Internal Measurement Approach
< Foundation Model >

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[1]

Proposal for an IMA formula

Standardised Approach (1)

Under the Standardised Approach

- Required capital for the bank
  = Σ Required capital amounts for all the business lines
  - Required capital for each business line
    = [ß determined by the regulators]
    x [Exposure Indicator (EI)]
- "Working Paper (September 2001)"
  - EI => Gross Income (GI)
- Required capital for the bank
  = Σ {Required capital for business lines = ß * GI --- (1-1) }

Standardised Approach (2)

{Structure}

- The level and size of the activity in each business line are reflected in GI.
- The risk characteristic of each business line is reflected in ß.

{Limitations}

- The result is not directly linked to the loss data.
- The difference in profile of operational risk between event types within the same business line is not reflected.

Advanced Measurement Approaches [AMA] (1)

{Structure}

Under the AMA

- Each bank measures the required capital
  - based on its own loss data;
  - with its own measurement method;
  - using the holding period and confidence interval determined by the regulators.
- WP refers to
  - Loss Distribution Approach (LDA)
  - Internal Measurement Approach (IMA)
  - Scorecard Approach

Advanced Measurement Approaches [AMA] (2)

{Limitations of Standardised Approach}

- The result is not directly linked to the loss data.
- The difference in profile of operational risk between event types within the same business line is not reflected.

{Features of the AMA}

- Based on the collection of loss data.
- "Low-frequency / high-severity" for each event type in addition to business line to be reflected.

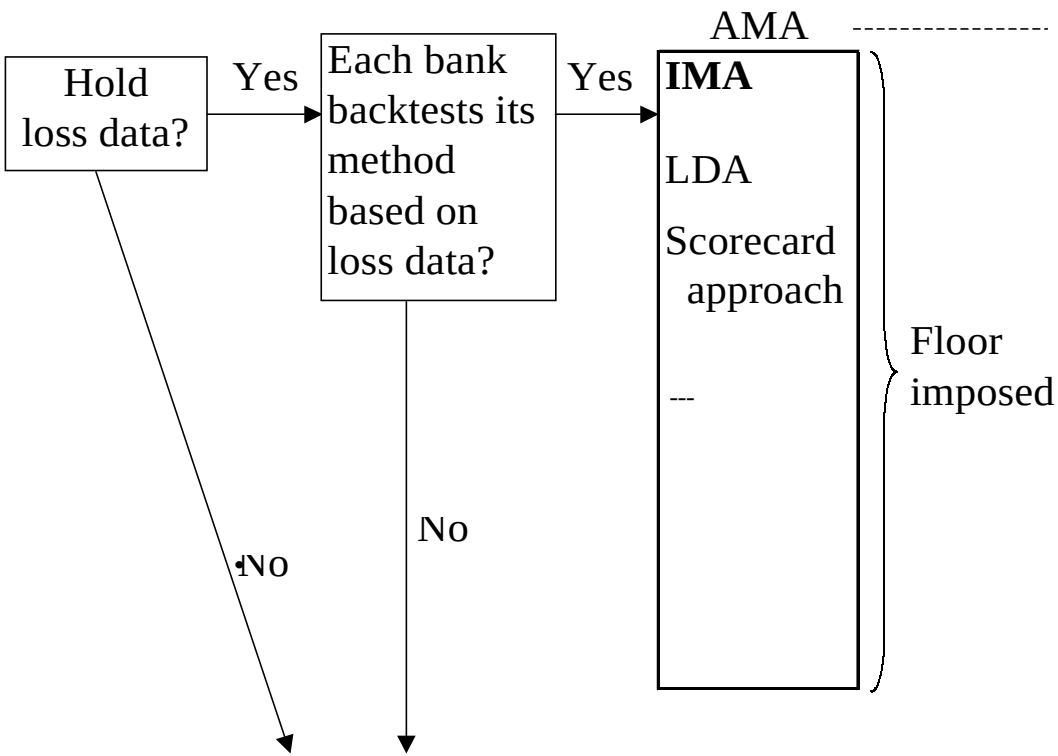
✧ **Backtesting**

To be verified through backtesting based on historical loss data.

✧ **Floor**

Initially set at 75% of the Standardised Approach.

