An Encompassing Framework to Estimate Systemic Risk Amplification Losses Based on Publicly Available Information*

Symposium
Macroprudential Stress Test and Polices:
A Framework

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* This presentations draws material from Alla et al 2017. The views expressed in this presentation are those of the authors solely and do not represent those of the IMF or IMF policy.

"Policy makers constantly face information and time constraints but in times of crisis, when volatility increases, these constraints hurt the most, as history becomes a poor guide (for the future), the significance of market perceptions increases, and reaction times decrease"

C. A. Goodhart, 1975

Outline

1. Systemic Risk and challenges to model it

2. Encompassing Frameworks

3. An EF Developed at the IMF

Challenges SR quantification: Definition

Initial Interpretations of SR Direct Contagion Indirect Contagion

Generalized shocks.
Bartholomew & Whalen (1995).

Relationship between the financial system and the real economy.
Mishkin (1995), Bartholomew & Whalen (1995).

Domino effects.
BIS (1994), Kaufman (1995)

However DE do not seem to provide the full explanation.
Adrian and Shin (2008)

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Challenges SR quantification: Definition

Initial Interpretations of SR → Direct Contagion → **Indirect Contagion**

Market Amplification Mechanisms

Fire sales in financial markets.

Collateralized agreements. Shleifer and Vishny (2011).

Interactions across Banks and Non-banks. Khandani and Lo (2011), (Segoviano et al, 2017).

Illiquidity spirals. Brunnermeier and Pedersen (2009).

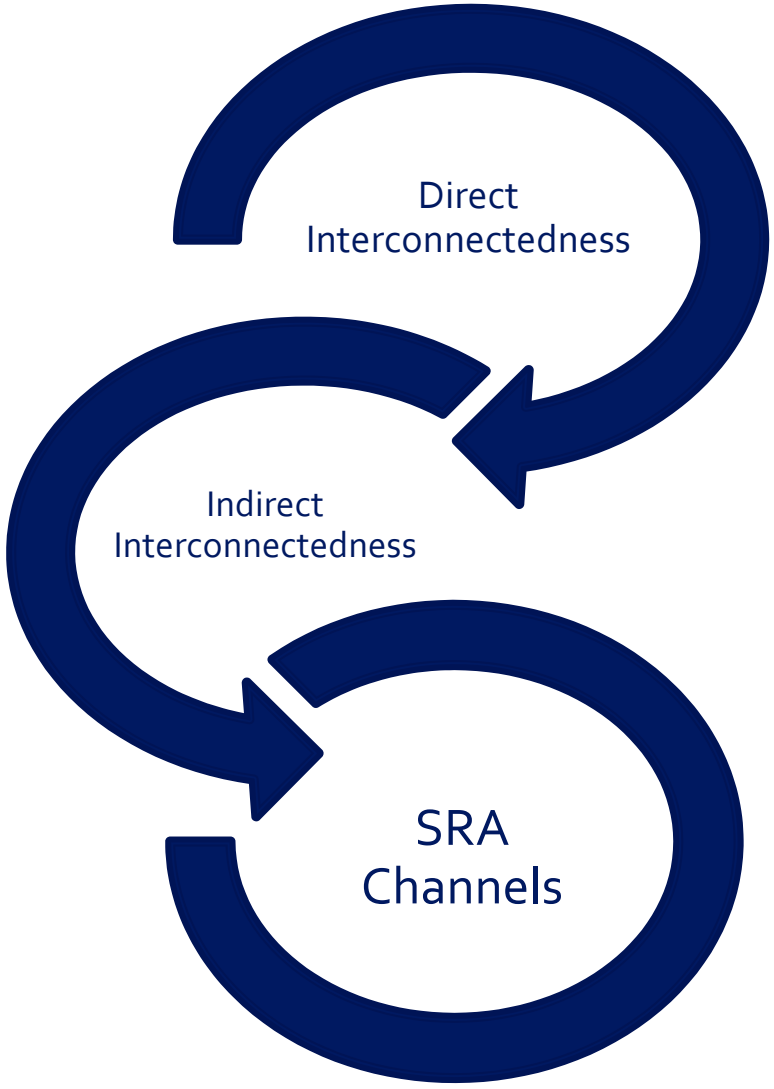
Leverage. Greenwood, et al. (2015)., Cont and Schaanning (2016) .

