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What is the information content of the SRISK measure as a supervisory tool?

Santiago Tavolaro and Frédéric Visnovsky*

*Autorité de Contrôle Prudentiel et de Résolution. Corresponding author : santiago.tavolaro@acpr.banque-france.fr
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Abstract
The SRISK measure is advertised as measuring the recapitalization needed by a financial institution in the event of a financial crisis. It is computed from the estimated reaction of the institution's share price in the event of a sharp drop in market prices. This indicator relies both on an economic analysis and an econometric model. It is applied to a large set of international and domestic financial institutions, updated regularly and made available online. Although innovative, it stirred naturally debates among academics, supervisors and professionals, highlighting some limitations, in particular when considering the SRISK measure as a supervisory tool. First, the SRISK is based on market return data: consequently, it applies only to listed institutions and is exposed to criticisms as to which extent it can mirror fundamentals. Second, the SRISK seems to lack sound foundations for policy analysis: with a reduced-form approach, conclusions regarding causality are not obvious from an economic point of view. Moreover the SRISK is a conditional measure to an event whose likelihood is not integrated in the framework. Third, empirical analyses of SRISK as a supervisory tool, used for instance to identify systemic financial institutions (SIFIs) or as an early-warning indicator, have shown some limited perspectives.

Keywords: Systemic Risk Measures, Market Data, Financial Monitoring
JEL: D81, L51, G01, G21, G28

Une analyse de la mesure SRISK comme outil de supervision

Résumé
Le SRISK est présenté comme une mesure du besoin en recapitalisation d'une institution financière en cas de crise. Ce besoin est calculé à partir d'une estimation de la réaction du prix de l'action d'une institution en cas d'une forte chute du marché action. Cet indicateur repose à la fois sur une analyse économique et un modèle économétrique. Il est publié en ligne, avec des mises à jour régulières, pour un large ensemble d'institutions financières internationales ou nationales. Bien qu'innovant, il a naturellement généré des débats au sein des académiques, des superviseurs et des professionnels, soulignant quelques limites, en particulier concernant l'usage du SRISK comme outil de supervision. Premièrement, le SRISK se fonde sur des données de marché: par conséquent, il ne peut s'appliquer aux institutions non-cotées en bourse et prête le flanc à la critique sur sa capacité à prendre en compte correctement les fondamentaux des institutions. Deuxièmement, le SRISK ne semble pas reposer sur des fondements solides permettant de tirer des conclusions de politique économique: en adoptant une approche sous forme réduite, il n'est pas évident de pouvoir mettre en évidence un lien de causalité au plan économique. De plus, le SRISK est une mesure conditionnelle à un événement dont la vraisemblance n'intervient pas dans l'approche. Troisièmement, plusieurs études empiriques sur l'utilisation du SRISK comme outil de supervision, par exemple pour identifier les institutions financières systémiques (SIFIs) ou comme indicateur avancé de crise, présentent des avis mitigés quant à sa pertinence.

Mots clés: risque systémique, données de marché, surveillance du secteur financier
JEL: D81, L51, G01, G21, G28

1. Introduction

The Stern Business School at New York University reports on a weekly basis a ranking of the more systemic financial institutions (banks, insurance companies…).[2] This ranking is based on a measure of systemic risk called SRISK which is mainly based on market data.[3] Major banking groups often appear at the top of the rankings. Beyond the publication, the SRISK is often promoted as a regulatory measure: identification of SIFIs (Systematically Important Financial Institutions) identification, "taxation" of Too-Big-To-Fail, capital stress testing... We take the view that, while this measure is likely to bring information to the regulator, basing supervisory action on this indicator may appear as not appropriate for several reasons that we develop in this paper.

Section 2 presents the SRISK model which is based on both an economic analysis of banks and a sophisticated econometric specification approach. A subsection, introducing surprising or unexpected results for a few institutions, completes this presentation. In Section 3, we highlight the main limitations of the SRISK when we *consider it as a supervisory tool*. These limits stem from the use of market data and the underlying assumptions of the SRISK. We also report some empirical evidence of using the SRISK to identify SIFIs. In Section 4, we briefly discuss some additional shortcomings about (systemic) risk measures for the SRISK. Section 5 concludes regarding future research on systemic risk measures for supervision.

2. Main features of the “Systemic RISK” indicator

The "Systemic RISK" (SRISK) is a measure of systemic risk proposed by Acharya *et al.* (2012) based on market data: according to its proponents, the SRISK measures the recapitalization level needed by a given institution in the case of a crisis. This measure combines an economic analysis of Acharya *et al.* (2010) and an econometric model developed by Brownlees and Engle (2012). A presentation of the SRISK is also done in Engle *et al.* (2012).[4] We summarize first the economic analysis based on Acharya *et al.* (2010), and then we present how this economic model is associated with the work of Brownlees and Engle (2012). Lastly, few excerpts from the associated website (V-Lab website) are discussed.

[2] See V-LAB website: http://vlab.stern.nyu.edu/welcome/risk/

[3] The total liabilities is the unique figure coming from the balance sheet.

[4] Note that the SRISK is also presented in Engle *et al.* (2012a) and Acharya *et al.* (2012b).