Advanced Measurement Approaches [AMA] (3)



<Features>

1. Based on the loss data.
2. Reflects the risk profile of each event type / business line (low-frequency, high-severity).

<Limitations>

1. Not directly linked to loss.
2. Risk profile of each event type / business line not reflected.

Banks can choose between methods under the AMA and the Standardised Approach depending on the characteristics of the business line concerned.

Proposal for an IMA formula (1)

- Proposal for an explicit formula for the IMA, one alternative under the AMA
  - Required capital is determined for each combination of business line / event type.
    - Required Capital = γ *EL
      - EL = Average annual loss amount
        => Derived from the bank's own internal loss data

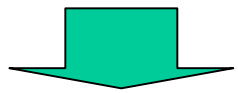
Proposal for an IMA formula (2)

"Low-frequency / high-severity" is reflected through

- An adjustment factor $(1+A/\sqrt{n})$ incorporated as follows.
  - Required Capital = $\lambda * EL * (1+A/\sqrt{n})$ --- (1-2)
    - λ = Constant determined for each business line based on the holding period and confidence interval specified by the regulators.
    - A = Constant for each business line / event type combination
    - n = Number of events.

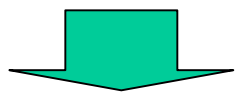
IMA Foundation Model

- Parameters A and λ ;
  - Estimated by each bank based on its own internal data.



"Generic Model"

  - Could also be uniformly determined by the regulators based on the global data.



"Foundation Model"

Floor for AMA

✧ A floor is imposed on AMA because;

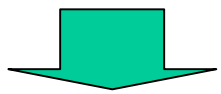
- The internal methods are still in early stages of implementation.
- AMA still lacks detailed criteria for specific quantification methods.

✧ The effect of such factors varies between different methods.

The regulators should examine the degree of such an effect to determine the level of the floor accordingly.