Information Asymmetry Channel

I-A key source of bank runs. Jacklin and Bhattacharya (1988), Khandani and Lo (2011).

Under high uncertainty, the impact of I-A becomes more severe. Kapadia, et al. (2012), Khandani and Lo (2011)

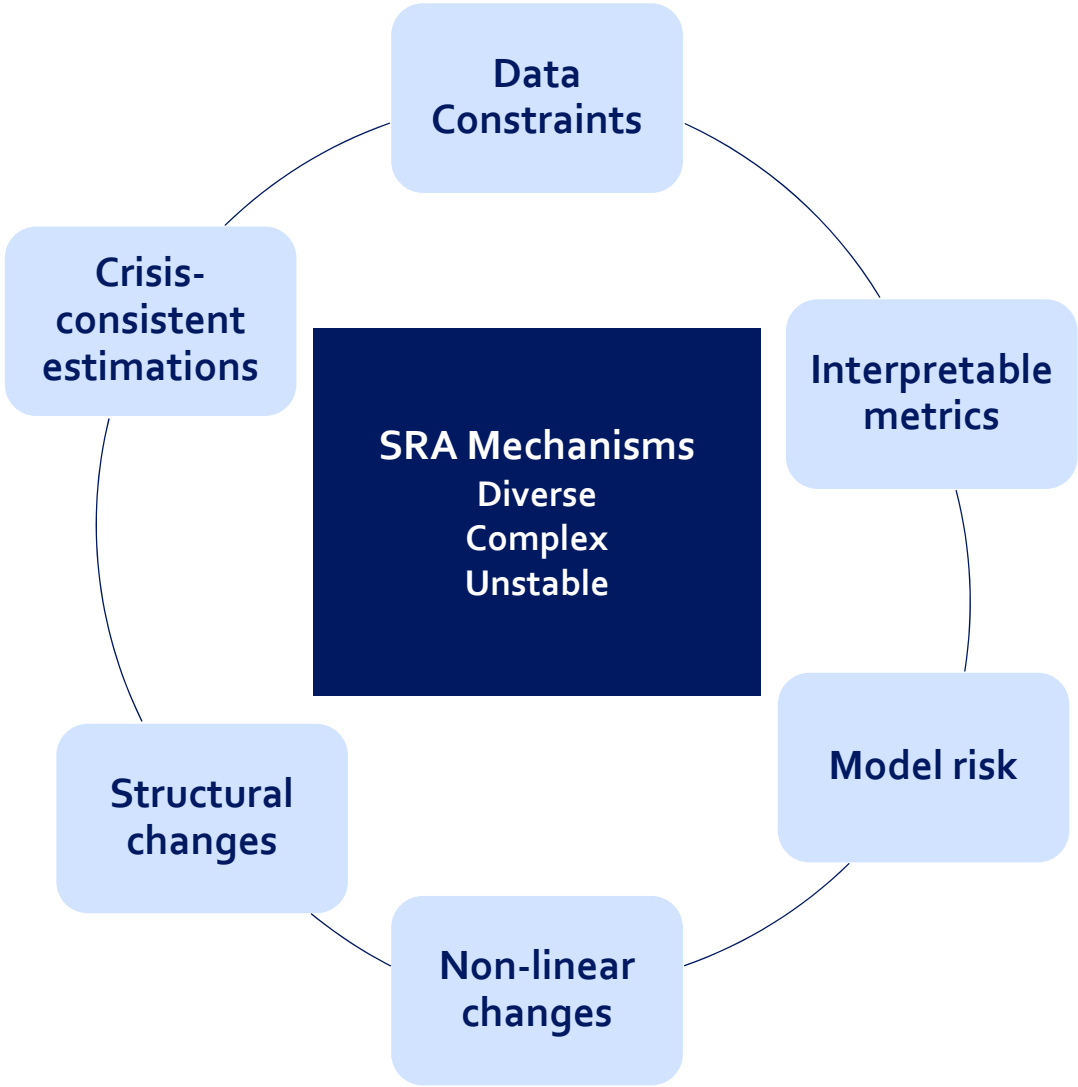
Challenges SR quantification: Channels



Domino Effects
Diverse Contractual Obligations

Market Price Channels
Asset Fire Sales
Information Asymmetry

Challenges SR quantification: Definition

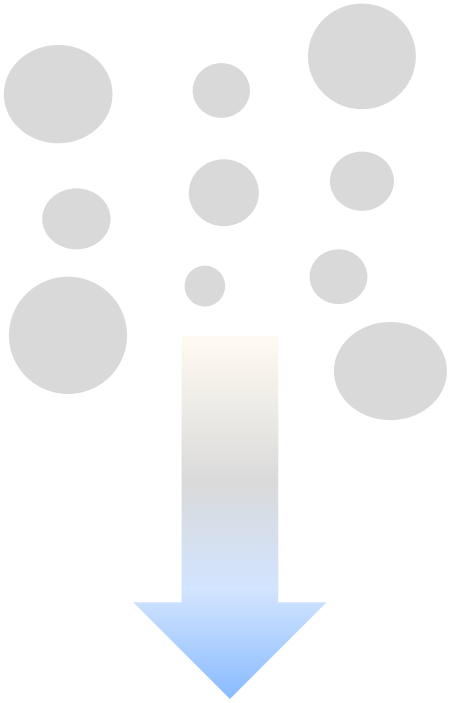