2.1. Economic components

Acharya *et al.* (2010) adapt the standard expected loss (or Expected Shortfall) risk measure to assess systemic risk in the financial system (here reduced to the financial market) under an adverse scenario. Formally, $r_{m,t}$ is the performance of the market index at time *t* and *C* is the threshold level defining a systemic event (often *C=-40%*). The Expected Shortfall of the system, denoted $ES_{m,t}$, is then the expected market return conditional on the fact that its performance is below *C*. Since the market index is a weighted sum of the performance of participating financial institutions we get:

$$ES_{m,t}(C) = \mathbb{E}_{t-1}\left(r_{m,t} \middle| r_{m,t} < C\right) = \sum_{i=1}^{N} w_{i,t}\mathbb{E}_{t-1}\left(r_{i,t} \middle| \sum_{j=1}^{N} w_{j,t}r_{j,t} < C\right), \qquad \text{(Eq. 1)}$$

where $r_{i,t}$ is the performance of institution *i*, $w_{i,t}$ is its weight in the market index, *N* is the total number of institutions and $\mathbb{E}_{t-1}$ is the conditional expectation on all the information available in $t-1$. This indicator is an overall measure of systemic risk, being the expected impact on total market return of a severe negative event. To obtain the contribution of each institution to the total shortfall, the authors use the Marginal Expected Shortfall (MES) (see Tasche, 2000) by differentiating $ES_{m,t}$. In order to capture the contribution of the individual institution *i*, the authors differentiate by its weight in the Expected Shortfall of the system to get:

$$MES_{i,t}(C) = \mathbb{E}_{t-1}\left(r_{i,t} \middle| \sum_{j=1}^{N} w_{j,t}r_{j,t} < C\right). \qquad \text{(Eq. 2)}$$

Acharya *et al.* (2012) define the Long Run Marginal Expected Shortfall (LRMES) allowing the indicator to become a special stress testing tool. It is defined as the MES conditional to a market decline of at least 40% over the next six months.

However, given that the simulations of the trajectories of the market returns over 6 months on a daily basis is significantly time-consuming, the authors propose to estimate market price changes over 6 months by duplicating a daily variation, using the following approximation:

$$\begin{aligned} LRMES_{i,t} &= -\mathbb{E}_{t-1}\left(R_{i,t+6months} \mid R_{m,t+6months} < -40\%\right) \\ &\approx 1 - exp\left(18 \times MES_{i,t}(2\%)\right), \end{aligned} \qquad \text{(Eq. 3)}$$

with $R_{i,t+6months}$ (respectively $R_{m,t+6mois}$) the exponential return of the institution *i* (respectively of the market) in 6 months.[5] With this definition of a crisis, the authors take into account the structure of the balance sheet to define the SRISK of an institution by:

[5] For detailed calculations and analysis of the underlying assumptions, see Engle, Jondeau, Rockinger (2012) or Benoit (2013).

$$SRISK_{i,t} = max\left[0\ ;\ \underbrace{k\left(\underbrace{D_{i,t} + MV_{i,t}}_{Total\ asset\ proxy}\right)}_{Regulatory\ capital\ level} - \underbrace{\left(1 - LRMES_{i,t}\right) MV_{i,t}}_{Remaining\ capital\ in\ case\ of\ a\ crisis}\right] \qquad \text{(Eq. 4)}$$

where $D_{i,t}$ is the debt of the institution (balance sheet information), $MV_{i,t}$ is the market capitalization of the institution *i* (market information) in *t*, and *k* is a factor defining a "prudential capital ratio" that is taken to be as 8 percent in Acharya et al. (2012).[6]

2.2. Econometric components

In Brownlees and Engle (2012), the authors develop a multivariate approach, TARCH-DCC, to model the correlations between the returns of financial institutions. This technical model is used to compute the conditional expectation in the SRISK formula (LRMES factor given in Equation 3). The econometric model combines various advanced features: a common factor affects all individual returns in a time-varying framework, returns exhibit volatility clusters (where periods of high volatility alternate with periods of low volatility) and volatility reacts differently to an increase or a decrease based of market returns.

Technically, the authors propose to model the market return ($r_{m,t}$) characterizing the common factor in the equations of individual returns ($r_{i,t}$ for *i* from *1* to *N*) by the following specification:

$$\begin{cases} r_{m,t} = \sigma_{m,t}\,\varepsilon_{m,t} \\ r_{i,t} = \sigma_{i,t}\,\rho_{i,t}\,\varepsilon_{m,t} + \sigma_{i,t}\sqrt{1-\rho_{i,t}}\,\xi_{i,t} \\ \left(\varepsilon_{m,t}, \xi_{i,t}\right) \sim F \end{cases} \qquad (Eq. 5)$$

where the shocks, $\varepsilon_{m,t}$ and $\xi_{i,t}$ are independent and identically distributed over time with zero mean, unit variance and zero covariance. The cumulative distribution function of innovation is denoted by *F*. The market return, $r_{m,t}$, is decomposed into a volatility factor, $\sigma_{m,t}$, and an innovation factor $\varepsilon_{m,t}$. The return of institution *i*, $r_{i,t}$, is a mixture of a common term, $\varepsilon_{m,t}$, and a specific term, $\xi_{i,t}$. The two terms are related to each other through a dynamic correlation, $\rho_{i,t}$, and a dynamic volatility, $\sigma_{i,t}$, that both depend on institution *i*. $\xi_{i,t}$ represents the innovation specific to institution *i*. The volatility terms, $\sigma_{m,t}$, and the , $\sigma_{i,t}$, are modeled according to a TGARCH specification. TGARCH model leads to get financial time series with volatility clustering and threshold effects. The specification is:

