# Macroprudential Stress Tests and Policies: Searching for Robust and Implementable Frameworks

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**Financial Crises: Predictability, Causes and Consequences**

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**Systemic Risk Centre, London School of Economics**

# Introduction

Collaboration between the Monetary and Capital Markets Department (MCM) of the IMF and the Systemic Risk Centre (SRC) of London School of Economics (LSE)

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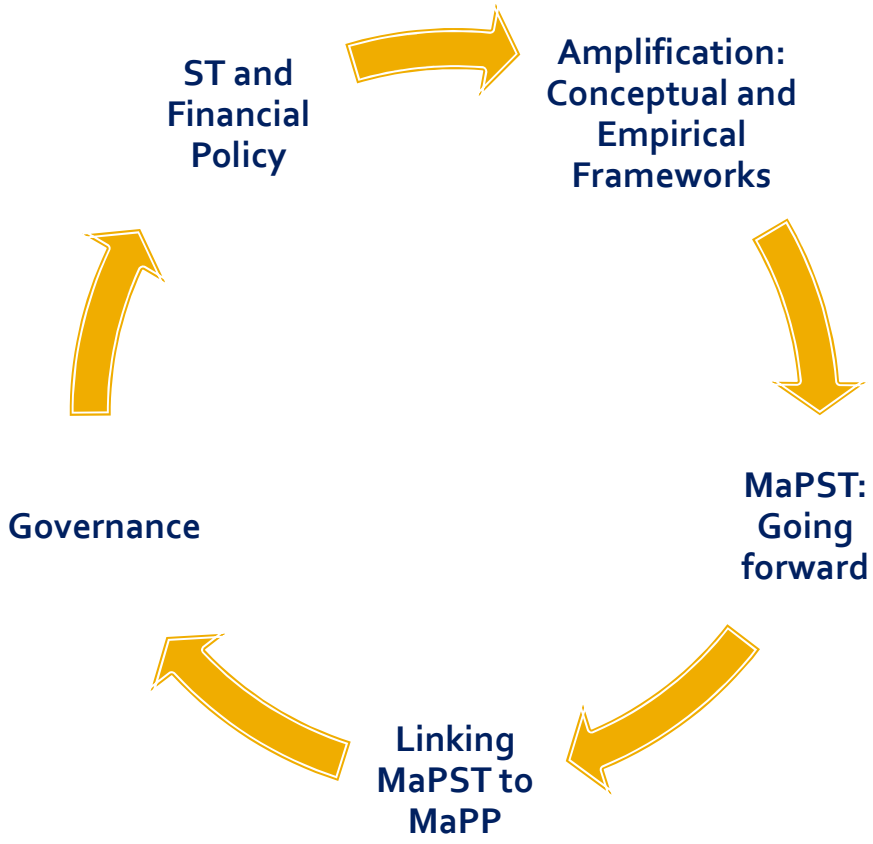
# Objective

**Present state-of-the-art MaPST methodologies** discussing modelling **and implementation challenges**;

Provide **a roadmap for future research** and **practical implementations** in stress testing and;

Guide authorities on the **use of MaPST to support macroprudential tool calibration**.



# ST and Amplification Mechanisms

- Most stress testing is microprudential, focusing on **individual institutions** and their **resiliency to exogenous** shocks.
- But almost all stress events and crises are caused by **endogenous risk** — the interaction of all market participants in equilibrium;
- Thus, need to account for **amplification mechanisms** due to the **interaction** between the variety of **financial institutions and markets**

# Why do we care of MaPSTs?

**MaPSTs are beginning to play an increasingly major role in financial sector policymaking.**

- Losses that have the potential to **magnify moderate exogenous shocks** into **substantial negative** financial **outcomes** with **significant welfare losses**.

**A properly designed MaPST can generate valuable information for policymakers.**

- Provide forward-looking quantitative assessment of the **resilience of individual banks and financial system as a whole**
- **Inform the use/calibration of relevant macroprudential policy instruments**.
- Generate **useful information for risk management and decision making processes** in periods of financial distress
- Contribute to the **design/improvement of recovery and resolution** frameworks.

# 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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Initial Interpretations of SR | Direct Contagion | **Indirect Contagion**

**Amplification Mechanisms**

***Fire sales in financial markets.***

***Exposures to common risk factors***

**Collateralized agreements.** Shleifer and Vishny (2011).

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

**Illiquidity spirals.** Brunnermeier and Pedersen (2009).

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

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**Amplification Mechanisms**

***Fire sales in financial markets.***

***Exposures to common risk factors***

***Information Asymmetry Channel***

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**Illiquidity spirals.** Brunnermeier and Pedersen (2009).

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

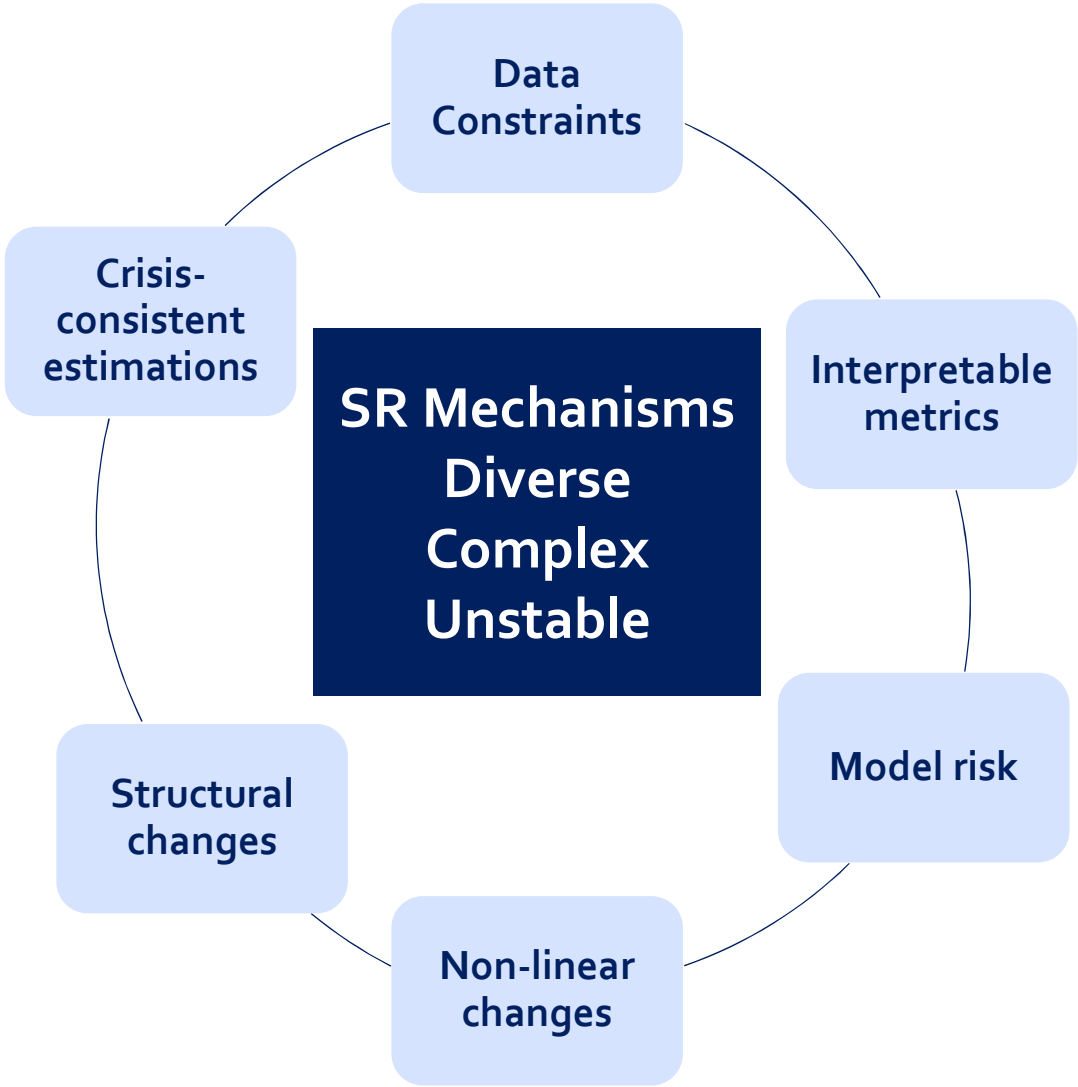
**I-A key source of bank runs.** Jacklin and Bhattacharya (1988), Khandani and Lo (2011).

