

Attributing Systemic Risk to Individual Institutions by Nikola Tarashev, Claudio Borio and Kostas Tsatsaronis

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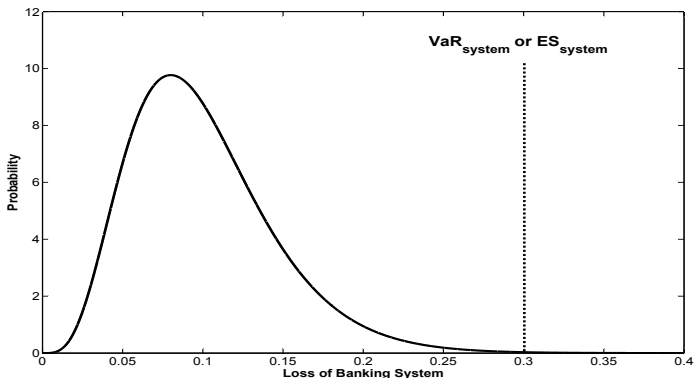
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* Comments are my own and not those of the Bank of Korea.

Summary: Attributing Systemic Tail Risk

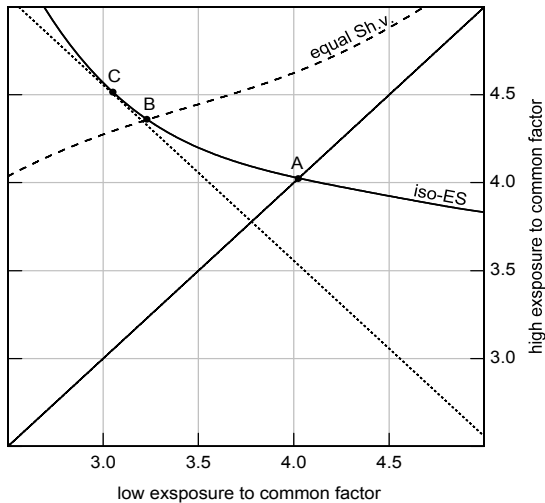
- Decompose system-wide VaR or ES and allocate it across financial institutions according to their Shapley values:

$$VaR_{system} \text{ (or } ES_{system}) = \sum_{i=1}^n ShV_i : \textit{Additivity}$$



Summary: Three Alternative Prudential Policy Approaches

Banks differ in one aspect²



Three Alternative Prudential Policy Approaches-continue

- A. Equalize the capital ratios (or PDs) across all institutions: Microprudential approach

$$\frac{K_1}{s_1} = \frac{K_2}{s_2} = \dots = \frac{K_n}{s_n}$$

- B. Equalize the ShVs across all institutions: Macroprudential approach I

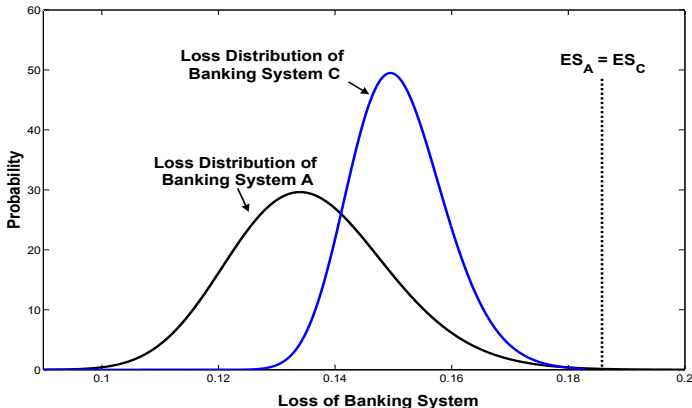
$$\frac{ShV_1(k_1)}{s_1} = \frac{ShV_2(k_2)}{s_2} = \dots = \frac{ShV_n(k_n)}{s_n}, \quad k_i = \frac{K_i}{s_i}$$