$$\begin{cases} \sigma_{m,t}^2 = \varpi_{mG} + \alpha_{mG} r_{m,t-1}^2 + \gamma_{mG} r_{m,t-1}^2 1_{r_{m,t-1}<0} + \beta_{mG}\sigma_{m,t-1}^2 \\ \sigma_{i,t}^2 = \varpi_{iG} + \alpha_{iG} r_{i,t-1}^2 + \gamma_{iG} r_{i,t-1}^2 1_{r_{i,t-1}<0} + \beta_{iG}\sigma_{i,t-1}^2 \end{cases} \qquad (Eq. 6)$$

[6] As stated in Acharya et al. (2012), *k* is considered to be a leverage ratio while under Basel III, the denominator of the leverage ratio includes on-balance sheet assets as well as off-balance sheet items.

Intuitively, the volatility of returns has a time dependency β and increases with the square value of the return (α and γ). However, the response is asymmetric because the volatility does not respond identically in the case of a loss or a gain since the threshold effects depend on the sign of the returns.

Finally, it is necessary to specify the dynamic correlations, $\rho_{i,t}$, between the common factor and the individual ones. This dynamic is based on the DCC (Dynamic Conditional Correlation) methodology.[7] The main idea of the methodology is to specify the correlation matrix dynamics with the same characteristics as a GARCH model: allowing periods of high correlation interspersing with periods of small changes in correlations.

2.3. A few surprising results

In order to motivate the need to assess the empirical content of the SRISK, we provide the results of the SRISK indicator for two significant institutions (Loyds Bank and Crédit Agricole S.A.) in terms of size and activity in the financial system revealing some unexpected shortcomings of the approach.

Before the 2008 crisis, the approach presented above computes a null SRISK for Lloyds Bank (Figure 1). This is certainly explained by a negative correlation between the Lloyds Bank's share price and the reference stressed market index as the SRISK includes a *Max(0,X)* operator (see equation 4). Empirically, the interpretation of this result is that Lloyds Bank would have not been affected, either positively or negatively, by any potential systemic risk during that pre-crisis period. This institution appears to be totally independent from systemic risk during the pre-crisis period. Such a conclusion is not very intuitive for a supervisor. In parallel, the sudden jump of the SRISK in 2009 (Figure 1: 400% in one day) is likely explained by the merger of Lloyds with Halifax Bank of Scotland. However, it is hard to find out the reason of this jump. Based on the SRISK framework, a supervisor is not properly informed of the reason(s) of such a jump as we may consider, for instance, an increase in the market capitalization of the group, or a change in the correlation with the market index.

[7] A full description is beyond the scope of this analysis.

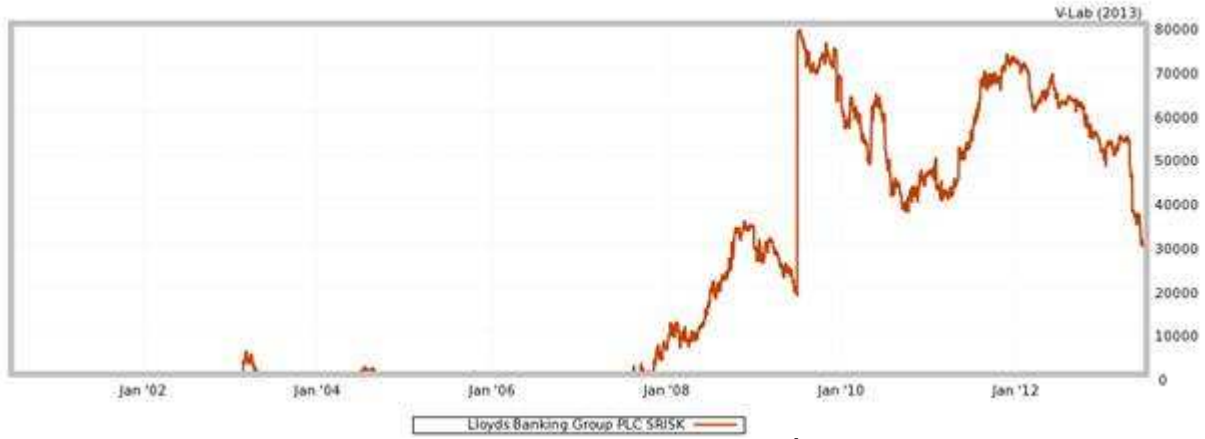

Figure 1 : Lloyds Bank SRISK (July 5th, 2013)