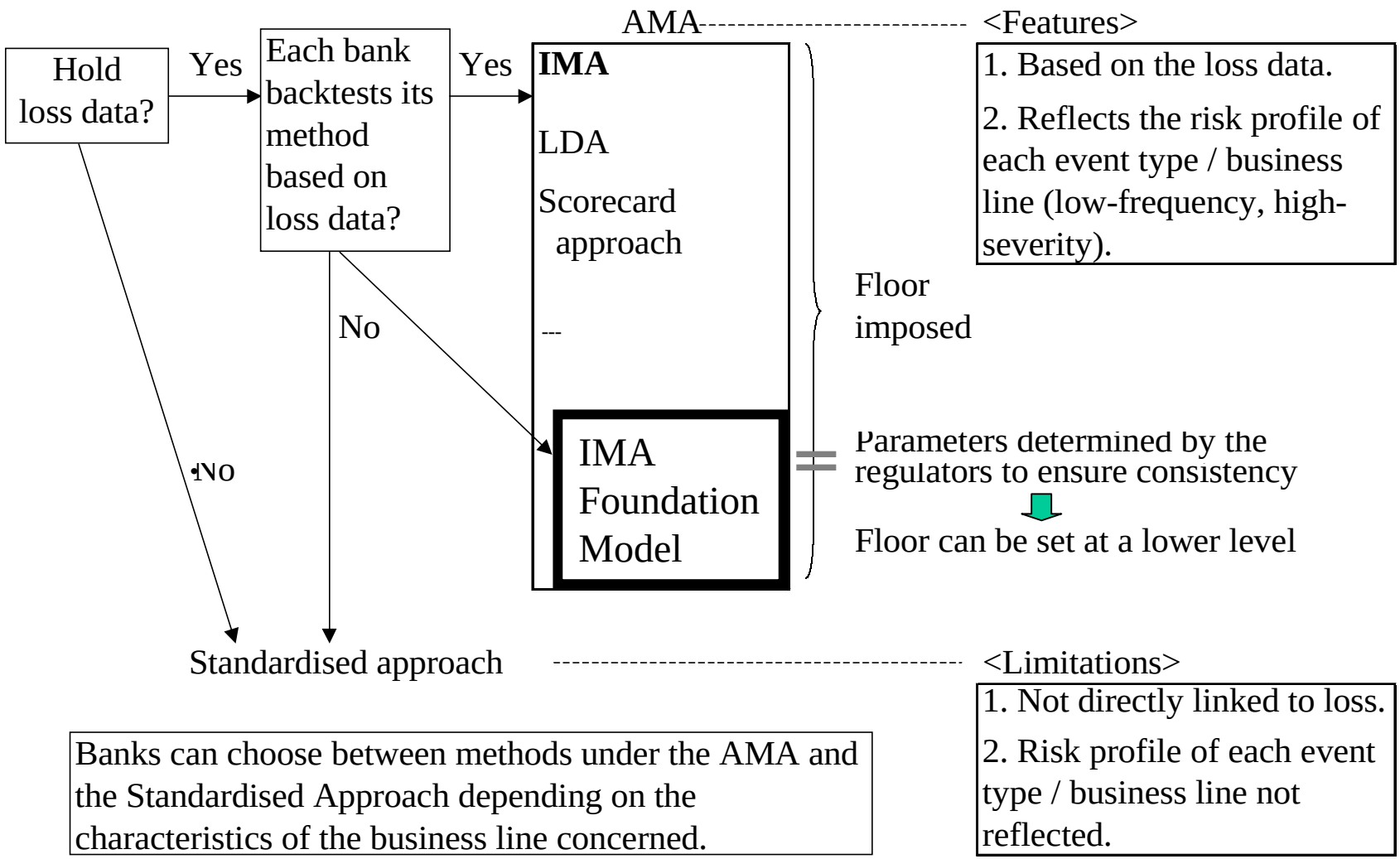
Floor for IMA Foundation Model

- ✧ All the parameters are fixed under the IMA Foundation Model.
  - ✧ The stage of implementation does not matter as verification of methods employed by individual banks is not required.
  - • Detailed criteria for quantification methods are uniformly established.



- ✧ If IMA in a rigorous form is developed, it should be able to enjoy a floor set at a lower level in light of the very reasons for imposition of the floor articulated in the WP. Eventually, such a floor could be dropped.

IMA Foundation Model (Summary)



[2]

Relationship with the basic structure proposed in Consultative Paper 2

Relationship between formulae

- Basel Committee proposed the following structure of the IMA formula in CP2 (January 2001).
  - Required Capital (CP2) = λ * EI * PE * LGE * RPI
- The IMA Formula (1-2) proposed in this presentation can be related to this basic structure as follows.
  - Required Capital = λ * EL * $(1+A/\sqrt{n})$ --- (1-2)

EI	PE	LGE	RPI
EL			$1+A/\sqrt{n}$

EL (1)

- The issues raised as to actual implementation of;
  "Required Capital = λ * EI * PE * LGE * RPI" proposed in CP2.
  - In the case where the size of the bank's business operation is changed due to merger/demerger on a large scale or acquisition/divestiture of important new businesses, the bank can modify the internal loss data based on the EI (scaling adjustment).
  - The following issues, however, would be raised.
  - Definition of EI can be difficult depending on the event type.
  - Even if such a definition is possible, it is difficult to actually collect data on the EI. The calculation of PE is therefore difficult .

EL (2)

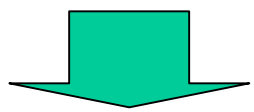
◆ When total transaction amount (= Nμ) is selected as EI;

- ➢ actual calculation of EI * PE * LGE shows that EI and PE cancel out each other.
- ➢ the result equals the annual loss amount.

EI * PE * LGE = $N\mu * n/N * \mu_L/\mu = n\,\mu_L$ = EL (annual loss amount)

N: Total number of transactions, μ: Average transaction amount,

n: Number of events, μ_L : Average of loss amount



✧ Formula (1-2) enables calculation of required capital <u>without</u> directly measuring EI and PE. by incorporating EL.

λ

- λ
  - A factor related to the required capital / EL ratio.
  - A constant determined for each business line by the confidence interval and the holding period.

$1+A/\sqrt{n}$ (1)

- RPI reflects the “low-frequency / high-severity”

  ⇒ can be divided into;

- Adjustment factor for frequency
  - Incorporates the profile of each bank as to the level of low-frequency.
  - Required capital / EL becomes greater when n becomes smaller.
  - This feature can be reflected in the IMA formula by introducing a non-linear factor $1 / \sqrt{n}$.
  - Easily calculated based on internal data.