- C. Minimize the system-wide capital: Macroprudential approach II

$$\frac{ShV'_1(k_1)}{s_1} = \frac{ShV'_2(k_2)}{s_2} = \dots = \frac{ShV'_n(k_n)}{s_n}$$

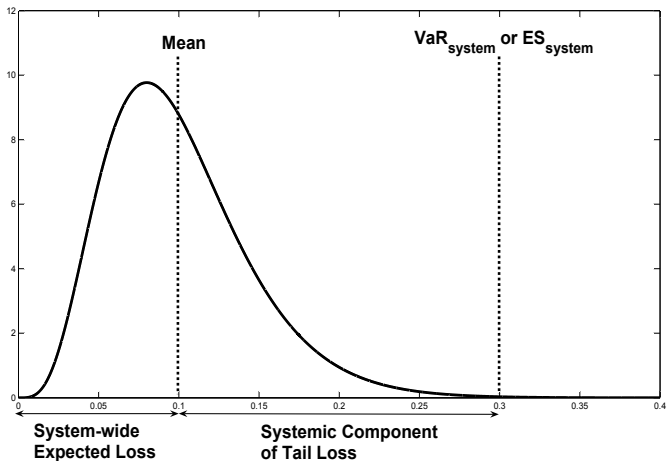
Shapes of Loss Distributions and Systemic Risk

- Banking System A and C have same tail risks (i.e iso-ES) but different shapes of distributions.
- Prudential policy implications of the differences between the two banking systems.



Two Components of Systemic Tail Risk

- VaR or ES =
System-wide Expected Loss (EL) + Systemic Component of Tail Loss (SL)



- *System-wide EL* = $\sum_{i=1}^n s_i \cdot LGD \cdot PD_i$
 - Mainly determined by PDs, regardless of default correlation.
 - Minimum EL could be attained by equalizing PDs across all institutions, i.e the microprudential approach.

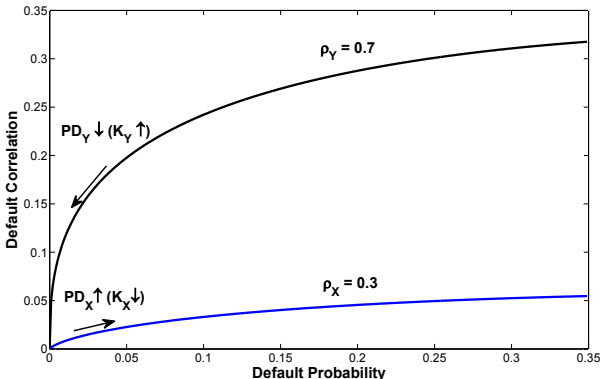
- *SL = VaR or ES - System-wide EL*
 - Determined by lumpiness(s_i) and default correlation.
(SL \rightarrow 0 as $\max(s_i) \rightarrow$ 0 and default correlation \rightarrow 0)
 - SL can be reduced by increasing n or decreasing default correlation.

How to Reduce Default Correlation?

- Default correlation = $f(\text{PDs, asset correlation})$

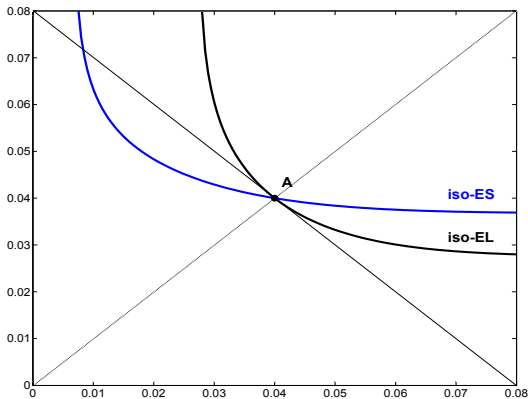
$$\text{Default Correlation between } X \text{ and } Y = \frac{PD_{XY} - PD_X \cdot PD_Y}{\sqrt{PD_X(1 - PD_X) \cdot PD_Y(1 - PD_Y)}}$$

- $PD_X \uparrow$ and $PD_Y \downarrow$ by capital reallocation, then system-wide default correlation \downarrow , thus systemic component of tail loss (SL) \downarrow .