Another point that raises questions concerning the relevance of the SRISK refers to groups that are partially listed or unlisted, a quite frequent situation in Europe, but not only. For example, in France three of the six largest banking groups, Group Crédit Mutuel, BPCE and HSBC France, have no SRISK just because they are unlisted while they may, as any other institution, be potentially concerned by systemic risk. This issue is not salient only for France: for instance, the German banking sector is largely composed of unlisted banks (cooperative or public banks). Besides, in the case of partially listed entities, it is worth illustrating this point with Crédit Agricole S.A. (CASA). Descriptive data presented on the V-Lab website (Figures 2 and 3) provide a leverage ratio of 77 for CASA (as of the November 15th, 2013).[8] This figure is unrealistic due to the use of banking information from different sources. CASA is the only listed subsidiary within the consolidated Group Crédit Agricole (GCA). About only half of the equity of CASA is publicly traded. This way, the estimation of the market capitalization of CASA is based on half of its equity level. In parallel, CASA has a total balance sheet almost equivalent to the one of GCA since CASA reports its balance sheet figures on a sub-consolidated basis, where intra-group transactions with other entities of the group (the "Caisses Régionales") are not netted. These intra-group transactions would not be taking into account at the consolidated level of GCA.

Therefore, it appears that the SRISK raises some questions around its figures, its ranking procedures and the set of assessed institutions. The ranking procedure seems to mix different accounting standards between institutions (consolidated, sub-consolidated and solo levels) without considering their differences and implications. Moreover, the capital estimation is strongly dependent on the number of shares that are publicly traded over the total of shares creating significant discrepancies. Last, as simple as it is, unfortunately unlisted banks have no SRISK.

[8] Note that the Swiss Central Bank is the 14th most important contributor to systemic risk in Europe according to SRSIK ranking. It has a leverage of 4734. About half of the Swiss Central Bank only is publicly traded.

Figure 2 : Crédit Agricole S.A. SRISK (V-Lab, June 28th, 2013)

Systemic Risk Rankings for 2013-11-08 ☐ View changes

Institution	SRISK%	RNK	SRISK ($ m)	MES	Beta	Cor	Vol	Lvg	MV
Credit Agricole SA	8.19	1	114,657	4.13	1.62	0.46	27.[illegible]	77.64	30,445.9
Deutsche Bank AG	7.71	2	107,957	4.25	1.66	0.67	22.2	50.37	47,444.7
Barclays PLC	6.48	3	90,785	4.22	1.65	0.44	29.3	34.14	65,764.1
BNP Paribas	6.12	4	85,707	3.99	1.56	0.55	23.9	27.02	88,330.4
Royal Bank of Scotland Group PLC	5.20	5	72,762	5.17	2.02	0.38	52.7	30.49	58,249.1
Societe Generale	5.11	6	71,594	4.69	1.84	0.49	27.8	38.29	43,526.5
ING Groep NV	4.50	7	62,959	5.60	2.19	0.57	31.9	30.41	49,480.6
UniCredit SpA	2.86	8	40,104	4.10	1.61	0.52	39.3	26.67	41,774.6
Banco Santander SA	2.77	9	38,748	4.10	1.60	0.57	26.9	16.48	97,092.4
UBS AG-REG	2.66	10	37,191	5.71	2.23	0.39	45.8	16.84	69,784.6
Commerzbank AG	2.56	11	35,846	4.82	1.89	0.37	43.9	49.15	15,918.5
Credit Suisse Group AG	2.51	12	35,190	5.48	2.15	0.41	39.7	21.26	46,190.9
Natixis	2.15	13	30,060	3.76	1.46	0.41	24.2	42.05	16,912.3
Schweizerische Nationalbank	2.11	14	29,572	0.78	0.30	0.14	23.8	4734.71	113.9

Figure 3 : Crédit Agricole S.A. SRISK ranking (V-Lab, November 15th,2013)

3. Main concerns about the SRISK as a supervisory tool

The SRISK, as any model in the systemic risk field, has raised numerous questions. They go from economic analysis, to econometric considerations and to concerns about applications. As a supervisor, our focus is related to the potential use of the SRISK in order to monitor financial stability using it as an early warning indicator or as a substitute for systemic risk stress-test exercises. The SRISK does not seem to be properly adapted to this specific use for several reasons that are developed below. These criticisms stem from shortcomings associated with the use of market data and from some other characteristics of SRISK design that are misaligned with financial stability monitoring. Existing results from empirical analysis of SRISK (or MES) measures are also reported.

In order to have broader views of the SRISK, the Appendix gathers some specific points (market capitalization computation, volatility modeling and estimation techniques) that are not directly linked to usual supervisory framework.

3.1. Stock market data based model

Relying on market data, the SRISK has a restricted scope in terms of covered institutions for supervisory purposes. As presented in Section 2, computing the SRISK indicator requires using the returns on financial institutions' equities. In other words, the SRISK can be applied only to publicly traded institutions. This characteristic immediately raises the problem of the scope of this indicator (see Section 2.3). A supervisory (or a regulatory) framework, for instance for SIFIs identification, could not be based on the SRISK since unlisted financial institutions would have no systemic measure. In this perspective, the list of SIFIs proposed by the Financial Stability Board includes unlisted financial institutions. In parallel, the supervisor has a constraint, in terms of equality of treatment across supervised financial institutions, which would not be met with this market based framework.