Encompassing Frameworks

No data or model *is completely satisfactory for capturing SRA mechanisms*

We should try to capture
the best elements of a variety of approaches

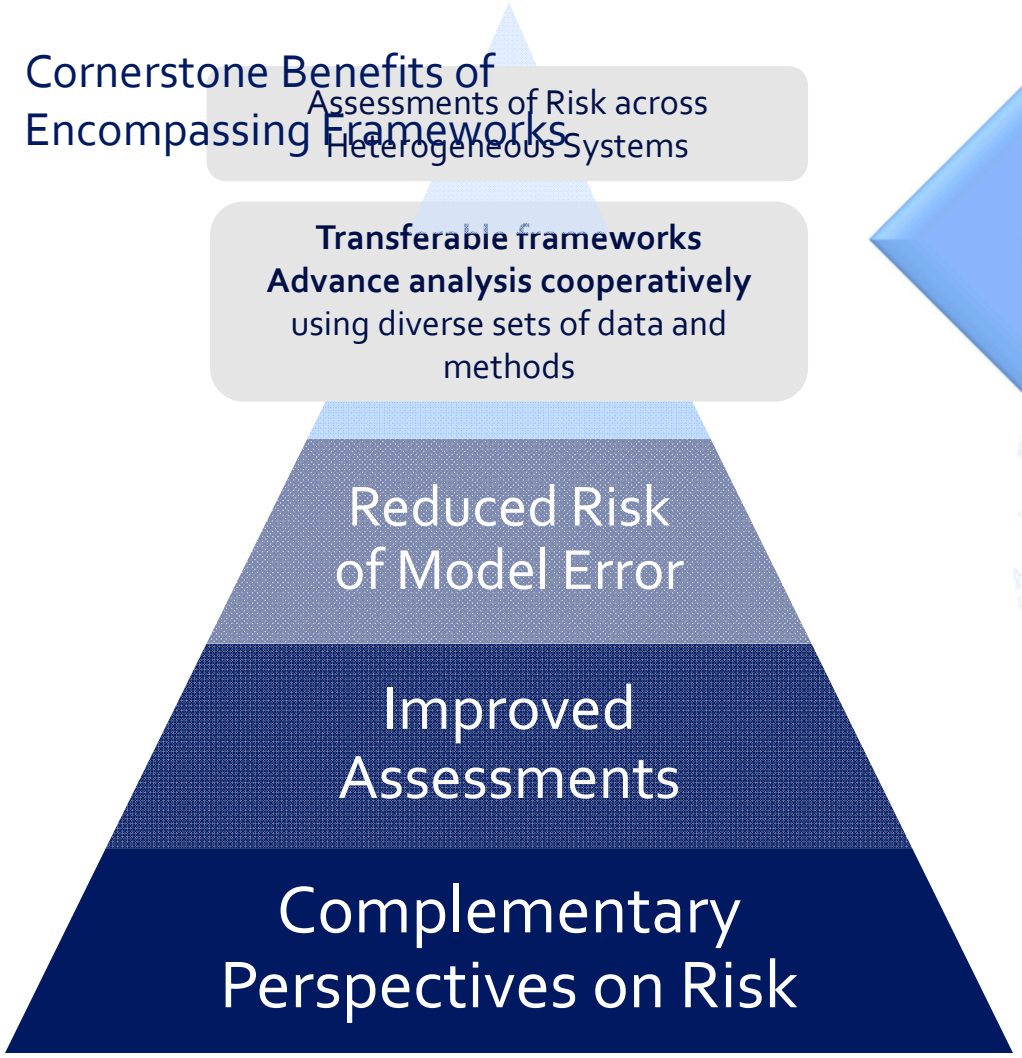
Flexible, yet organized *approaches to combining separate analyzes*



Encompassing Framework

Encompassing Frameworks

Cornerstone Benefits of Encompassing Frameworks



Frameworks **implemented with** a combination of **publicly available and supervisory-based data** and embed **diverse types of methods**.