Policy Discussion: Microprudential policy

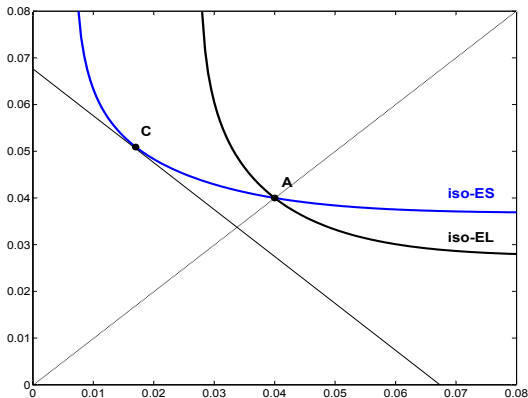
- Microprudential policy (i.e equalises PDs) does not concern the SL, i.e lumpiness and default correlation.
- However, microprudential policy minimizes the system-wide EL.



- No relevant reasons to equalize the Shapley values across all institutions from the point of view of macroprudential regulator.
- What advantage does the equal Sh.V have? Fairness?
- In order to achieve fairness, it is better to impose a levy or capital surcharge on banks according to their systemic importances (i.e Sh.Vs).
- Equalising contributions to systemic risk could increase systemic risk itself.

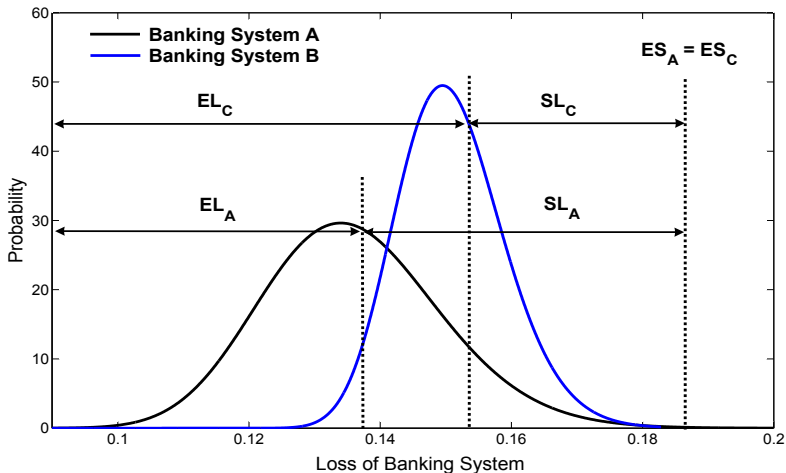
Policy Discussion: Macroprudential policy II

- Macroprudential policy II could achieve the target level of systemic risk with the minimum aggregate capital in the system.
- However, the system-wide EL increases, i.e being worse from the microprudential perspective.



Policy Discussion: Macroprudential policy II-continue

- $ES^A = ES^C$, but $EL^C > EL^A$ and $SL^A > SL^C$.



How to Marry Micro and Macro Prudential Policies

- A two step approach

Step 1: **Minimum Capital Requirements : Microprudential level**

- Minimize aggregate capital subject to target level of system-wide EL.

$$\begin{aligned} \min_{k_i} \quad & \sum_{i=1}^n s_i \cdot k_i \\ \text{s.t} \quad & \sum_{i=1}^n s_i \cdot PD(k_i) \leq EL^{Target} \\ \Rightarrow \quad & k_1 = k_2 = \dots = k_n = k^* \end{aligned}$$