Reflecting the perception of market participants, market data do not necessarily reflect the fundamentals of financial institutions. More specifically, fundamental risk is the risk stemming from the economic environment (such as non-performing loans) and from idiosyncratic risks. The assessment of risks by market participants can be distant from the fundamental risks for (at least) two main reasons. First, in order to assess properly the risks faced by a given agent, market participants have only access to public data which composes a reduced information set. Second, stock prices may be temporarily affected by bubbles, fads, etc while supervisors focus on fundamentals driving financial institutions' health. Unfortunately, there is no clear assessment of the underlying impacts on market-data based measures such as SRISK, on the discrepancy between fundamental risks and market-implied risks.

In any case, one has to keep in mind that market and accounting data are not exclusive. For instance, models for predicting defaults or changes in ratings are shown to be empirically more efficient when combining accounting (and regulatory) data and market returns (see for instance Berger *et al.*, 2000, Krainer and Lopez 2004, Gropp *et al.*, 2006). Empirical assessments of systemic risk measures based on market returns favor cautious opinions (see Section 3.4).

3.2. Economic foundations of the SRISK indicator

Integrating directly aggregated values, such as market capitalization in the SRISK, excludes diagnosis and causality analysis. The reduced-form feature does not allow to model interactions and behaviors of economic agents, namely financial institutions. In the end, this measure has not the capacity to inform on the underlying mechanisms or potential mechanisms at stake while the central

banks academic researchers agree on the composite nature of systemic risk. The currently proposed systemic risk measures based on market-returns, such as SRISK, MES or ΔCoVaR, are unable to disentangle the different potential risk factors involved (such as contagion, liquidity, solvency, fire sales, funding...).

In particular, the SRISK is mainly based on the market capitalization and on a common adverse exogenous factor (see Equation 4). Here, market capitalization is used as a proxy to follow the market value of equity which represents the difference between the total assets and the total liabilities. Therefore, risks on the asset side (such as credit risk, market risk, liquidity market risk…) and on the liability side (for instance, funding risk) are intertwined in this model. Since each class of risk requires specific corrections from the supervisor (better screening, portfolio rebalancing, provisioning…), specific actions cannot be justified by the outputs of the SRISK. Moreover, the unique common factor, capturing only the market risk associated with a specific set of institutions behind it (the choice of the market index), may in the end correspond to a very particular source of risk. In parallel, despite sophisticated returns correlations treatments, this measure actually realize a form of simultaneity. For a supervisor, the SRISK does not provide the potential sources of risk or the mechanisms at stake required for an immediate or a preventive action.

Combining items from accounting and mark-to-market sources, the SRISK is exposed to approximations. While the Marginal Expected Shortfall is only based on market-data, the SRISK combines market-data and balance-sheet information (see Equation 4). Market capitalization is measured at the market value while total liabilities are at their accounting value. Total assets are derived by summing these two figures. This assumes that the market capitalization coincides perfectly with equity's value. However, it is common to observe large differences between them,, especially with regards to their variations (see Figure 4 where, for instance for BNPP, the market capitalization was almost twice the equity value in 2006 and then less than the half in 2011).

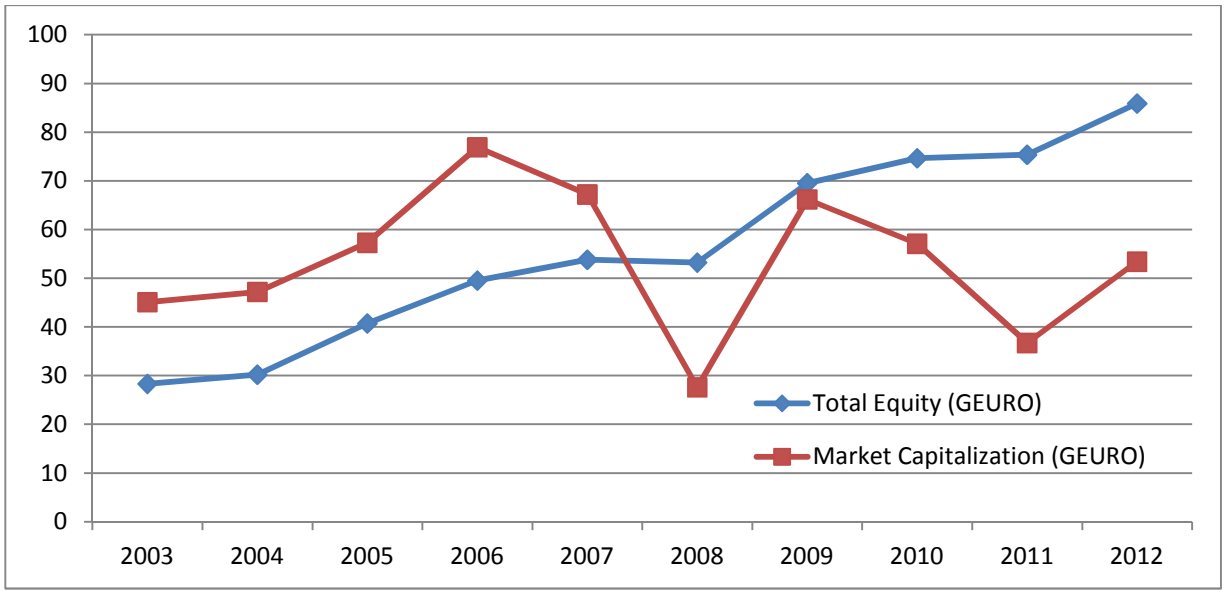

Figure 4 : Total Equity and Market Capitalization of BNPP

(source: public financial communication of BNPP)