$1+A/\sqrt{n}$ (2)

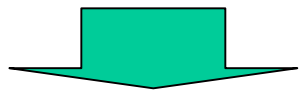
- Adjustment factor for severity
  - The greater the dispersion of the loss distribution (mean μ_L; standard deviation σ_L), the greater becomes the adjustment factor for severity.
  - Incorporates the profile of each bank as to the level of high-severity.
  - Determined for each business line / event type combination as a constant A.

$1+A/\sqrt{n}$ (3)

- The profile of loss distribution varies between business line / event type combinations.
- This difference is explained by the difference between business line / event type combinations.
- By establishing A for each business line / event type combination, therefore, it is possible to reflect different characteristics of different loss distribution in the formula.

Common determination of A and λ based on the global data

- A and λ can be different between banks.



- We propose the Foundation Model for which;
  - A and λ are determined by the regulators based on the global data.
    - λ depends mainly on business line, and
    - A on business line / event type combination.

Characteristics of the IMA formula (1-2)

- The characteristics of the IMA formula (1-2)
  - Based on the linear formula EI * PE * LGE (= EL).
  - Non-linearity is incorporated through multiplication by the inverse of the square root of the number of events.
  - The level of severity is differentiated between event types
  - Exposure Indicator is not explicitly shown.
  - Furthermore, under the Foundation Model;
    - The parameters A and λ can be commonly determined on a global basis.
    - No necessity for model validation for each bank in the actual implementation.

    ⇨ Possible to set the floor at a lower level than for other methods under the AMA.

[3]

Determination of the parameters for the IMA formula

Method for calibration (1)

- In the IMA formula (1-2), Required capital• is expressed as;
  - $\lambda * EL * (1+A/\sqrt{n})$

    where the following observations are made.

    - λ for each business line.
    - A for each combination of business line / event type.
    - EL and n for each combination of business line / event type.

  Accordingly, the required capital for each combination of business line / event type is measured with the IMA formula as follows.

  - $\lambda_j * EL_{ij} * (1+A_{ij}/\sqrt{n_{ij}})$ (i: Event type, j: Business line)

(Note) This presentation demonstrates that the above formula with A and λ calibrated inductively gives the required capital amount. A theoretical demonstration is also possible given a certain distribution.

Method for calibration (2)

- As IMA is an alternative under the AMA, the required capital for each combination of business line / event type is the unexpected loss (the tail of the distribution) with the holding period and confidence interval specified by the regulators.(Expressed as UL_{ij}). $U\bullet_{ij}$ is determined either on the basis of actual distribution or theoretically.
- Calibrating IMA formula ⟺ Approximating the UL with IMA.

$UL_{ij}\bullet \Leftrightarrow IMA_{ij} = \lambda_j * EL_{ij} * (1 + A_{ij}/\sqrt{n_{ij}})$

Observed (directly or theoretically) based on the loss data

Determine constants λ and A (regression analysis)

- Calibration of the Foundation Model demonstrated later.

  Common λ and A for all the banks determined based on the global data (consecutive QIS etc.).

Method for calibration (3)

Business Line j

Unexpected loss with the holding period and confidence interval specified by the regulators: ULij

⟺

Required capital measured with IMA:IMA_{ij}

$= \lambda_i \times EL_{ij} \times (1 + \mathbf{A_{ij}} / \mathrm{sqrt}(n_{ij}))$

Parameters λj and Aij are determined so that they can be common to all the banks and event

Regression Analysis

Bank A	**Event type 1**	UL_{1j}	⟺	IMA_{1j}	= λ_i ×	EL_{1j}	× (1+	$\mathbf{A_{1j}}$	/sqrt(n_{1j})
	Event type 2	UL_{2j}	⟺	IMA_{2j}		EL_{2j}		$\mathbf{A_{2j}}$	/sqrt(n_{2j})
	Event type 3	UL_{3j}	⟺	IMA_{3j}		EL_{3j}		$\mathbf{A_{3j}}$	/sqrt(n_{3j})
	Event type 4	UL_{4j}	⟺	IMA_{4j}		EL_{4j}		$\mathbf{A_{4j}}$	/sqrt(n_{4j})
	Event type 5	UL_{5j}	⟺	IMA_{5j}		EL_{5j}		$\mathbf{A_{5j}}$	/sqrt(n_{5j})
	-	-		-		-			-
	-	-		-		-			-
	-	-		-		-			-
Bank B	**Event type 1**	-		-		-			-
	-	-		-		-			-
	-	-		-		-			-
-	-	-		-		-			-
-	-	-		-		-			-

Sample calibration

- The result of the process shown above for commercial banking (business line 1)is as follows. The UL has been measured with the boot-strap method (*) using the actual loss data.
  Coefficient of determination for the regression analysis = 0.93.