Fund staff often work under **highly restrictive data constraints, especially for SRA mechanisms**

Need to analyze **heterogeneous financial markets**

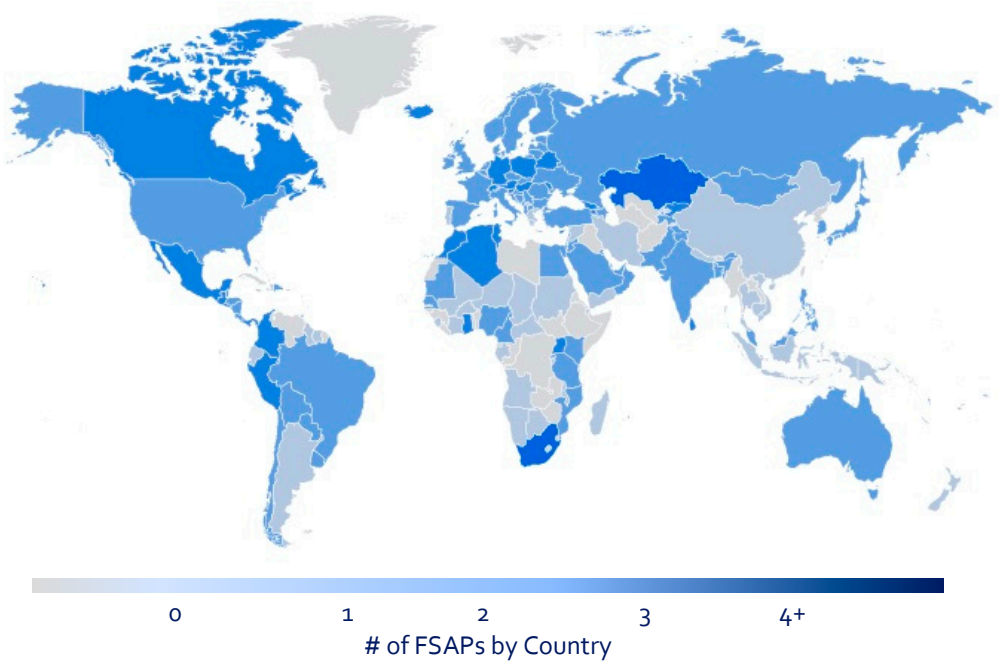
IMF-EF

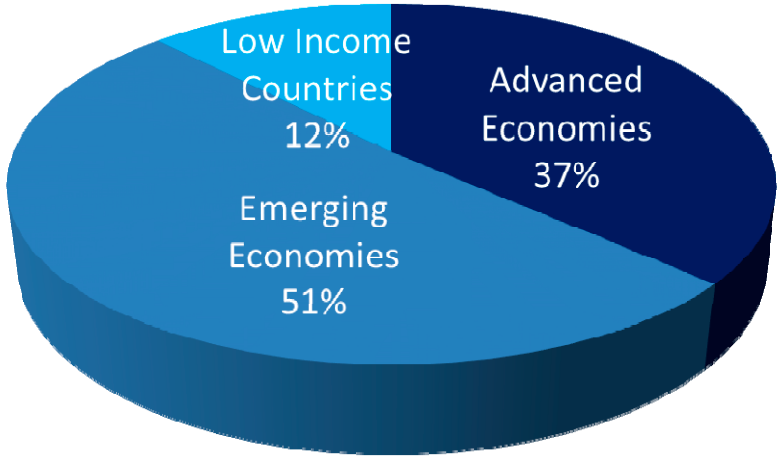
Microprudential ST
First order effects of adverse scenarios on individual entities
Diverse methods: ST implemented by the IMF (workbox), National authorities, Firms, jointly
Combination of data: Publicly available, supervisory