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

***Financial Imbalances***
***Minsky (1992)***
***(Adrian, Covitz, Liang, 2013)***

# Challenges SR quantification: Implementation





# SR quantification: Modeling Approaches



## REDUCED-FORM MODELS

| Pros | Cons |
|---|---|
| ***Infer from market data the effect of agents' behavior***<br>• *Publicly available data*<br>• *Capture all possible channels accounted by markets*<br>• *No assumptions on agents' behaviors/market structures*<br>• *Frequent updating* | • *Market data maybe " noisy"*<br>• *No information on mechanisms*<br>• *Difficult to embed into stress tests* |

## STRUCTURAL/SIMULATED MODELS

| Pros | Cons |
|---|---|
| ***Explicitly model agents' behavior***<br>• *Identification of Specific amplification channels*<br>• *Rooted in theory* | • *Limited sets of amplification mechanisms*<br>• *Complex*<br>• *Need granular data*<br>• *Difficult to calibrate* |

**No model or data are completely satisfactory**

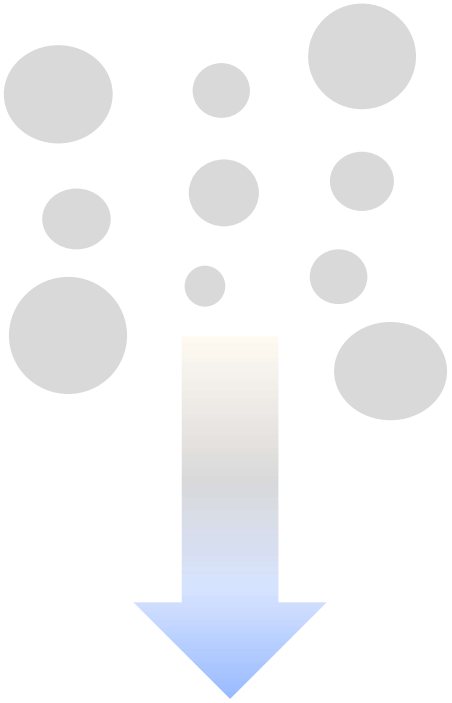
# Encompassing Frameworks



***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*

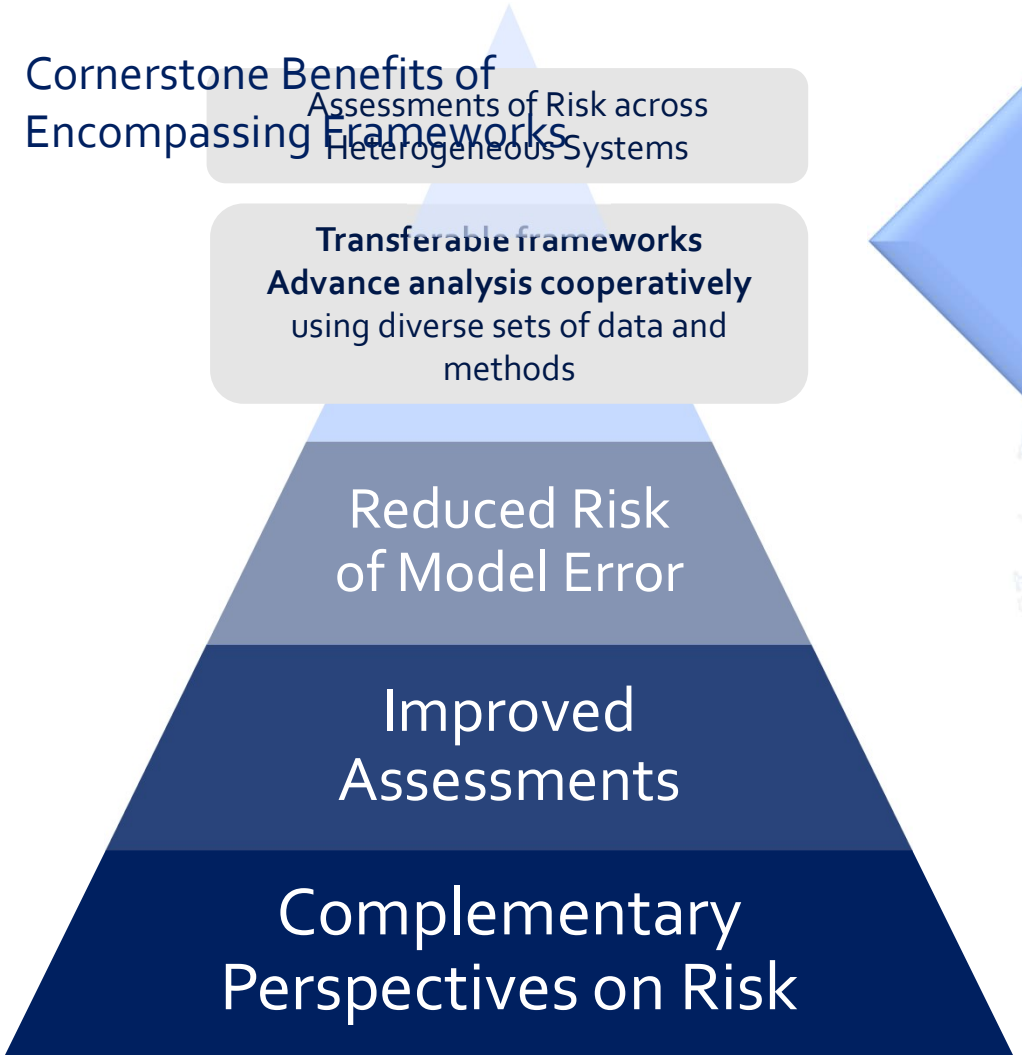


**Encompassing Framework**

# 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

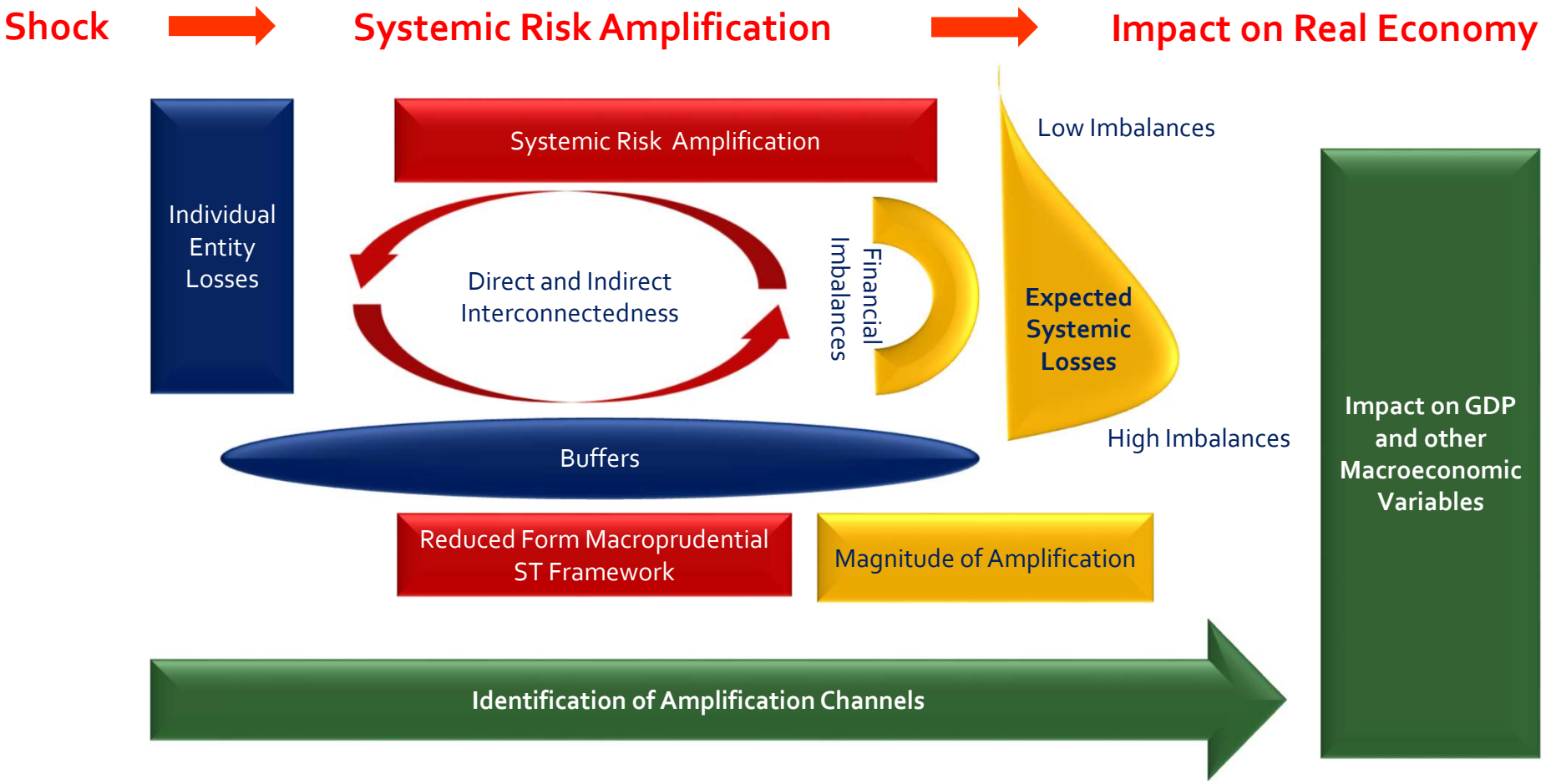


**Microprudential ST**
**First order effects of adverse scenarios on individual entities**
**Diverse methods:** ST implemented by the IMF (workbox), National authorities, Firms, jointly
**Combination of data:** Publicly available, supervisory

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

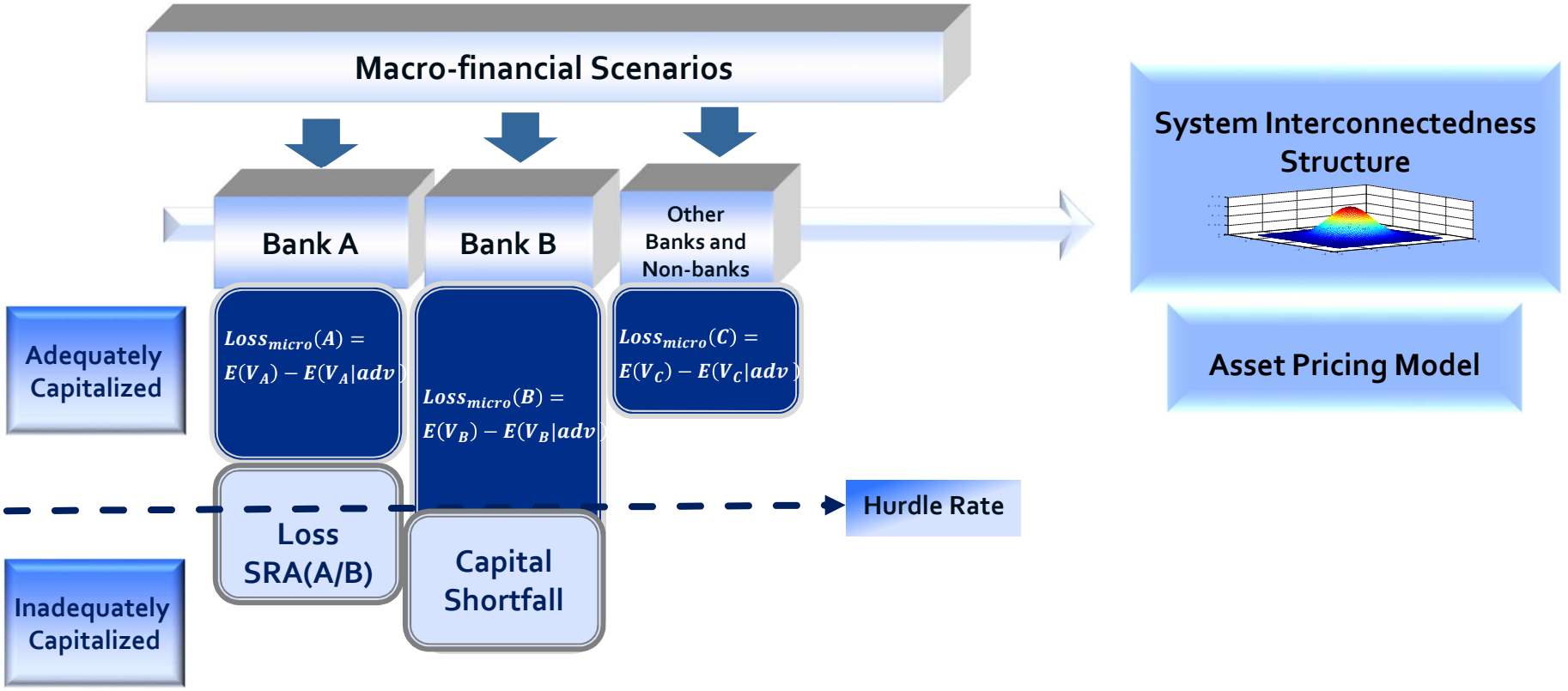
# Conceptual Framework: Systemic Risk Assessment