	Unexpected loss$_{i1}$ (1y:99.9%)	n_{i1}	EL_{i1}		λ_1	A_{i1}
Event type 1	4,468	16	365		19.46	2.11
Event type 2	*****	**	****	Regression Analysis	19.46	6.02
Event type 3	*****	**	****		19.46	0.90
Event type 4	123,688	76	1,440		19.46	15.31
Event type 5	*****	**	****		19.46	1.96
Event type 6	*****	**	****		19.46	11.95
Event type 7	5,240	2,428	864		19.46	23.84

Boot-strap ↑ ↑ Directly ↑

Observed based on the loss data (QIS2)

(*) Based on a method we developed separately, for which detailed explanation is not given in this presentation. We employ it here to calibrate the Foundation Model with the global data. It is also envisaged that each bank will further develop such a method to build its own LDA.

[4]

Sample calculation of required capital with IMA

Sample for Commercial banking / Trading & Sales (1)

- Following is a sample calculation based on the assumption shown below.
  - IMA = λ* EL * (1+A/ √ n)
    Constants λ and A are as follows.

	Commercial banking		Trading & Sales	
	λ	A	λ	A
Event type 1	19.46	2.11	25.12	2.54
Event type 2	19.46	6.02	25.12	5.95
Event type 3	19.46	0.90	25.12	2.31
Event type 4	19.46	15.31	25.12	16.34
Event type 5	19.46	1.96	25.12	2.04
Event type 6	19.46	11.95	25.12	14.32
Event type 7	19.46	23.84	25.12	18.54

  - ß under the Standardised Approach
    12% (commercial banking), and 20% (trading & sales)

Sample for Commercial banking / Trading & Sales (2)

- The observed actual loss data are as follows. (JPY Thousand)

	EL (Commercial banking)	n (Commercial banking)	EL (Trading & Sales)	n (Trading & Sales)
Event type 1	301,287	5	54,528	5
Event type 2	8,666	200	32	20
Event type 3	60	3	0	0
Event type 4	1,880,360	30	32,497	11
Event type 5	8,920	15	0	0
Event type 6	200	5	3,421	4
Event type 7	912,204	920	5,124	56
Total	3,111,697	1,178	95,602	96

- GI= JPY 1,500,000 million (Commercial banking)
  JPY 200,000 million (Trading&sales)

Sample for Commercial banking

- Sample for Commercial banking
  - Required capital under the IMA = JPY 182,501 million

$$\lambda * EL * (1 + A / \sqrt{n})$$

Parameters: λ, A

Observed loss data: EL, n

(JPY Thousand)

	λ	A	EL	n	IMA (=UL)
Event type 1	19.46	2.11	301,287	5	11,395,536
Event type 2	19.46	6.02	8,666	200	240,427
Event type 3	19.46	0.90	60	3	1,774
Event type 4	19.46	15.31	1,880,360	30	138,873,615
Event type 5	19.46	1.96	8,920	15	261,428
Event type 6	19.46	11.95	200	5	24,692
Event type 7	19.46	23.84	912,204	920	31,703,833
Total			3,111,697	1,178	182,501,305

UL/EL=58.6

  - Required capital under Standardised Approach
    = 1,500,000 x 12% = JPY 180,000 million

Sample for Trading & Sales

- Sample for Trading & Sales
  - Required capital under the IMA = JPY 8,914 million

$$\lambda * EL * (1 + A / \sqrt{n})$$

Parameters　　Observed loss data

(JPY Thousand)