SRA Losses
Multivariate perspective of financial system
"Crisis consistent conditional losses" based on markets' perceptions
Publicly available data

IMF-EF
Microprudential ST: Diverse Financial Systems

321 FSAPs in more than 160 Jurisdictions

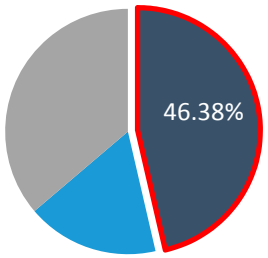




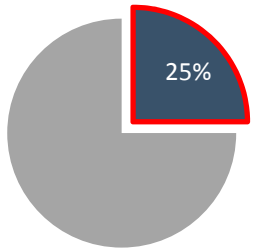
IMF-EF
Microprudential ST: Heterogeneous Methods and Data

Top Down

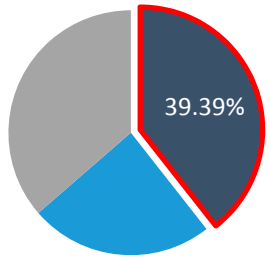
Bank solvency



Insurance solvency



Bank liquidity



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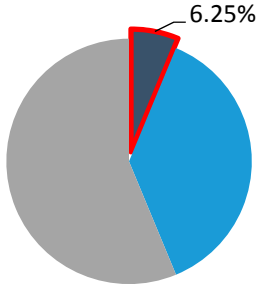

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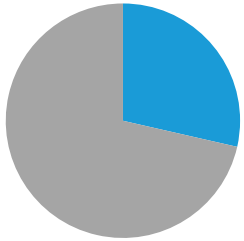

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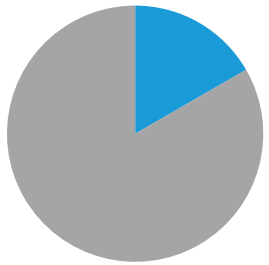
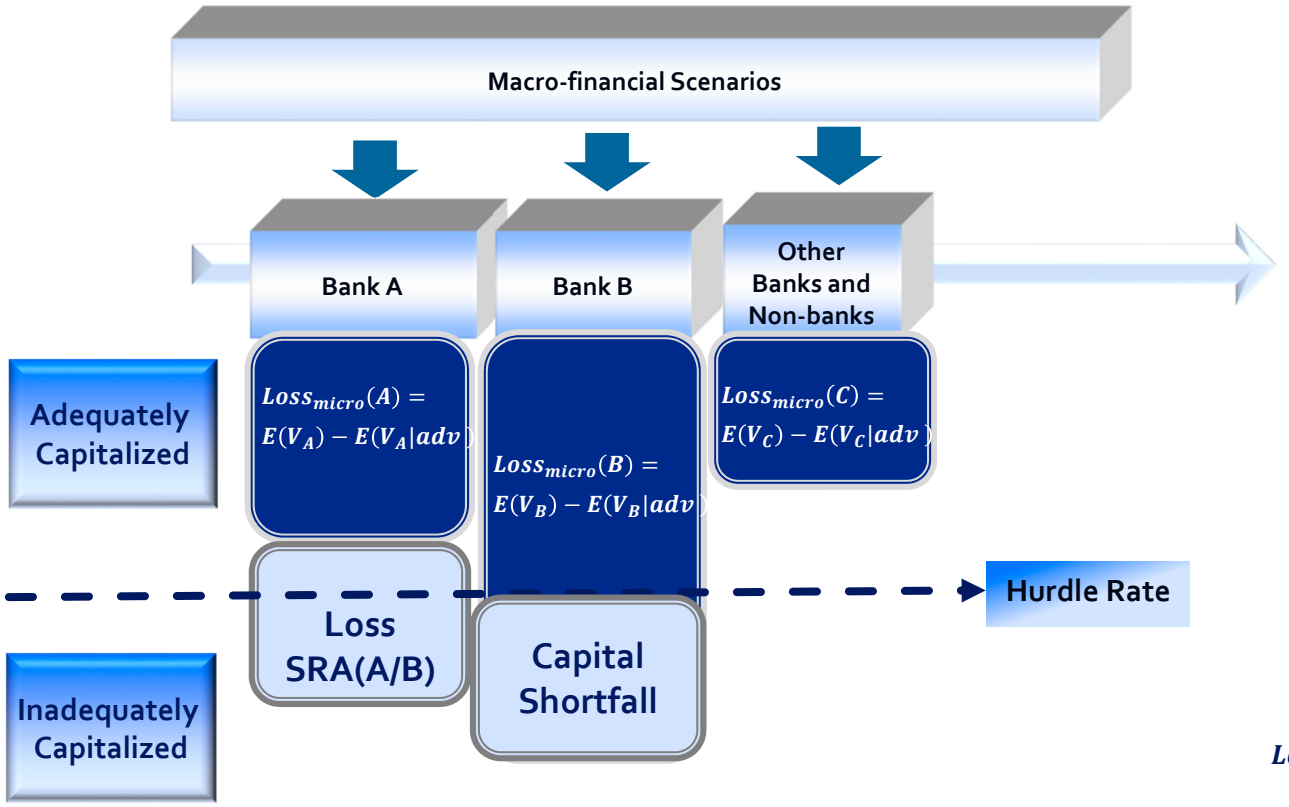