# A reduced-form Approach to Quantifying Systemic Risk Losses (ctd.)



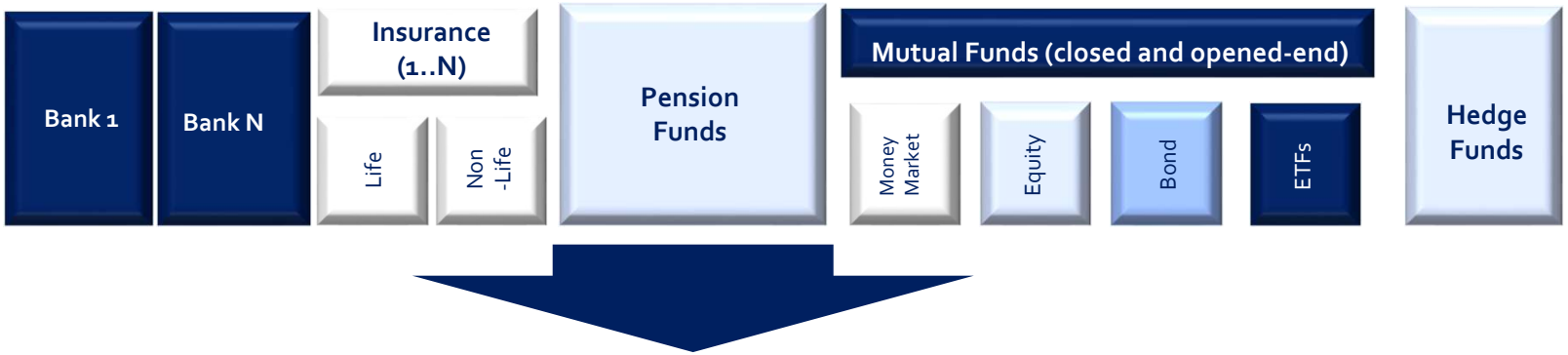


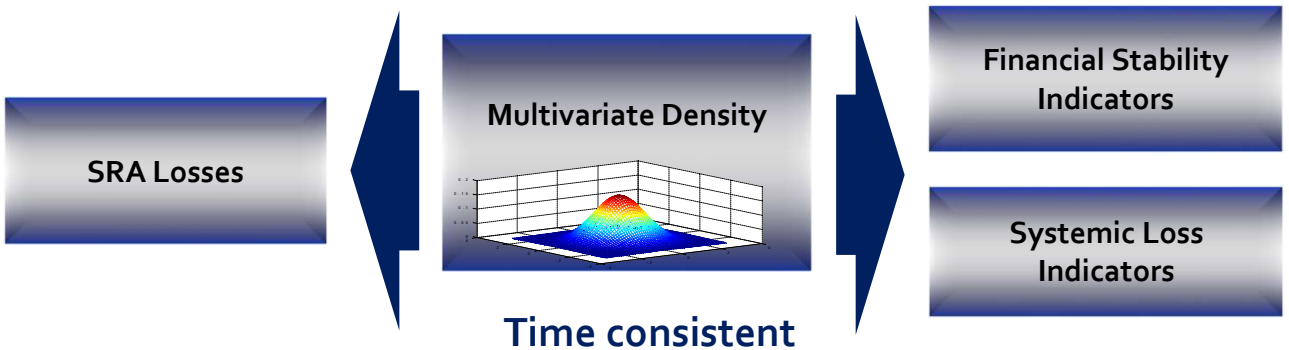

**Systemic Risk Losses (SR)**

**Expected losses given the realization of a given event:** $Loss_{SR}(Ai|S) = E(V_{Ai}|adv) - E(V_{Ai}|adv \cap S)$

# IMF EF
# Multivariate Perspective






**Time consistent**
**Distress dependence structure**

# Characterization



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

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

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

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

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

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

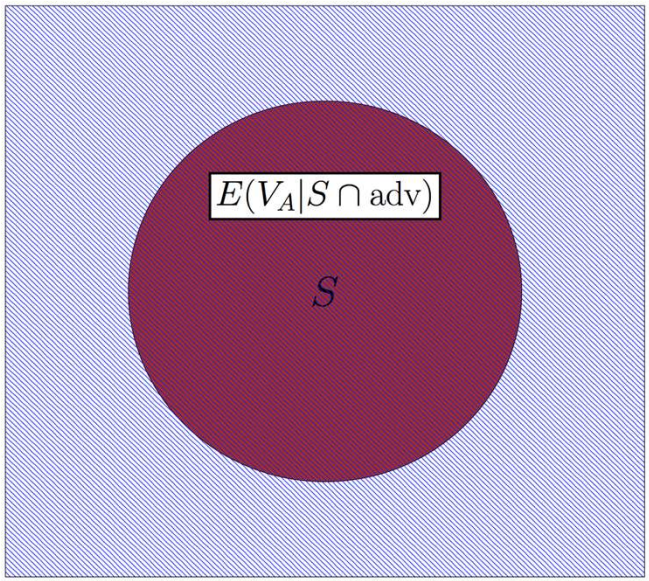
# SRA Loss: Decomposition



- The SR Loss accounts for all the potential connections across all entities
- A high SR Loss (A/B) does ***not*** necessarily mean that there is a strong straight connection between A and B.
- The contagion path may include another bank, 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.

# Identification of the SR loss in a Venn Diagram






**MicroST Loss of a given bank.**

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

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

**SR Loss**.

Difference between the value of bank assuming an adverse M.S., and its value assuming an adverse M.S. ***and*** the realization of the event S.

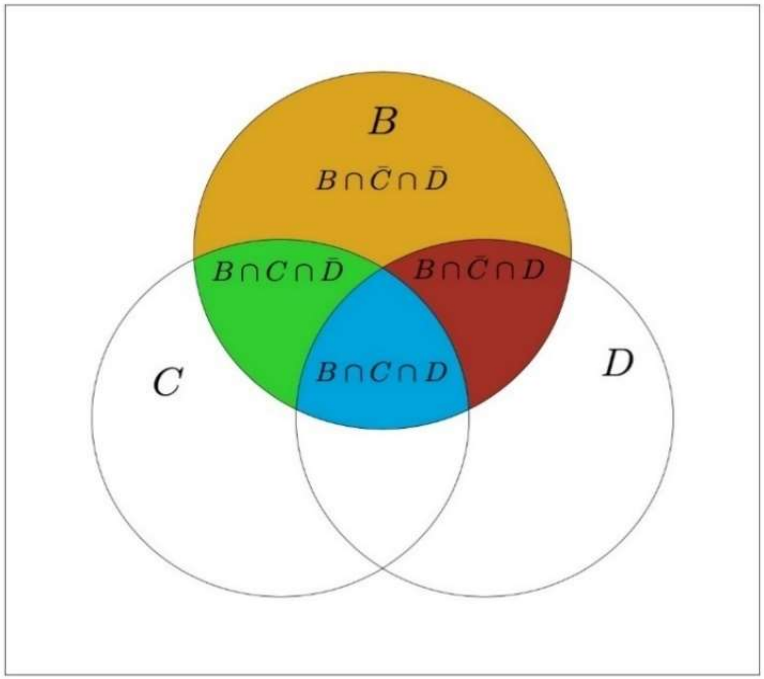
**The event S is represented by the dark-circled area in the Figure 1.**