	λ	A	EL	n	IMA(=UL)
Event type 1	25.12	2.54	54,528	5	2,925,666
Event type 2	25.12	5.95	32	20	1,873
Event type 3	25.12	2.31	0	0	0
Event type 4	25.12	16.34	32,497	11	4,838,107
Event type 5	25.12	2.04	0	0	0
Event type 6	25.12	14.32	3,421	4	701,234
Event type 7	25.12	18.54	5,124	56	447,608
Total			95,602	96	8,914,488

UL/EL=93.2

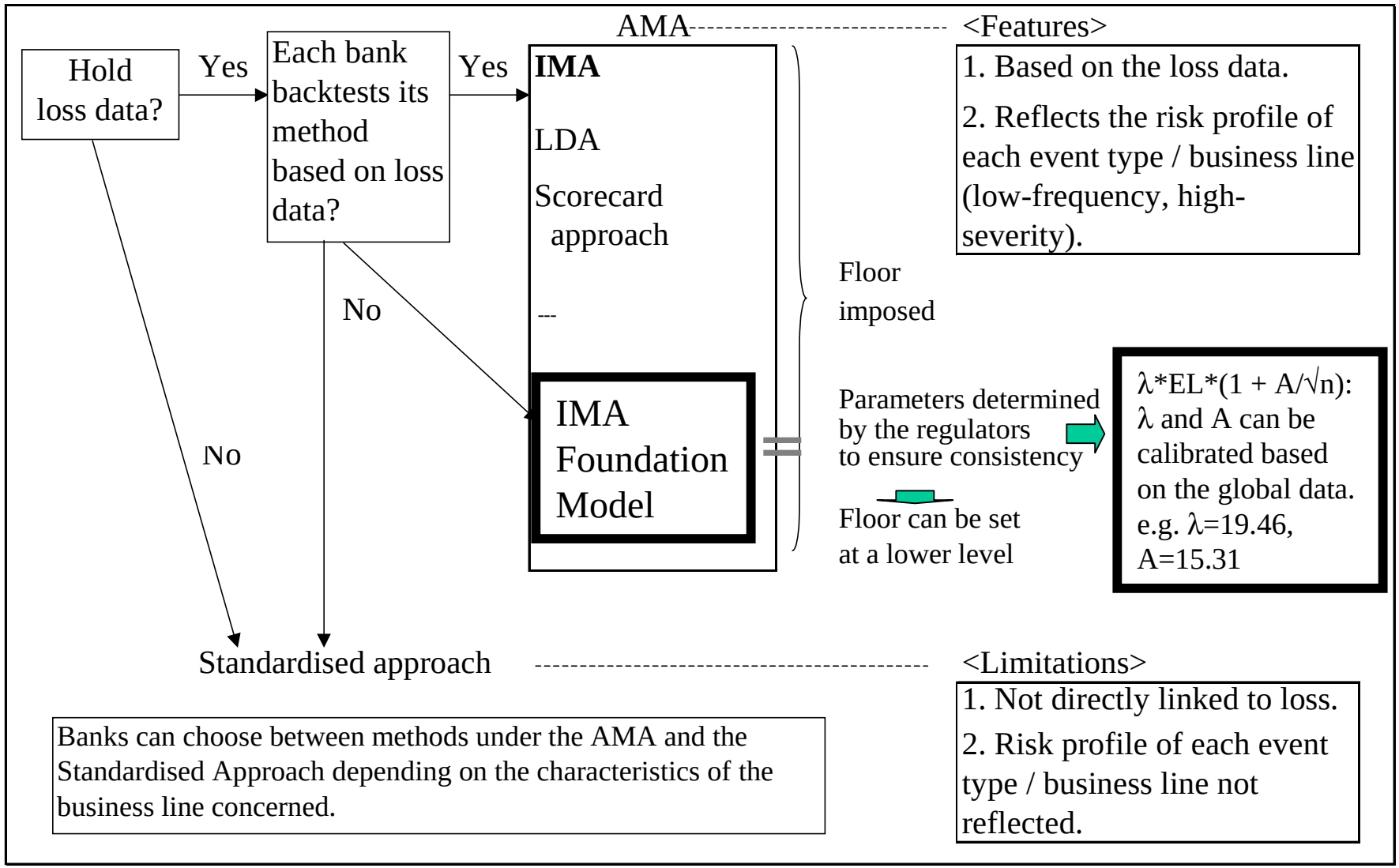
  - Required capital under Standardised Approach
    = 200,000 x 20% = JPY 40,000 million

Bank as a whole

- If the bank has only two business lines shown above, i.e. commercial banking and trading & sales, the required capital for the bank as a whole is the sum of the above.