The SRISK is a measure of loss conditional to a specific event which needs sound economic foundations. The discussion is probably not around on how to fine tune the threshold *C* (in Equation 1), but on the underlying economic event in the conditioning. Three concerns may be raised. First, the SRISK framework does not consider that a financial institution may go into insolvency,[9] as the losses arising from a financial institution are limited to the initial market capitalization (see the *Max (0,X)* operator in equation 4). This prevents the approach to consider an event such as a liquidation process where the bankruptcy of an institution implies losses to all its creditors (schematically, when total assets is lower than total liabilities) or to estimate the cost of a resolution. Second, the SRISK corresponds to a decrease in the capitalization of an institution under a stock market decline event (40% drop in 6 months). However, empirically, an adjustment mechanism is usually observed after strong declines in stock markets. In this context, it might be more appropriate to calculate the recapitalization needs at the end of the cycle instead of a 6-month fix period. Third, the likelihood of the conditioning event would gain from a quantitative assessment. The SRISK addresses the question of the loss given a certain fixed event and not the likelihood of the adverse event that potentially generates systemic risk (see also subsection 3.3).

Regulatory individual stress-testing exercises are based on different macroeconomic situations. They assess, through projections, how each agent of the financial sector may behave according to several "adverse but plausible" scenarios. These deterministic scenarios are explicitly described and expressed in macroeconomic terms (GDP growth, CPI, interest rate, unemployment…). Besides, the stress-test

[9] In accounting standards, the solvency default is defined for institution whose total assets value is below its total debts value. This definition is different from the supervisors' one that is related to a capital ratio threshold.

impact on an institution is measured through a set of indicators with the objective to at least cover existing regulation but as well ongoing new and future regulatory frameworks. Nowadays, a very new set of stress-tests, network stress-tests, are being developed by supervisors to consider potential second round effects through contagion mechanisms between entities (solvency contagion, funding contagion or liquidity hoarding, fire sales) that were not possible to assess only through individual stress-test exercises.

3.3. Concerns associated with the use of an index

The market index is a cornerstone of the SRISK measure that goes with some concerns. Let us highlight two of them.

Usually, market indices are constructed with time-varying weights. For example, the weights in the CRSP[10] indices that are commonly used in the literature (*e.g.* Brownlees, Engle, 2012) are periodically rebalanced (often on a quarterly basis) based on the market capitalization of the index components.

Thus, for an index based on *N* assets, if $s_{i,t}$ is the number of floating shares and $p_{i,t}$ is the share price at time *t* (stochastic process), the weighting of *i* is:

$$w_{i,t} = \frac{p_{i,t} \times s_{i,t}}{\sum_{j=1}^{N} p_{j,t} \times s_{j,t}} \qquad \text{(Eq. 7)}$$

From Equation 7 and considering that the conditional event occurs over six months, the weights $w_{i,t}$ are not constant but stochastic processes avoiding to simply move them outside the conditional expectation expression in Equation 1.

The Marginal Expected Shortfall is based on a particular type of differentiation. Let us assume that the weights in the index are nevertheless constant over time (see below) to curb the first point. To get the MES of institution i (Equation 2), the authors differentiate the Capital Shortfall (CS) in Equation 1 with respect to the weight w_i. However, this differentiation may suffer from the omission of the equation expressing that the index weights have to sum up to 1.[11] Illustratively, when there are only two institutions, the differentiation of the market return with respect to the weight of the first institution (conditional to the event"the market return is lower than *C*") is:[12]

[10] Center for Research in Security Prices.

[11] One assumption that can make the differentiation correct without explicitly taking into account the constraint is to consider that all the underlying assets vary in the same proportion. In the case of SRISK, this assumption is more difficult to verify as the time period is 6 months and is focused on an index decline.

[12] More precisely, the market return is $r_{m,t} = w_1 r_{1,t} + (1 - w_1) r_{2,t}$. Therefore the expected capital shortfall is $ES_{m,t}(C) = \mathbb{E}_{t-1}\left(r_{m,t} \middle| r_{m,t} < C\right) = w_1 \mathbb{E}_{t-1}\left(r_{1,t} \middle| r_{m,t} < C\right) + (1 - w_1)\mathbb{E}_{t-1}\left(r_{2,t} \middle| r_{m,t} < C\right)$. See also Qin and Zhou (2013).

$$\frac{\partial ES_{m,t}(C)}{\partial w_1} = \mathbb{E}_{t-1}\left(r_{1,t} \mid r_{m,t} < C\right) - \mathbb{E}_{t-1}\left(r_{2,t} \mid r_{m,t} < C\right), \qquad (Eq.8)$$

which is not what is provided by Equation 2:

$$\frac{\partial ES_{m,t}(C)}{\partial w_1} \neq \mathbb{E}_{t-1}\left(r_{1,t} \mid r_{m,t} < C\right). \qquad (Eq.9)$$

In Engle, Jondeau, and Rockinger (2012), the definition of the SRISK is modified to explicitly take into account constant weights and stating directly the MES formula (Equation 2) without claiming that it is derived from a differentiation. While this change avoids the two points aforementioned, this new approach may not be entirely satisfactory. Firstly, the MES of an institution can no longer be interpreted as the marginal contribution of this specific institution. Secondly, one may be exposed to difficulties when calibrating the SRISK on usual data (S&P500, CRSP indices…) for instance to compare the threshold *C*=-40% with historical data on indices since they have time-varying weights.