# SRA Loss: Decomposition



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

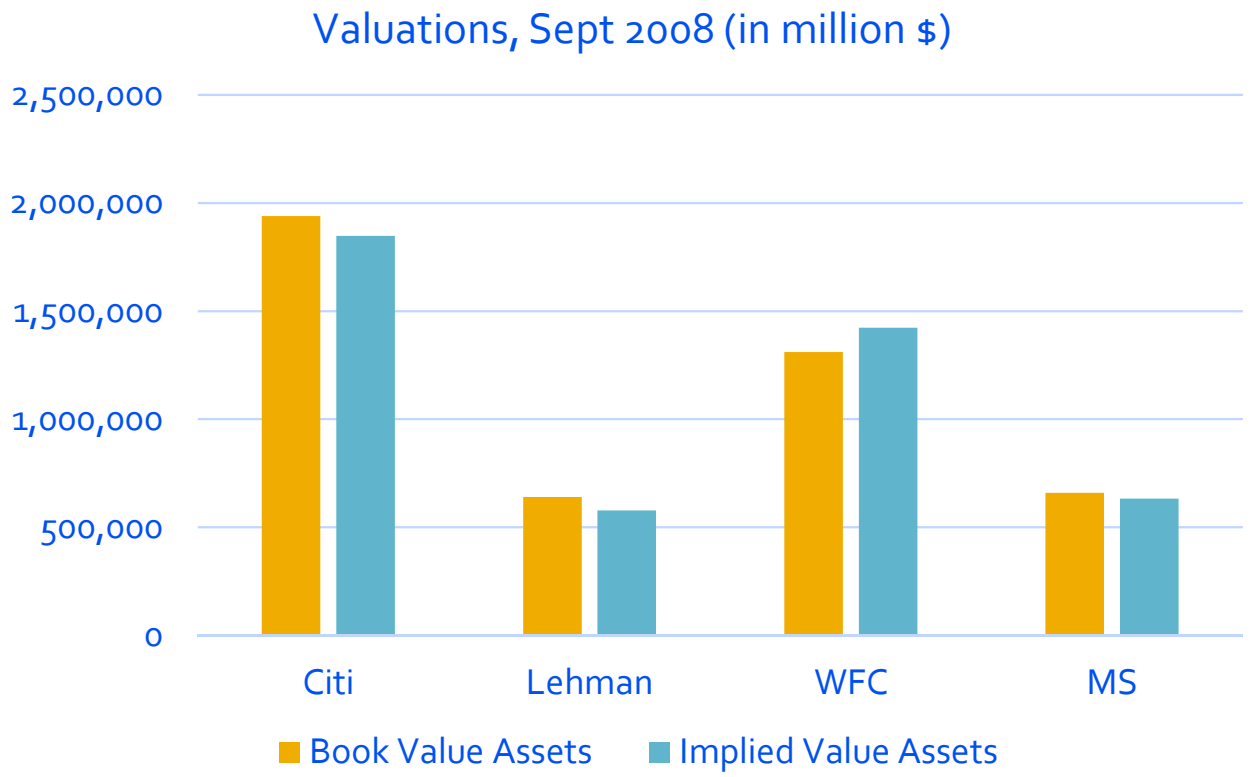
$$
\begin{aligned}
&Loss_{SR}(A|B) \\
&= P(B \cap C \cap D|B) Loss_{SR}(A|B \cap C \cap D) + P(B \cap \bar{C} \cap D|B) Loss_{SR}(A|B \cap \bar{C} \cap D) \\
&+ P(B \cap C \cap \bar{D}|B) Loss_{SR}(A|B \cap C \cap \bar{D}) + P(B \cap \bar{C} \cap \bar{D}|B) Loss_{SR}(A|B \cap \bar{C} \cap \bar{D})
\end{aligned}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



# Consistency Checks



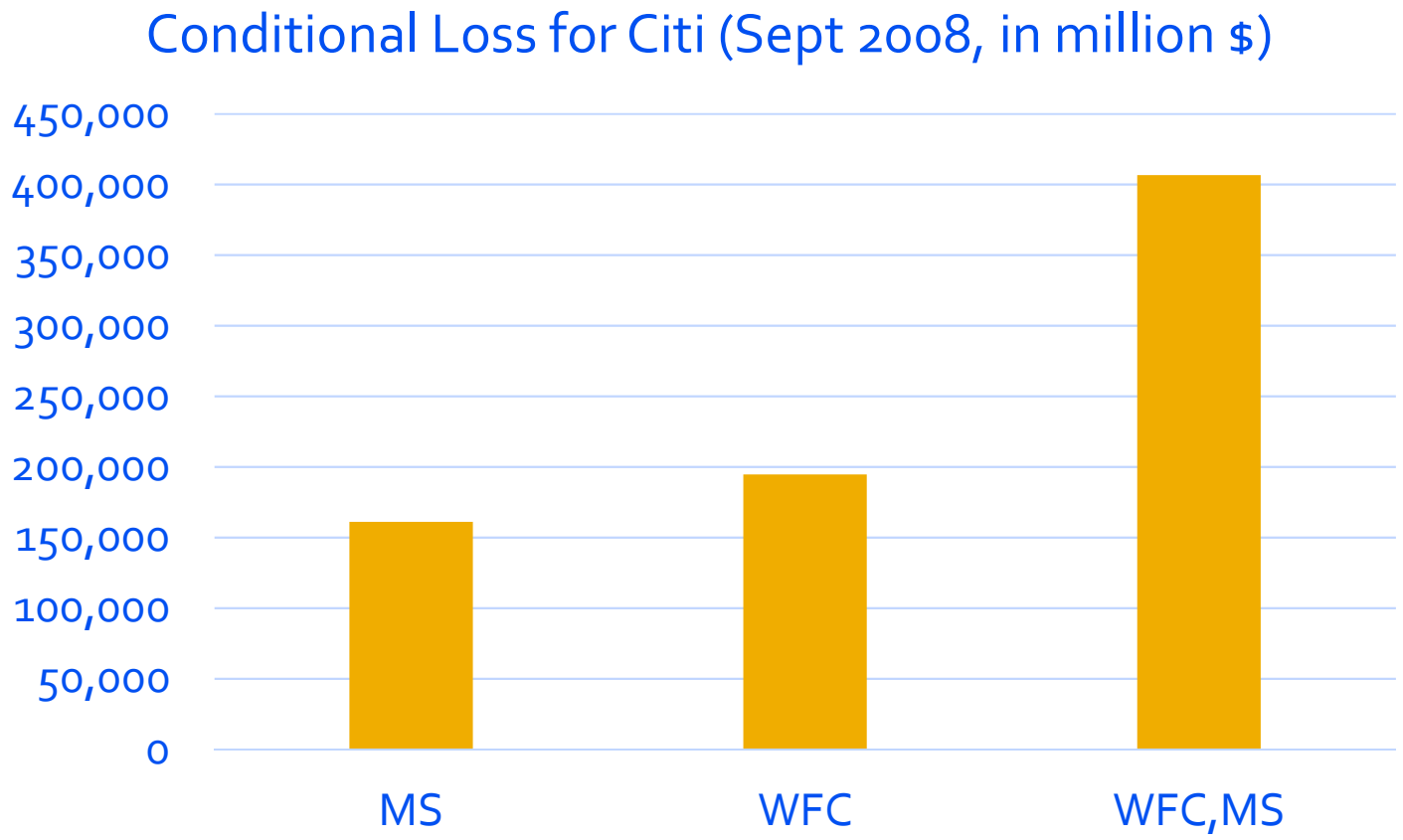
Comparing TA with asset pricing model estimate of expected asset values