- Required capital under the IMA
  = 182,501 + 8,914 = JPY 191,415 million
- Required capital under Standardised Approach
  = 180,000 + 40,000 = JPY 220,000 million

Conclusion


AMA
<Features>
Hold loss data?
Yes
Each bank backtests its method based on loss data?
Yes
IMA
LDA
Scorecard approach

No
IMA Foundation Model
No
Floor imposed
Parameters determined by the regulators to ensure consistency
Floor can be set at a lower level
λ*EL*(1 + A/√n): λ and A can be calibrated based on the global data. e.g. λ=19.46, A=15.31
1. Based on the loss data.
2. Reflects the risk profile of each event type / business line (low-frequency, high-severity).
Standardised approach
<Limitations>
1. Not directly linked to loss.
2. Risk profile of each event type / business line not reflected.
Banks can choose between methods under the AMA and the Standardised Approach depending on the characteristics of the business line concerned.

[Appendix]

Application criteria for the IMA formula

Sufficiency of EL (1)

- The IMA formula (1-2) is based on EL.
  - ➢It is crucial that the observed amount of EL is sufficiently large.
  - – When the observed EL is large enough, the Formula (1-2) can be applied as it is.
  - – If not, the reliability of the calculation with this formula in its original form might be low.

Sufficiency of EL (2)

- Two cases where EL is not adequate depending on the size of EI.

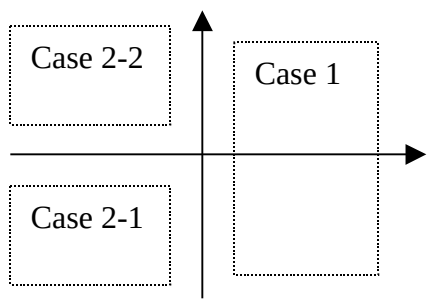
  Observed EL is deemed insufficient when;

  - EI is small. [Case 2-1]
    - ✧No event causing EL has occurred because the number of transactions in the past is very small.
  - EI is large. [Case 2-2]
    - ✧The frequency of events is limited to a very low level due to the high control capabilities etc. although the number of transactions is reasonably large.

Sufficiency of EL (3)

- Two cases correspond to
  - The second quadrant [Case 2-2]
  - The third quadrant [Case 2-1]

  among the three types of combinations of the size of EL and EI.



Sufficiency of EL (4)

- In Cases 2-1 and 2-2, EL is not significant.
  - The required capital amount calculated using the IMA formula (1-2) is not very reliable.
  - In order to ensure that the measurement is conservative, a floor is established for the IMA formula (1-2).

Sufficiency of EL (5)

◆ Steps towards required capital calculation:

[Step 1]

"Collect internal data"

– Banks collect internal data on loss and exposure indicators.

[Step 2]

"Check the significance / meaningfulness of the collected data"

– using the exposure indicator concerned.

Sufficiency of EL (6)

- [Case 1] The observed EL is sufficient.

  If the data collected proves statistically significant, the bank can calculate the capital charge using only the loss data.

✧ Formula (1-2): Required Capital = $\lambda * EL * (1+A/\sqrt{n})$

- [Case 2] The observed EL is not sufficient.

  If the data collected proves statistically not significant or the data is not available in the first place, the bank must use external data on the exposure indicator concerned to calculate the capital charge.

Sufficiency of EL (7)

- In Case 2-1, EI is small, i.e. EL is not sufficient because the number of transactions in the past is not large enough or for other reasons.
  - In this instance, neither PE nor LGE is significant.
  - The capital charge should be set at the larger of;
    - The required capital amount calculated with the Formula (1-2), or
    - The required capital amount based on the PE and the LGE both set at the average level of the global data.

Sufficiency of EL (8)

- The composition of the required capital based on the PE and the LGE both set at the average level of the global data:

EI	PE	LGE	γ
EI	$PE_{(G)}$	$\mu_{L(G)}$	$\lambda^* (1+A)$
EI	$ß_1$		

(Suffix G denotes global data.)

