of systemic risk, at least over this short time period. However, the significant concentration of SRISK in only three institutions poses potential challenges from a systemic risk standpoint.

Conclusions

We described SRISK as a measure to identify and quantify the contribution of financial institutions to systemic risk and its applications to recent stress events in the financial market.

This quantitative metric, which provides estimates in real time based on publicly available market and accounting data, is a useful complement to capital requirements for SIFIs and stress tests periodically conducted by regulators around the world. A timely scrutiny of a potential build-up of systemic risk would help monitor ongoing business activities of interconnected firms, particularly under a challenging economic environment.

Our SRISK analysis of Brexit, the Trump election, and the Italian Referendum shows a material but temporary increase of aggregate systemic risk in the wake of these events. But, more importantly, it sheds light on the contributions of individual financial institutions to specific stress conditions. A recurring finding from these three cases is the presence of both Banks and Insurance companies as the main contributors to aggregate systemic risk. If we also consider that some Asset Managers are part of these financial conglomerates (this is a typical case, for example, among European banking groups), we can conclude that any kind of financial institution can present transmission channels in terms of systemic risk[21].

However, the effects of these three events did not appear to persist over time, highlighting a significant resilience of financial institutions to these shocks. This is also attributable to the strengthened regulatory and supervisory framework put in place after the subprime crisis.

As recently stated[22] by the President of the European Central Bank, Mario Draghi: "[...] it is too early to judge the impact of political uncertainties generated by the election of Donald Trump, the Brexit vote and Italy's referendum or the Eurozone economy [...]".

Despite the potential noise in market and accounting data underlying SRISK, and the long-term consequences of stress events, the dynamic and forward looking nature of this metric contributes to increasing the transparency around the quantification of systemic risk.

[21]For a comprehensive analysis of systemic risk in the asset management industry, see Milken Institute (2016)
[22]See Khan, Mehreen. "Draghi: Trump and Brexit effect still unknown for eurozone." Financial Times. N.p., Dec. 2016. Web. <https://www.ft.com/content/8b9832b0-5dee-37b2-8351-dc93c9ee0c49>

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Appendix I

List of global systemically important financial institutions

Banks

No.	Bank	Country	Additional Capital Buffer for Systemic Risk
1	Citigroup	US	2.50%
2	Jp Morgan Chase	US	2.50%
3	Bank of America	US	2.00%
4	BNP Paribas	France	2.00%
5	Deutsche Bank	Germany	2.00%
6	HSBC	UK	2.00%
7	Barclays	UK	1.50%
8	Credit Suisse	Switzerland	1.50%
9	Goldman Sachs	US	1.50%
10	Industrial and Commercial Bank of China	China	1.50%
11	Mitsubishi UFJ FG	Japan	1.50%
12	Wells Fargo	US	1.50%
13	Agricultural Bank of China	China	1.00%
14	Bank of China	China	1.00%
15	Bank of New York Mellon	US	1.00%
16	China Construction Bank	China	1.00%
17	Groupe BPCE	France	1.00%
18	Groupe Credit Agricole	France	1.00%
19	ING Bank	Netherlands	1.00%
20	Mizuho FG	Japan	1.00%
21	Morgan Stanley	US	1.00%
22	Nordea	Sweden	1.00%
23	Royal Bank of Scotland	UK	1.00%
24	Santander	Spain	1.00%
25	Societe Generale	France	1.00%
26	Standard Chartered	UK	1.00%
27	State Street	US	1.00%
28	Sumitomo Mitsui FG	Japan	1.00%
29	UBS	Switzerland	1.00%
30	Unicredit Group	Italy	1.00%

Source: Financial Stability Board, "2016 list of global systemically important banks (G-SIBs)", November 2016

Insurers

No.	Insurer	Country	Additional Capital Buffer for Systemic Risk
1	Aegon NV	Netherlands	Calculated using a factor-based approach. For further details, see IAIS (2015).
2	Allianz	Germany	
3	American International Group	United States	
4	Aviva	United Kingdom	
5	Axa	France	
6	MetLife	United States	
7	Ping An Insurance Company	China	
8	Prudential Financial	United States	
9	Prudential plc	United Kingdom	

Source: Financial Stability Board, "2016 list of global systemically important insurers (G-SIIs)", November 2016

Appendix II

Current Top 10 SRISK firms in Europe and Americas (as of April 7, 2017)

Europe

Systemic Risk Rankings for Apr 7, 2017 ☐ View changes

Institution	SRISK%▼	RNK	SRISK ($ m)	LRMES	Beta	Cor	Vol	Lvg
BNP Paribas SA	8.11	1	80,254	55.21	1.57	0.49	24.4	26.79
Deutsche Bank AG	7.79	2	77,103	63.74	1.99	0.54	32.7	48.37
Credit Agricole SA *	6.93	3	68,518	54.88	1.56	0.45	24.4	41.55
Societe Generale SA	6.10	4	60,316	57.41	1.67	0.44	27.0	35.81
Barclays PLC	5.86	5	57,977	54.30	1.53	0.40	25.1	32.06
UniCredit SpA	3.74	6	37,024	54.60	1.55	0.43	27.1	28.99
Royal Bank of Scotland Group PLC	3.51	7	34,699	50.92	1.39	0.38	26.1	27.47
Banco Santander SA	3.43	8	33,949	55.29	1.58	0.52	22.9	15.59
London Stock Exchange Group PLC	3.11	9	30,758	44.36	1.15	0.40	19.9	50.40
Credit Suisse Group AG	3.06	10	30,284	58.60	1.73	0.49	25.1	26.38

Americas

Systemic Risk Rankings for Apr 7, 2017 ☐ View changes

Institution	SRISK%▼	RNK	SRISK ($ m)	LRMES	Beta	Cor	Vol	Lvg
Bank of America Corp	12.15	1	54,104	53.33	1.49	0.59	26.2	9.28
Citigroup Inc	9.54	2	42,481	46.01	1.21	0.58	18.8	10.39
MetLife Inc	8.72	3	38,827	47.41	1.26	0.57	20.2	15.53
Prudential Financial Inc	8.51	4	37,869	49.95	1.35	0.64	19.7	17.06
JPMorgan Chase & Co	6.66	5	29,662	48.29	1.29	0.67	19.3	8.13
Morgan Stanley	6.38	6	28,414	58.07	1.70	0.58	28.4	10.30
Manulife Financial Corp	5.60	7	24,942	50.98	1.40	0.56	20.5	15.70
Banco do Brasil SA	4.34	8	19,337	52.64	1.46	0.40	39.8	14.57
Goldman Sachs Group Inc/The	4.00	9	17,802	48.77	1.31	0.58	21.6	9.27
Power Corp of Canada	3.91	10	17,394	46.05	1.21	0.48	20.7	25.99

Source: Volatility Lab, NYU-Stern School of Business (https://vlab.stern.nyu.edu/), April 2017

Contact us

market.intelligence@spglobal.com