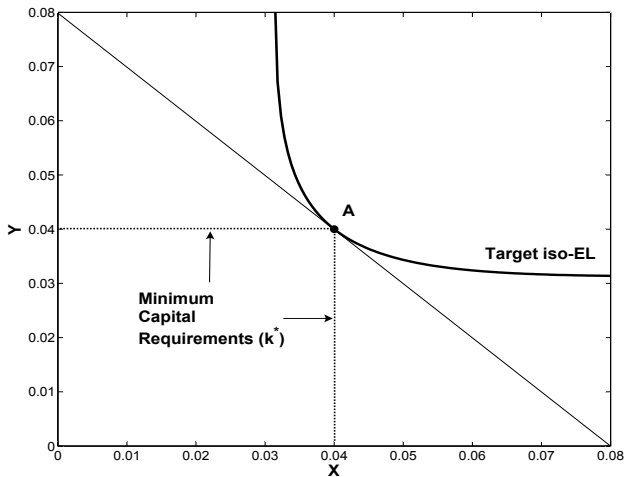
Step 2: **Capital Surcharges : Macroprudential Level**

- Minimize aggregate capital subject to target level of systemic risk (ES) and minimum capital requirements.

$$\begin{aligned} \min_{k_i} \quad & \sum_{i=1}^n s_i \cdot k_i \\ \text{s.t} \quad & (i) \quad \sum_{i=1}^n Sh.V_i(k_i) \leq ES^{Target} \\ & (ii) \quad k_i \geq k^* \quad \forall i = 1, \dots, n. \end{aligned}$$

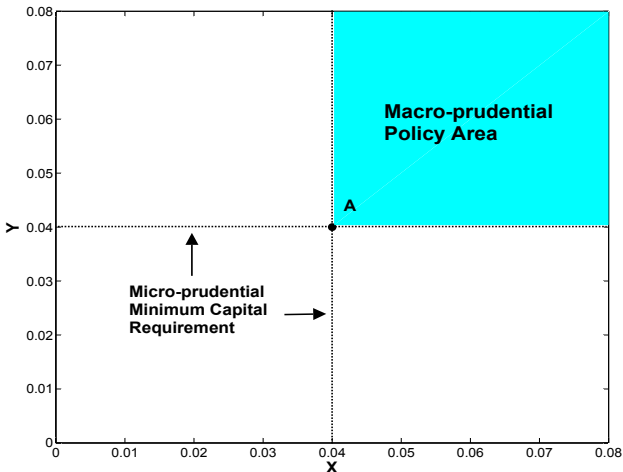
Microprudential Policy: Minimum Capital Requirements

- Apply minimum capital requirements (k^*) for all institutions.



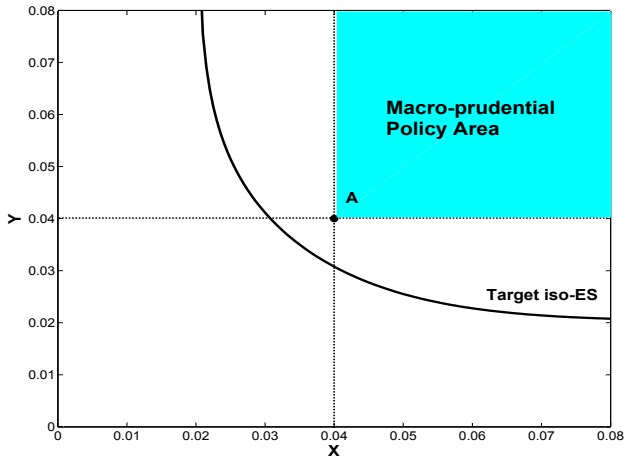
Macroprudential Policy Area

- Macroprudential regulator may impose capital surcharges on banks within the area to attain the target systemic risk (ES).