3.4. Existing empirical analysis of SRISK as a supervisory tool

The relevance of the subject addressed by the SRISK as well as the V-LAB website attracted central banks and academic interests. Several papers did produce interesting analyses of the SRISK as a supervisory tool. Let us briefly report two papers that contribute to assess the capacity of the SRISK to identify SIFIs. Finally, a last paper reports on the incentives for banks to base capital surcharge on a market-based systemic risk measure.

First, Idier *et al.* (2012) address the predictive power of the MES measure to identify which financial institutions would be severely affected by a crisis. A panel of 65 large US banks over the last decade and a half is used. The authors show that the MES has not a good predictive power and therefore "based on all this evidence, **[they] thus strongly doubt that the MES can really help regulators to identify systematically important banks on the eve a future severe systemic crisis**". Due to the very strong correlation between SRISK and MES, they suggest that "**SRISK indicator does not fare better than the original MES**".

Second, Benoit *et al*. (2013) focus on the ranking of financial institutions according to different systemic risk indicators, namely MES and SRISK.[13] They show that the ranking based on MES is mainly driven by the sensitivity to the market index return while "the SRISK-based ranking seems to be largely determined by the indebtedness of the firms". Thus the authors conclude "**our finding**

[13] The scope of their analysis is all US financial firms with a market capitalization above $5 billion as of end of June 2007 (94 firms) between 2000 and 2010.

indicate that these measures [namely MES and SRISK] fall short in capturing the multifaceted nature of systemic risk".

Last, Löffler and Raupach (2013) examine practical supervisory implications of using market-based measure of systemic risk. According to their analysis, difficulties steam from the lack of extreme events on data used to estimate the underlying models. Consequently, they show that "a direct application to regulatory capital surcharges could create wrong incentives for banks". Actually, the authors present several management strategies for institutions leading to misidentification of risky (and no risky) institutions.

4. Additional concerns regarding the use of SRISK as a supervisory tool

In debates on supervision and financial regulation, the SRISK is sometimes said to have some interesting characteristics from a supervisory point of view (with respect to other systemic risk measures). We discuss in this section three of those characteristics.

4.1. Is the SRISK immune to size effects?

The SIFIs identification relies on 5 criteria: global activity, size, interconnectedness, substitutability and complexity (see BIS 2011). The size, capturing the Too-Big-To-Fail feature, is one key criterion. At first sight, as it is based on returns, the MES, key component of the SRISK, seems to be insensitive to the size of institutions. One may be tempted to consider that the SRISK is immune to size effects.

The balance sheet size of an institution can be involved in the condition event through the index weighting if this one relies on size (being the case for most indices). If the market index is low, it is likely that yields of most significant large firms are low. It is therefore likely, the crisis event considered in the SRISK framework will be mainly driven by the institutions having a significant size.

4.2. Is the SRISK an early warning signal indicator?

A key component of a macro-prudential policy is to prevent crisis to occur by taking action before the bursting of a crisis. Thus, an important attention has risen in the literature for the so-call "early warning indicators" (see Frankel and Rose, 1996 or Babecky *et al.*, 2012 for instance). Intuitively, an early warning indicator is an indicator spotting out future potential crises with enough time to take actions. Since the SRISK has the advantage to be weekly updated and has a 6-month horizon, one may expect to use the SRISK as an early warning indicator.

The conditioning in the calculation of SRISK depends on past market prices and not on forward looking potential adverse scenarios. The simulations of the SRISK may never be encountered thereafter. Moreover, empirical assessments (see in particular Idier *et al.* 2012) have highlighted a low predictive power of the SRISK measure. Therefore, it does not seem appropriate to include the SRISK in the family of the "early warning" signals.

4.3. Is the SRISK suitable for aggregating risks?

The SRISK appears to be a model having an individual output measure. To get an aggregated perspective per jurisdiction, for instance to assess the resilience of a national financial sector, the SRISK of all the institutions of a specific country can be added..

This aggregation raises several questions on top of the issue of the restricted perimeter to publicly listed institution aforementioned. First, as the SRISK use a max operator *Max(0, X)* (see Equation 4), one consequence is that this measure is not additive. For instance, adding the SRISK of the institutions of a country does not reflect the SRISK of all the institutions consolidated (aggregated) in a single one. Second, the SRISK of one institution depends on the chosen index for the conditioning events. In Acharya *et al.* (2010), the conditioning is based on an index that includes only the set of considered institutions that would have a SRISK associated with. It is possible to extend this index to other firms. This way, different SRISKs are computed for a same bank depending of the market index used in the conditioning (MSCI World, S&P 500…). By changing the index, the definition of the underlying crisis can drastically change: "the crisis" can go from the sole banking sector, the global market or a domestic crisis. In parallel, despite this change of scope, the same definition of a crisis is kept (a decrease of at least 40% of the market over the next six months for the considered index) implying that the likelihood of the events are different from each other.