# Results

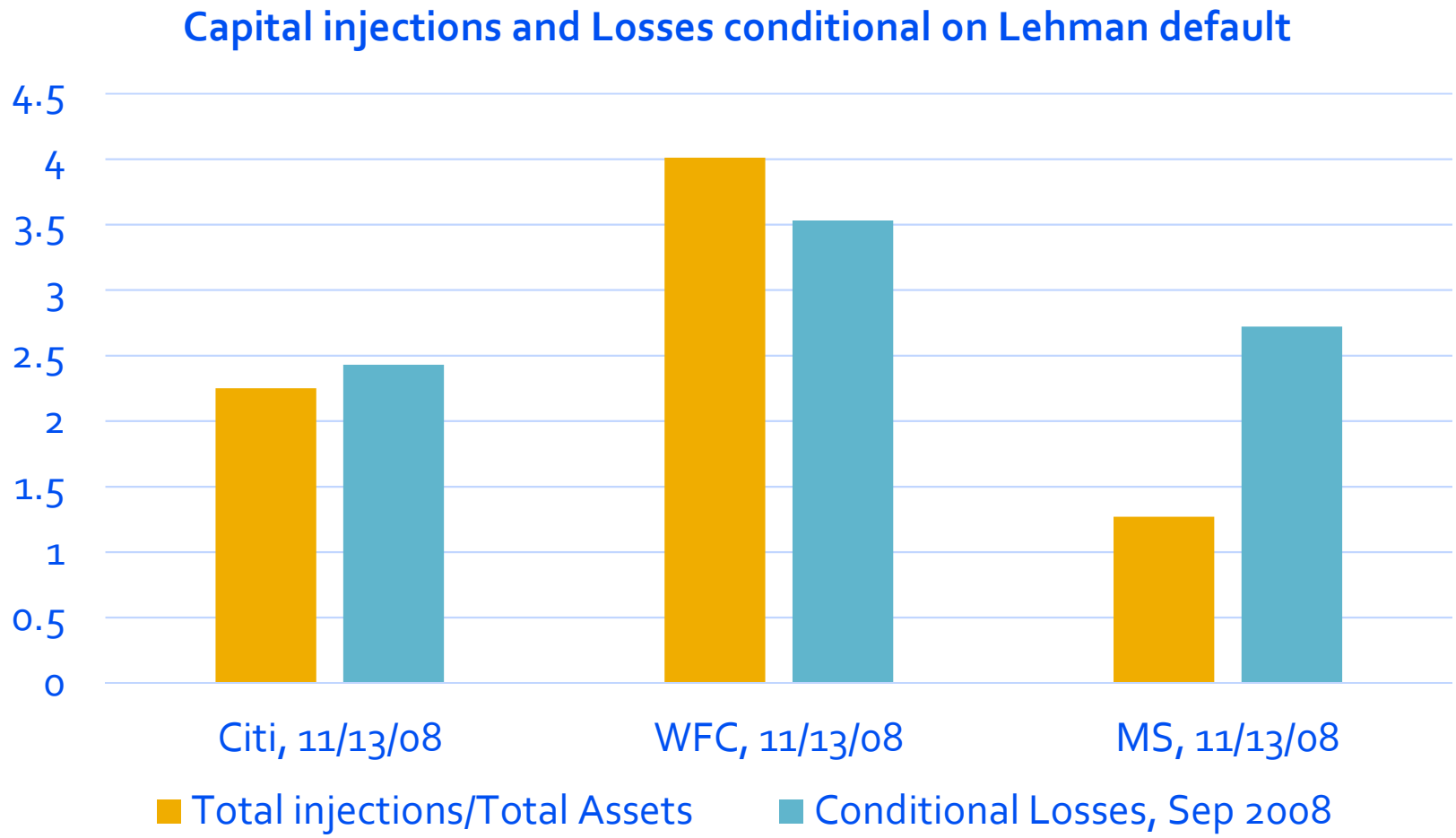


**Conditional losses are increasing in the size of the defaulting set**



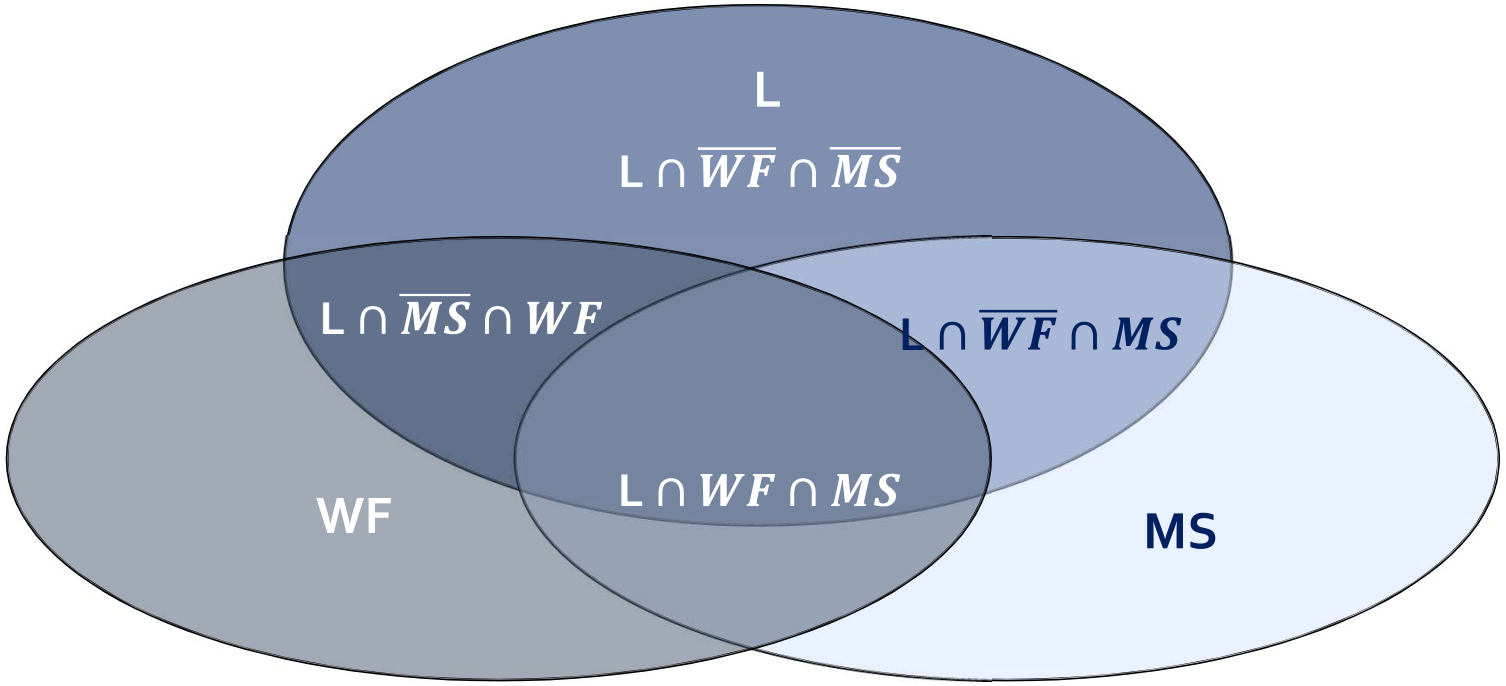
# Consistency check: Conditional Losses vs Government Injection





# Example: Lehman Default






| C | LB WFC MS | LB WFC MS | LB WFC MS | LB WFC MS |
|---|---|---|---|---|
| Pr(C\|LB) 1/ | 66.74 | 27.51 | 1.32 | 3.73 |
| In(C\|LB) 2/ | 0.52 | 1.76 | 2.02 | 3.89 |
| Co(C\|LB) 3/ | 34.47 | 48.42 | 2.66 | 14.52 |