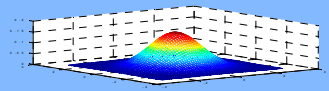
Bottom Up

IMF (Workbox) Jointly National Authorities

IMF EF Characterization



System Interconnectedness Structure

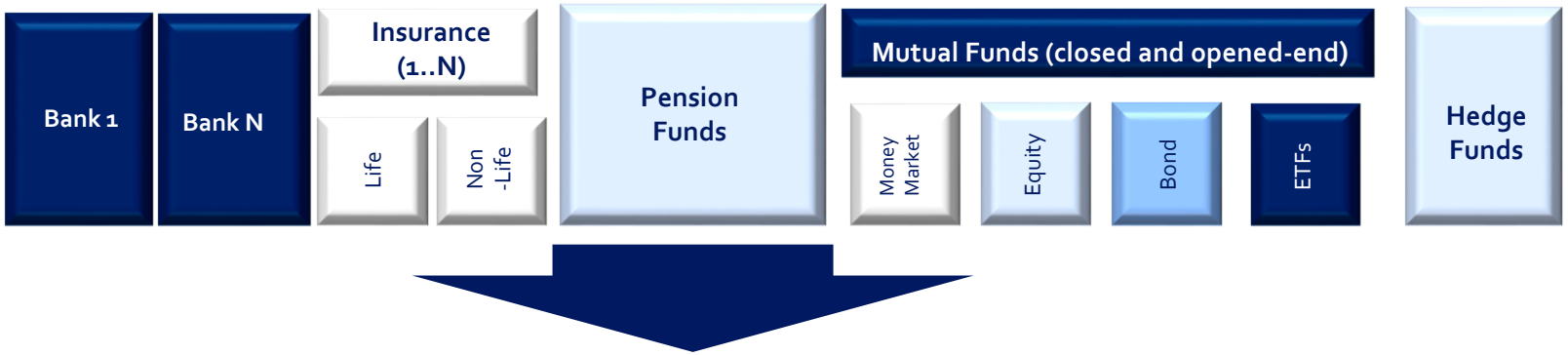


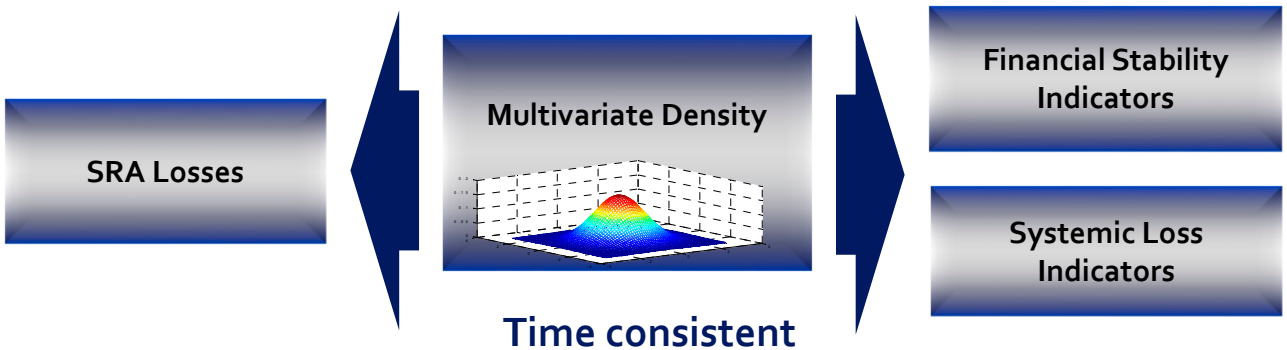
Asset Pricing Model

Systemic Risk Amplification Loss (SRA)
Expected losses given the realization of a given event