5. Conclusions and research perspectives

The SRISK indicator has undoubtedly advantages: it uses public data, it is based on a clear methodology that encompasses a refined economic analysis using the latest time-series econometric techniques and the results are publicly reported. Moreover, it addresses a very relevant topic. Academic contributions to systemic risk analysis enhance very stimulating debates about financial supervision and macro-prudential policies.

When considering the possible use of the SRISK indicator as a supervisory tool, some limitations appear. They appear to us so salient that hardly any supervisory action can directly rely on the SRISK figures or ranking. This is not to say that the SRISK is not informative and should not be monitored.

At a conceptual level, our key concern is about the information content. The SRISK reveals itself as mirroring market participants' expectations which may differ significantly from economic fundamentals. At a practical level, on top of its restricted application to listed institutions only, the main limit of the SRISK is that it provides little information on the economic or financial mechanism at play and on which are the main sources of risk. As a consequence, no preventive actions can be taken on the basis of the indicator. Note that several limitations presented in this note are also shared with other systemic risk indicators, notably the ΔCoVaR. Other strands of the literature dedicated to provide supervisory tools to handle systemic risk are quite promising but they need first to be carefully analyzed and assessed.

More generally speaking, the limitations of current proposed systemic risk measures from a supervisory point of view call for further research. This is a challenge since there are significant difficulties to overcome when one consider financial supervision purposes. While the expectations of a supervisor to measure systemic risk are numerous, five of them seem to be expected. First, the supervisor expects to be able to integrate a given systemic risk measure within its existing micro-supervisory approaches.[14] Second, the supervisor needs to be able to test different macro and idiosyncratic stress tests scenarios and to have a view on the likelihood of each event. Third, the supervisor would like to capture possible nonlinear effects such as thresholds above which systemic risk start to have significant impacts (e.g. the default of one bank due to contagion). Forth, the supervisor, with a macro-prudential mandate, needs to have information on the source of systemic risk to activate a dedicated macro-prudential policy. Last, the supervisor expects to be informed of when an action should be undertaken. The following table 1 presents a summary of the supervisor's expectations and the SRISK with regards to the main features highlighted in this paper. On top of these concerns, operational requirements appear important. A supervisory tool needs to be reviewed on its conceptual basis and in terms of practical implementation. This implies that the continuity of the team in charge of producing the indicator, the commitment to provide up-to-date information, the liability on communicated information, are paramount.

Systemic risk is a manifold concept embracing several dimensions of risk (common exposure, contagion, liquidity feature…) at different levels (financial, real economy and cross-border effects…). We consider that only a large set of indicators can assess systemic risk, and thus provide comprehensive and adequate information to supervisory policy.

[14] This point goes in line with an operational constrain and a global framework consistency.

Dimensions	Supervisor Expectations	SRISK
Consistency with micro-supervision	Consistent with existing micro-prudential framework	Independent from micro-supervisory stress tests
Stress scenarios	Able to test different macro and idiosyncratic scenarios (sensitivity)	-40% equity market index over 6 months
Nonlinear effects	The loss threshold where the default of one bank imply contagion effects	The output is a loss amount
The sources of risk	Identify and disentangle the sources of risk	Aggregated impact
When	When an action should be taken?	No early warning properties
Data	Balance sheet, Regulatory templates Market data	Market data Total debt from balance sheet data
Perimeter	All supervised institutions	Listed institutions

Table 1: Supervisor's expectations and SRISK

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Appendix: complementary points

This appendix gathers few academic concerns about the SRISK, which do not directly consider the use of the SRISK as a supervisory tool.

Computation of market capitalization

One lesser point may be the method to compute the market capitalization, apart from the distinction between market value and book value that has already been discussed. Even for the listed institutions, the shares being available for market trading represent only a fraction of the capital. Typically, this floating capital is about, for instance, 80% for Société Générale and 75% for BNPP. Consequently, since the SRISK compares the required capital and the (mark-to-market) available capital, this last term should encompass all the capital, not only the floating one. If not, even a healthy financial institution would appear spuriously undercapitalized. Assuming that the complement to floating capital follows similar dynamics to the floating one appears a sound candidate to correct this possible point. Of course, the debate about combining mark-to-market value and accounting value is still open.

Volatility modeling

Concerning the volatility modeling (see Equation 6), the authors choose that the variance of a factor, $\sigma_{i,t}{}^2$, only depends on the past information of the same factor. One by one this choice makes sense. However, when considering the whole system, it may be more difficult to justify this approach as the conditionings are not based on the same information sets. This point may be corrected by having consistent factors across institutions.

Estimation techniques

Last point, as any econometric model, discussions on estimation methods cannot be avoided, even if their practical implications for supervisory purposes are hard to assess. For instance, Qin and Zhou (2013) argue that since the SRISK consider very rare event it cannot be properly estimated without specific tools provided by the extreme value theory.[15]

[15] See also Cai *et al.*, 2012.

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61, rue Taitbout
75009 Paris
Téléphone : 01 49 95 40 00
Télécopie : 01 49 95 40 48
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