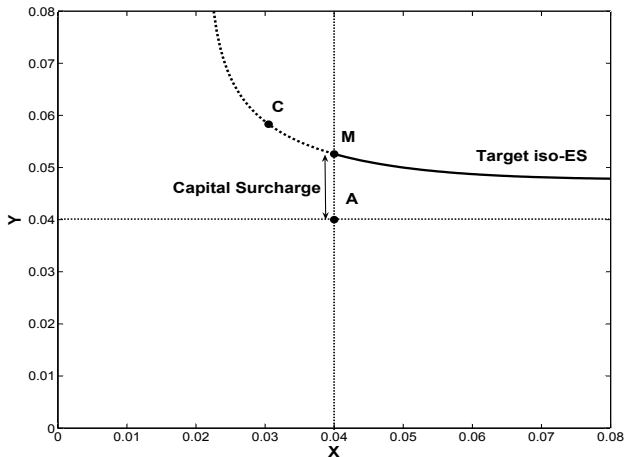
Case 1: No Need for macroprudential Policy

- Microprudential policy (A) attains the target systemic risk.



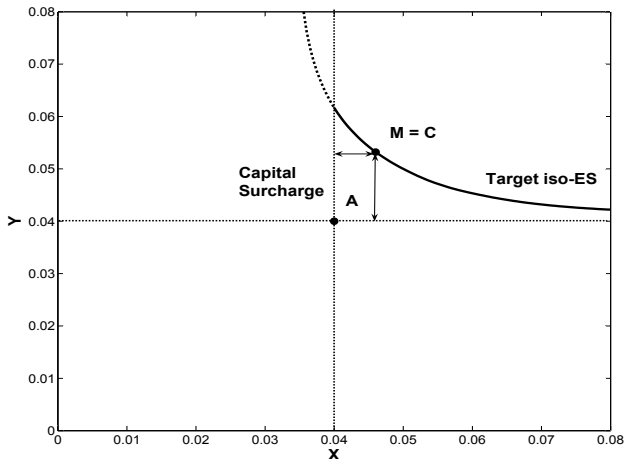
Case 2: Capital Surcharges

- Macroprudential regulator imposes capital surcharge on bank Y only.
- Macroprudential policy II (C) cannot satisfy the minimum capital requirement for bank X .



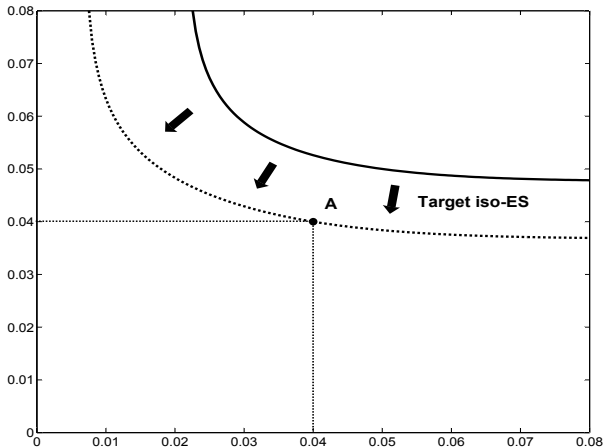
Case 3: No need for Microprudential Policy

- Macroprudential policy ($M = C$) satisfies the minimum capital requirements for all banks.



Other Macropprudential Policy Instruments

- Other macroprudential instruments such as restrictions on size or interbank exposures shift the target iso-ES inward, so that the target systemic risk may be achieved by minimum capital requirements without imposing capital surcharges.



- Attribution procedure 2: Fixed tail events
 - Definition of systemic events is not relevant for a insurance premium scheme.
 - According to the definition of systemic events in the paper, the probabilities of systemic events are same for all banking systems, regardless of the risk level of the banking system.
- Systemic importance: PD vs Size and common exposures.
 - Systemic importance of small banks \uparrow as PD \uparrow .
 - Systemic importance of high-exposure banks \uparrow as PD \uparrow .
 - This is because default correlation \uparrow as PD \uparrow , thus the systemic effect of size \downarrow and the systemic effect of common exposures \uparrow .

Conclusions

- Macroprudential policy could increase microprudential risk.
 - Combine macro and micro prudential policies.
- When microprudential instruments, such as capital charges, are used for macroprudential purpose, microprudential function should be preserved.
 - Develop macroprudential instruments that do not harm microprudential function.