- Accordingly, the capital charge is written as $ß_1 * EI$. The general expression for the capital charge is therefore;
  - Required capital = $\max [\lambda * EL * (1+A/\sqrt{n}), ß_1 * EI]$ (5-1)

Sufficiency of EL (9)

- In Case 2-2, on the other hand, EI is large, i.e. the observed EL is not sufficient because PE is low although the number of transactions is reasonably large.
  - In this instance, LGE is not significant. PE, which is close to zero, is not significant either.
  - The capital charge should be set at the larger of;
    - The required capital amount calculated with the Formula (1-2), or
    - The required capital amount based on the floor PE, i.e. the fixed minimum PE, and the LGE set at the average level of the global data.

Sufficiency of EL (10)

- The composition of the required capital amount based on the floor PE, i.e. the fixed minimum PE, and the LGE set at the average level of the global data:

EI	PE	LGE	γ
EI	Floor $PE_{(G)}$	$\mu_{L(G)}$	$\lambda * (1+A)$
EI	$ß_2$		

- Accordingly, the capital charge is written as $ß_2$ * EI. The general expression for the capital charge is therefore;

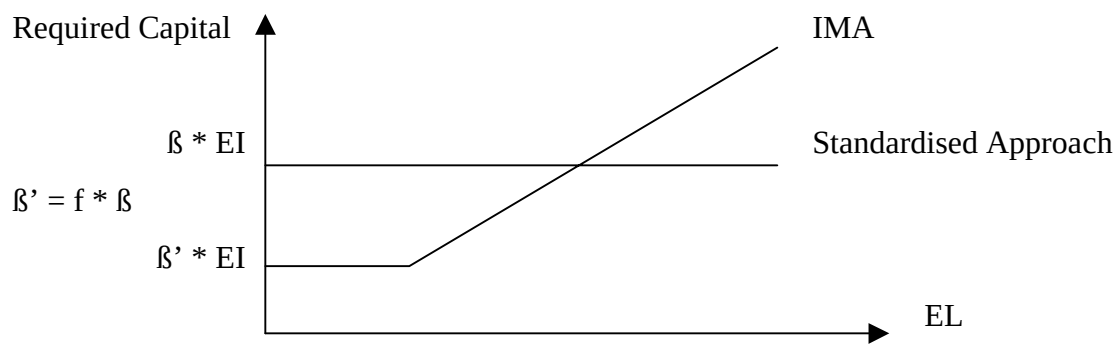
  - Required capital = max [λ * EL * $(1+A/\sqrt{n})$, $ß_2$ * EI] (5-2)

Sufficiency of EL (11)

- $ß_1$ * EI and $ß_2$ * EI can be interpreted in relation to the Standardised Approach under which EI is multiplied by certain factors.
- For the purpose of further simplification, formulae (5-1) and (5-2) can be combined by using a certain ß'.
  - Required capital = max [λ * EL * (1+A/$\sqrt{}$ n), ß' * GI]
  - In this formula, GI, the indicator under the Standardised Approach, is selected as EI.
  - When ß' = f * ß is assumed (ß is the multiplication factor in the Standardised Approach), f can be regarded as the floor for the IMA (in relation to the Standardised Approach).

Sufficiency of EL (12)

- Illustration



Stability of EL (1)

- The IMA formula (1-2) is based on the EL.
  - It should be ensured that in actual application the observed EL does not fluctuate from year to year.
  - However, when a loss is experienced, which is extremely large compared to the EL observed in the past, the EL will increase substantially, hence fluctuation of the required capital amount.

Stability of EL (2)

- Mean is vulnerable to extreme values. The method for calculating the average EL should therefore be robust or resistant enough to limit the influence from such extreme cases. An example of easy solution is “trimmed mean”.
- “Trimmed mean” is a method for calculating a mean based on the data consisting only of the data points within a $[1 - 2\alpha]$% range around the centre of the distribution. There are the following variations.
  - “Metric Trimming”: Influence of extreme values is removed by setting them at zero.
  - “(Metric) Winsorising”: All the extreme values are replaced with data points at $[\alpha]$% or $[1 - \alpha]$%.