$$Loss_{SRA}(Ai|S) = E(V_{Ai}|adv) - E(V_{Ai}|adv \cap S)$$

IMF EF
Multivariate Perspective





Time consistent
Distress dependence structure

IMF-EF Characterization

MicroST Loss. Difference between the value of bank A in normal times, and its value under an adverse macroeconomic scenario:

$$Loss_{micro}(A) = E(V_A) - E(V_A|adv\ )\ ;$$

SRA Loss. Assuming the realization of a given financial contagion event S

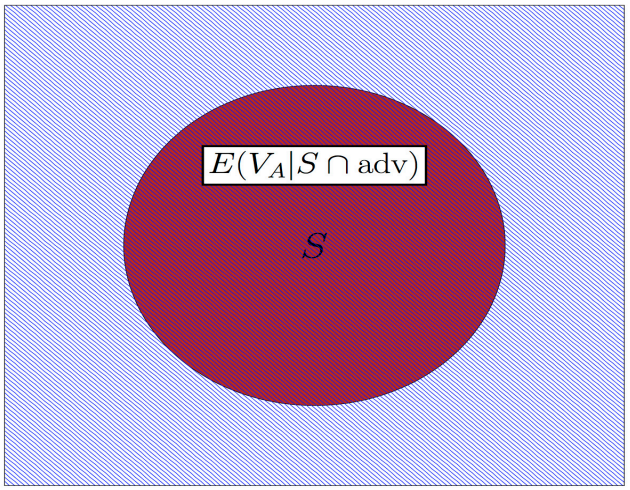
$$Loss_{SRA}(A|S) = E(V_A|adv\ ) - E(V_A|adv\ \cap S)\ ;$$

Total Loss. Assuming the realization of a the financial event S

$$\begin{aligned} Loss_{TS}(A|S) &= Loss_{micro}(A) + Loss_{SRA}(A|S) \\ &= E(V_A) - E(V_A|adv\ \cap S) \end{aligned}$$

IMF-EF
SRA Loss: Venn Diagram

Identification of the SRA loss in a Venn Diagram



MicroST Loss of a given bank.

Difference between its value in normal times and its value assuming the adverse M.S.;

This state of nature is represented by the **hatched rectangle in the Figure**.

SRA Loss.

Difference between the value of this bank assuming an adverse macroeconomic scenario, and its value assuming an adverse macroeconomic scenario and the realization of the event S.

The event S is represented by the dark-circled area in the Figure 1.

IMF-EF
SRA Loss: Decomposition

The SRA Loss takes into **account ALL the potential CONNECTIONS across ALL entities** and their effects on the bank whose loss is assessed.

A high **SRA Loss (A/B) does NOT necessarily mean that there is a strong straight connection between financial entity (FE) A and B**.

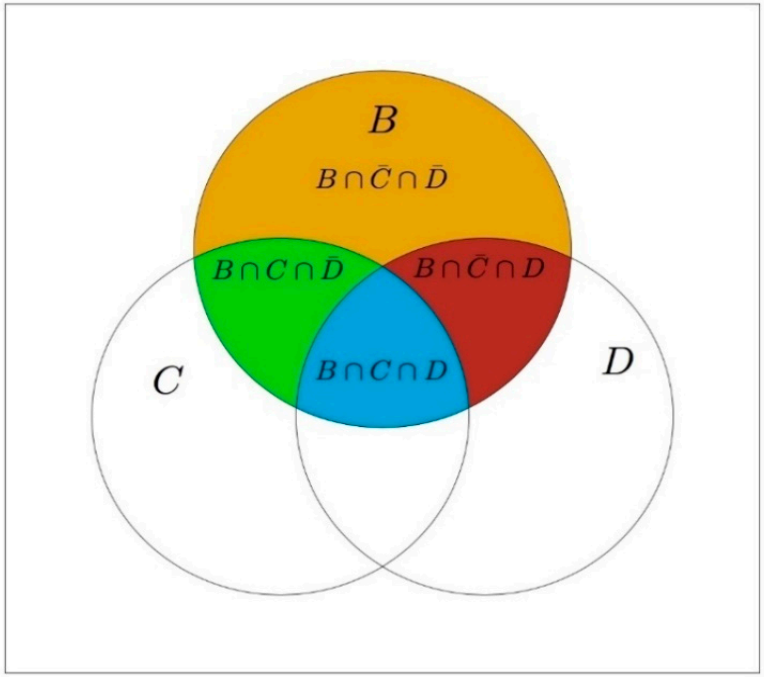
The **contagion path may for instance include another FE, which is strongly connected to A and/or B** and explains the high conditional loss of A/B.

