Attributing Systemic Risk to Individual Institutions
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* Comments are my own and not those of the Bank of Korea.
Decompose system-wide VaR or ES and allocate it across financial institutions according to their Shapley values:

$$VaR_{system} \ (or \ ES_{system}) = \sum_{i=1}^{n} ShV_i : Additivity$$
Banks differ in one aspect\(^2\)
A. Equalize the capital ratios (or PDs) across all institutions: Microprudential approach

\[
\frac{K_1}{s_1} = \frac{K_2}{s_2} = \ldots = \frac{K_n}{s_n}
\]

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

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

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

\[
\frac{ShV_1'(k_1)}{s_1} = \frac{ShV_2'(k_2)}{s_2} = \ldots = \frac{ShV_n'(k_n)}{s_n}
\]
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)
Two Components of Systemic Tail Risk-continue

- **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.
    \( (SL \to 0 \text{ as } \max(s_i) \to 0 \text{ and default correlation } \to 0) \)
  - SL can be reduced by increasing \( n \) or decreasing default correlation.
How to Reduce Default Correlation?

- Default correlation = f(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 ↓, thus systemic component of tail loss (SL) ↓.
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.
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.
\( ES^A = ES^C \), but \( EL^C > EL^A \) and \( SL^A > SL^C \).
A two step approach

Step 1: **Minimum Capital Requirements : Microprudential level**
- Minimize aggregate capital subject to target level of system-wide EL.

\[
\min_{k_i} \sum_{i=1}^{n} s_i \cdot k_i \\
\text{s.t} \sum_{i=1}^{n} s_i \cdot PD(k_i) \leq EL^{Target} \\
\Rightarrow k_1 = k_2 = \cdots = k_n = k^* 
\]

Step 2: **Capital Surchages : Macroprudential Level**
- Minimize aggregate capital subject to target level of systemic risk (ES) and minimum capital requirements.

\[
\min_{k_i} \sum_{i=1}^{n} s_i \cdot k_i \\
\text{s.t} (i) \sum_{i=1}^{n} Sh.V_i(k_i) \leq ES^{Target} \\
(ii) \quad k_i \geq k^* \quad \forall i = 1, \cdots, n. 
\]
Apply minimum capital requirements \((k^*)\) for all institutions.
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.

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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.

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Case 3: No need for Microprudential Policy

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

- Attribution procedure 2: Fixed tail events

  - Definition of systemic events is not relevant for an 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 ↑ as PD ↑.

  - Systemic importance of high-exposure banks ↑ as PD ↑.

  - This is because default correlation ↑ as PD ↑, thus the systemic effect of size ↓ and the systemic effect of common exposures ↑.
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.