1/ Probability of event

2/ Intensity of event: Loss (event) / $Loss_{SR}$(C/LB)

3/ Contribution of event to $Loss_{SR}$(C/LB)

# Work in Progress: Magnitude of Amplification

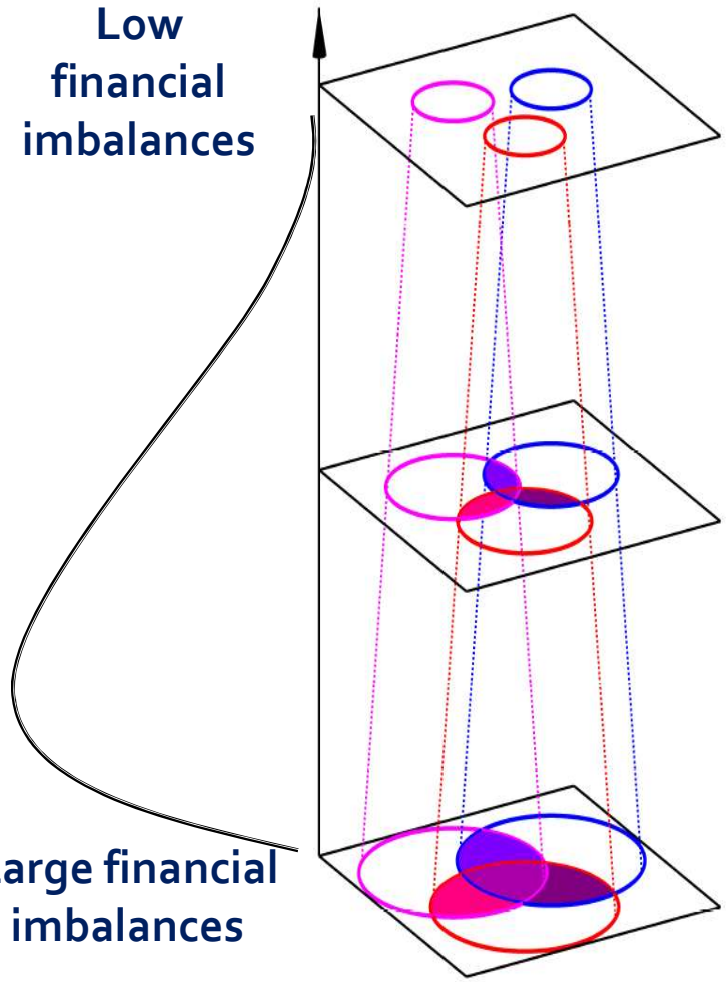


**Hiebert, Schueler, Segoviano, Zhao, "Systemic Risk Amplification Magnitude: Conditioning on Financial Imbalances"**

**Financial Imbalances**
**(Adrian et al 2013)**
Leverage
Liquidity Mismatch
Maturity Mismatch
Price of Risk

**Sectors**
Banks, Non Banks, HH, Corporate

**Markets**
Housing, Equity, Fixed Income, Derivative



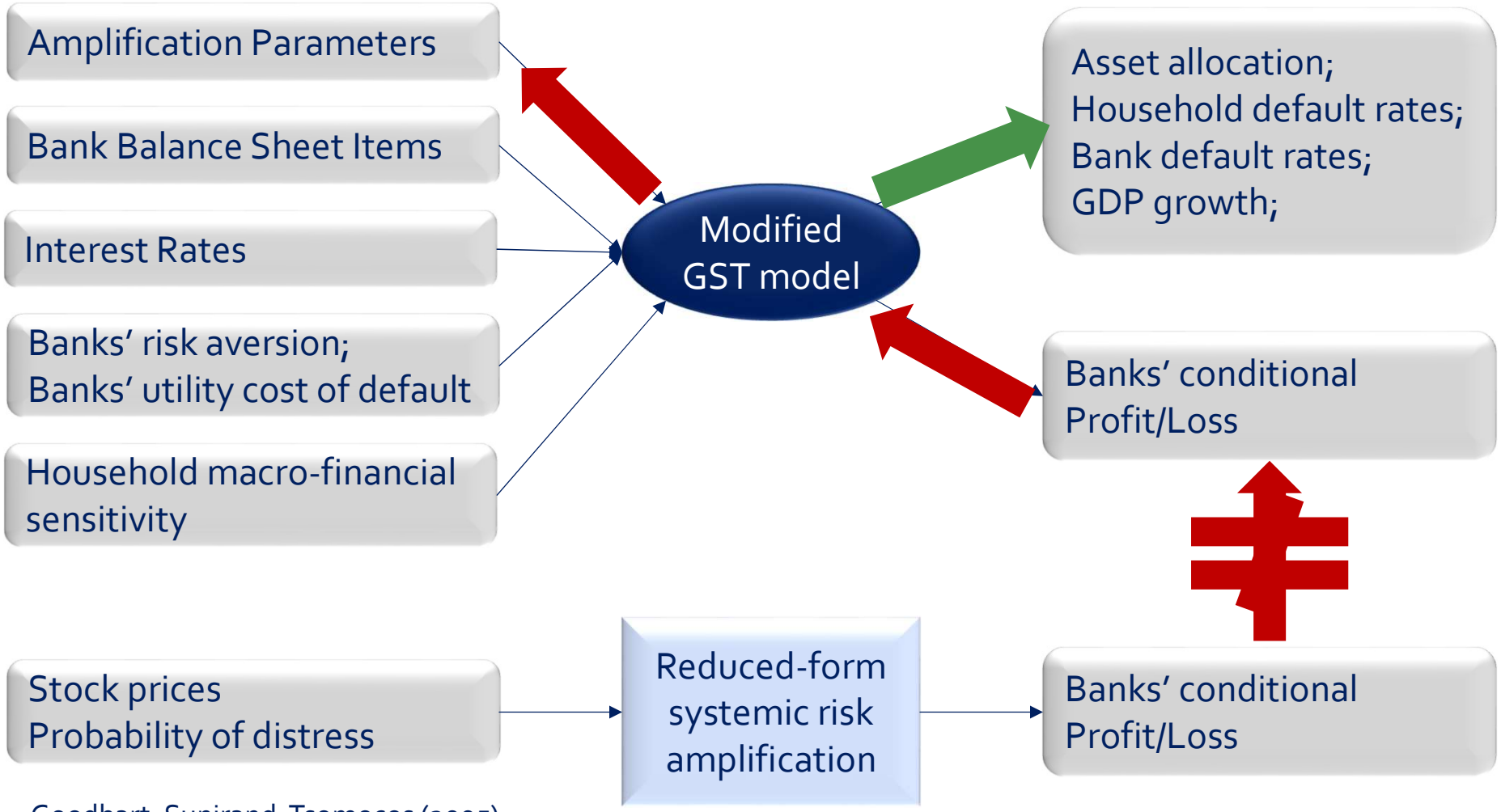

As imbalances worsen, the sets of events where A, B and C are in default expand, and so does the amplification magnitude

**Generate distribution of SR Losses/ Distribution of Imbalances**

# Work in Progress: Bringing together SR Theory and Empirics



**Espinoza, Segoviano, Yan, "Systemic Risk: Bringing Together Theory and Measurement"**




Goodhart, Sunirand, Tsomocos (2005)

# Use for Policy Makers: Calibration of Capital



Buffers

| | |
|---|---|
| Additional buffers for systemic banks (bank specific) | 0-3.5 %[2] |
| Countercyclical capital buffer (all banks) | 0-2.5 %[3] |
| Capital conservation buffer | 2.5% |
| Minimum capital requirement | 8% |

Buffers that can be calibrated by stress tests

1/ The above illustrates the minimum requirements presented in the Basel III framework. National authorities may have additional minimum capital requirements or other types of buffer requirements.
2/ National authorities can impose a capital buffer requirement on SIBs that is higher than 3.5 percent. The Basel framework introduces capital surcharges for G-SIBs ranging from 1 to 3.5 percent. For banks that are systemically important both globally and domestically, the higher of G-SIB and D-SIB capital surcharges applies.
3/ National authorities can impose a CCyB higher than 2.5 percent, while the mandatory international reciprocity applies only up to 2.5 percent.