Using the law of total expectations, we can **identify the connecting entities** between two given entities.

IMF-EF
SRA Loss: Decomposition

Decomposing the SRA Loss, we can quantify the **likelihood** and **intensity** of "contagion" events.

$$
\begin{aligned}
&Loss_{SRA}(A|B) \\
&= P(B \cap C \cap D|B) Loss_{SRA}(A|B \cap C \cap D) + P(B \cap \bar{C} \cap D|B) Loss_{SRA}(A|B \cap \bar{C} \cap D) \\
&+ P(B \cap C \cap \bar{D}|B) Loss_{SRA}(A|B \cap C \cap \bar{D}) + P(B \cap \bar{C} \cap \bar{D}|B) Loss_{SRA}(A|B \cap \bar{C} \cap \bar{D})
\end{aligned}
$$



IMF-EF
SRA Loss: Decomposition

$$Loss_{SRA}(A|B)$$
$$= P(B \cap C \cap D|B)Loss_{SRA}(A|B \cap C \cap D) + P(B \cap \bar{C} \cap D|B)Loss_{SRA}(A|B \cap \bar{C} \cap D)$$
$$+ P(B \cap C \cap \bar{D}|B)Loss_{SRA}(A|B \cap C \cap \bar{D}) + P(B \cap \bar{C} \cap \bar{D}|B)Loss_{SRA}(A|B \cap \bar{C} \cap \bar{D})$$

$$Intensity\ Ratio:\ R\left(D_j^i(k_1, \dots, k_l)|A_j\right) = \frac{Loss_{SRA}(A_i|D_j^i(k_1, \dots, k_l))}{Loss_{SRA}\left(A_i|A_j\right)}$$

$$C\left(D_j^i(k_1, \dots, k_l)|A_j\right) = \frac{P(D_j^i(k_1, \dots, k_l)|A_j)\ Loss_{SRA}(A_i|D_j^i(k_1, \dots, k_l))}{Loss_{SRA}\left(A_i|A_j\right)}$$

Defaulting sets D Metrics	$LB \cap \overline{WF} \cap \overline{MS}$	$LB \cap \overline{WF} \cap MS$	$LB \cap WF \cap \overline{MS}$	$LB \cap WF \cap MS$
$Prob(D\|LB)$	0.79	0.11	0.01	0.09
$R(D\|LB)$	0.45	2.62	2.30	3.69
$C(D\|LB)$	0.35	0.28	0.03	0.32

	Citi *(In millions of USD)*
TARP Injection	25,000[1]
TA (Q2 2008)	2,100,385
TARP/TA	1.19%
Loss SRA (Citi/LB)/TA	1.14%

[1]In December 2008, Citi received an additional 20 billion USD through TARP

IMF-EF
Conclusions

- **The EF makes use of MiPST frameworks that are already implemented;**

- **SRA Loss based on publicly available data.**
  - Market perceptions of financial systems' distress dependence structures, **relevant for crisis contingent estimates.**
  - Given the data limitations faced by the IMF and some authorities (to measure SRA losses), **proper calibration** of methods that rely on ex-ante modeled structures becomes **very challenging**.

- **Cost-efficient.** Become computationally simple and relatively light on data requirements. However, not come at the expense of analytical rigor (Demekas, 2015).

- **Reduced-form**. While can quantify SRA Losses, identify "connecting entities", estimate likelihood and intensity of contagion effects, **does NOT provide insights** into the economic and financial causes behind SRA mechanisms.

- **Parallel running.** Even if alternative frameworks might be feasible given data availability, IMF-EF can be helpful for improving calibrations of alternative frameworks; e.g., parallel DSGE (structural) and VAR (reduced-form).

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