**Source: Anderson, et al, 2017, "Macroprudential Stress Tests and Policies: Searching for Robust and Implementable Frameworks", Systemic Risk Centre, London School of Economics, forthcoming Discussion Paper.**

# Use for Policy Makers: Calibration of Capital



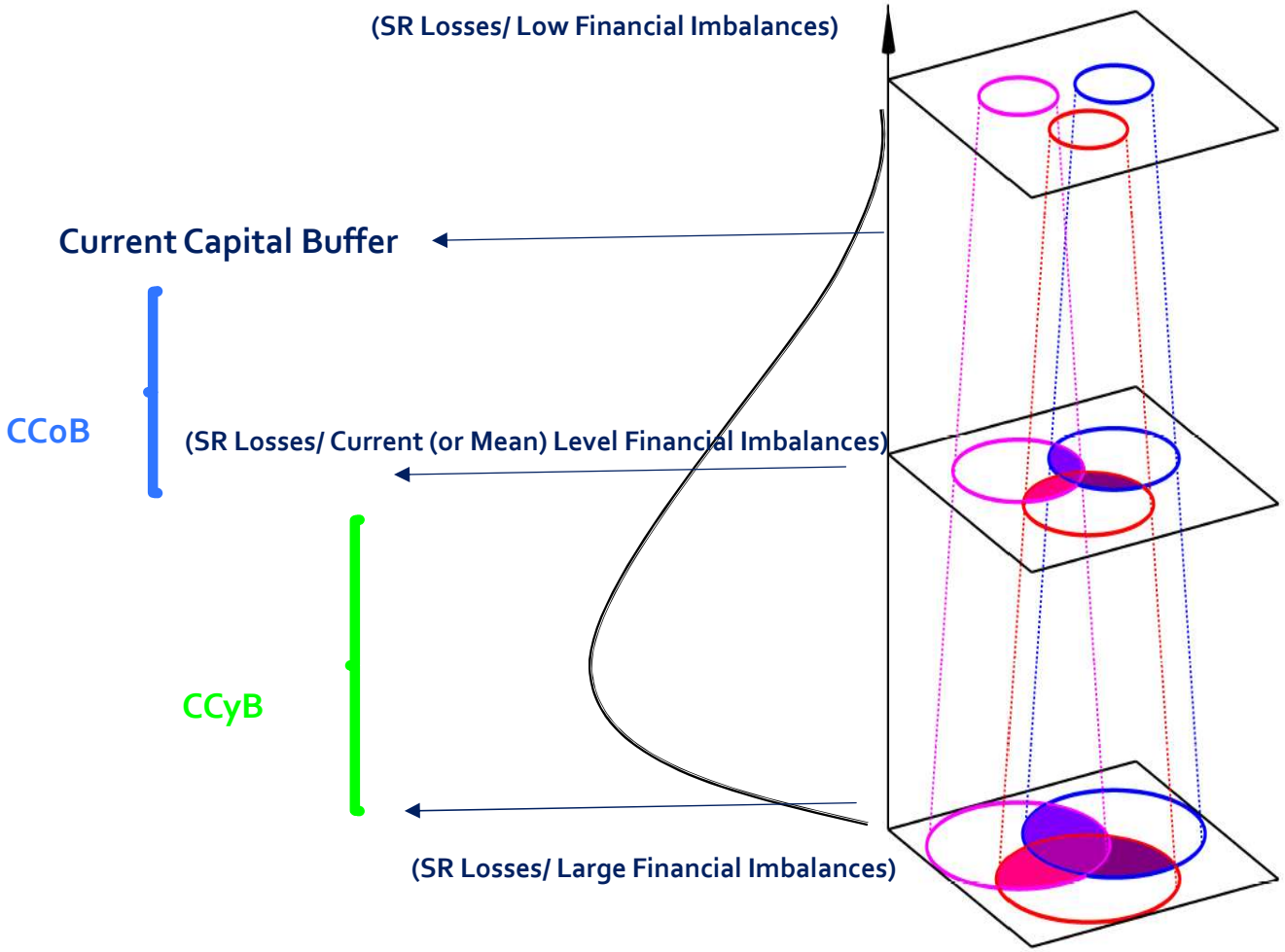
## There are many challenges for calibrating a capital buffer strategy.

- **Time consistency.** Aikman, Haldane, and Nelson (2015).
- **Regulatory discretion vs. quantitative calibration.**
- **Robustness of methods.**
- **Consistency of alternative uses of stress tests.**

# Use for Policy Makers: CCoB and CCyB Surcharge



## SR Amplification magnitude to calibrate capital buffers



# Use for Policy Makers: SIB Surcharge



- Currently, SIB surcharges unrelated to macroprudential ST
  - SIB surcharges are justified on ***perceived externalities***.

- This contradicts risk management perspective of capital:
  - Banks should hold **capital to withstand stress (unexpected) losses**, embedded in the Basel framework.
  - **Difficult to identify causality**: should requirements be on debtors, creditors, transactions?
  - **Capital to withstand vulnerabilities due to SR losses.** All banks subjected to different degrees.

- Important to question
  - Should only SIBs or G-SIBs be subjected to capital charges due to SR vulnerabilities?
  - ***Are other instruments better suited to address externalities?***
  - Regulation to **alter the magnitude of financial imbalances**? leverage, liquidity mismatch, etc.
  - Or policies to **alter structural features** of the financial system; e.g., Central clearing, bilateral margining, large exposure limits, etc.

# Use for Policy Makers: Other Uses



- **Identification of firms that could cause the most severe externalities or be most vulnerable to systemic shocks.**
- **Lending standards.**
- **MaPP responses targeting systems' structural features.**
- **Improving the design of recovery and resolution frameworks.** Goodhart and Segoviano (2015).
- **Understanding of the impact of regulatory constraints**. Divya Kirti and Vijay Narasiman (IMF Working Paper 17/68).

# Conclusion



- The proposed framework **makes use of micro stress tests** already implemented
- SR Loss based on **publicly available data.**
- **Cost-efficient.** Computationally simple and relatively light on data requirements.
- **Reduced-form**.
  - We can quantify SR Losses.
  - We can identify "connecting entities"
  - We can estimate likelihood and intensity of contagion effects
  - We ***cannot*** provide insights into the channels of SR amplification.
- **Conditioning on Financial Imbalances.** Improvement of estimation of **magnitude of amplification** and possibility to estimate a **density of SR losses**.
- **Combining theoretical models with reduced-form measurement. Identification of amplification channels** with improved measurement of SR.

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