Internal Measurement Approach to Operational Risk Capital Charge

(Discussion Paper)

Bank of Japan

Toshihiko Mori, Senior Manager
Eiji Harada, Financial Analyst

March 14th, 2001

Note: The authors intend to periodically revise the paper in order to incorporate on-going discussions with the industry.

Contents

1. Introduction

This paper summarizes the recent discussions on the regulatory framework for operational risk capital charge, incorporating various comments that the Bank of Japan (BOJ) has received since the authors published a discussion paper titled "Internal Risk Based Approach[1]" on the website of BOJ in August 2000 (August paper).

In the first few sections of this paper, an evolutionary framework for operational risk measurement is briefly outlined, whose basic contents are almost the same as in the August paper. However, terminology and mathematical expressions used in this paper are slightly different from those used in the August paper, reflecting recent dialogues between the industry and supervisors. (For example, an approach that was previously called "Internal Risk Based Approach" in the August paper is now called "Internal Measurement Approach" in this paper[2].)

Then, the next few sections focus on the structure of the Internal Measurement Approach (IMA). While the concept of the measurement approach has already been explained in the August paper, this paper describes elements related to the approach as specifically as possible, including the definition of operational loss, methods of parameters estimation, calibration of supervisory scaling factors, and the structure of loss database.

Furthermore, a simplified method on how to incorporate risk mitigation effect by insurance in the regulatory framework is proposed in the final sections. In developing the concept, the authors have conducted various researches on this matter cooperating with professionals from both banking and insurance industry, including actuaries.

2. Outline of evolutionary framework

As discussed in the August paper, an evolutionary framework that consists of four stages is now being considered under the Pillar 1 capital charge of the New Basel Accord (minimum regulatory capital charge pillar). The outline of each of four approaches is as follows.

Firstly, in the **Basic Indicator Approach**, the required capital is determined by multiplying a financial indicator, such as gross income, by a fixed percentage ('alpha' factor). Secondly, in the **Standardised Approach**, a bank would divide its activities into a number of standardised business lines. Within each business line, the required

---

1 " Internal Risk Based Approach, -- Evolutionary Approaches to Regulatory Capital Charge for Operational Risk" by Toshihiko Mori and Eiji Harada, August 2000. (http://www.boj.or.jp/en/ronbun/ronbun_f.htm).

2 The name of the approach has been changed in order to avoid confusion between the Internal Risk Based approach for operational risk, which is called IRB as an acronym, and the Internal Ratings Based approach for credit risk, which is also called IRB as an acronym.

capital is calculated by multiplying an indicator, such as gross income or asset size of the business line, by a fixed percentage ('beta' factor). The total capital charge will be the simple sum of the required capital across each of business lines. These two approaches are regarded as "one-size-fits-all" type concept, in a sense that these approaches assume that each unit of indicator is exposed to the same degree of risk regardless of a bank's level of risk management and control[3].

The third approach, the **Internal Measurement Approach**, is developed so as to directly capture a bank's underlying risk by using the bank's internal loss data as key inputs for capital calculation. In this approach, operational risk is categorized based on a matrix of business lines and event types, which would also be standardised by supervisors. To calculate the required capital, a bank would estimate elements of Expected Loss Amount (ELA) of each of cells in the matrix of business lines and event types, based on its internal loss data. Then, the required capital within each business line and event type combination will be calculated by using these elements the ELA and a fixed parameter ('gamma' factor). It is also proposed to use a Risk Profile Index (RPI), which reflects the differing risk profile of individual bank's loss distribution, to adjust the required capital. The total capital charge will be the simple sum of the required capital across each of business line and event type combinations.

Finally, in the **Loss Distribution Approach**, a bank estimates frequency and severity distributions of its operational loss events, using its internal loss data, for each business line and event type combination. Based on the two distributions, the bank then computes the probability distribution of the cumulative operational losses over a holding period. The total required capital is the sum of the Value at Risk (VaR) of each business line and event type combination.

The first three approaches outlined above are those currently considered in the industry and by supervisors as a basis for the regulatory capital charge framework. The last approach is considered as a future option. Of course, the authors recognize that there exist other measurement approaches that may be more advanced than the four approaches outlined above. Among them is one that incorporates correlation effect between business lines and event types. Also, some sophisticated banks have been developing risk models that are devised to analyze causality of loss events or quality of control environment. While these advanced approaches are not addressed at this point,

[3] When developing the Basic Indicator and the Standardised Approaches, it should be needed to conduct further analysis on correlation between operational risk losses and indicators. These two approaches may give adverse incentive to banks and trigger regulatory arbitrage, because these two approaches charge unfairly excessive regulatory capital on a bank that manages its operational losses properly but has relatively large indicators.

the authors will continuously examine the possibility of developing these approaches as a future option and the way to evaluate these methods under the Pillar 2 of the New Capital Adequacy Framework (supervisory review pillar).

To summarize, here are the mathematical expressions of the four approaches.

- Stage 1: Basic Indicator Approach

  Required capital = α * Indicator
- Stage 2: Standardised Approach

  Required capital = Σi [β(i) * Indicator(i)]
- Stage 3: Internal Measurement Approach

  Required capital = Σi Σj [γ (i,j) * ELA(i,j) * RPI(i,j)]

  (i is the business line and j is the event type)
- Stage 4: Loss Distribution Approach

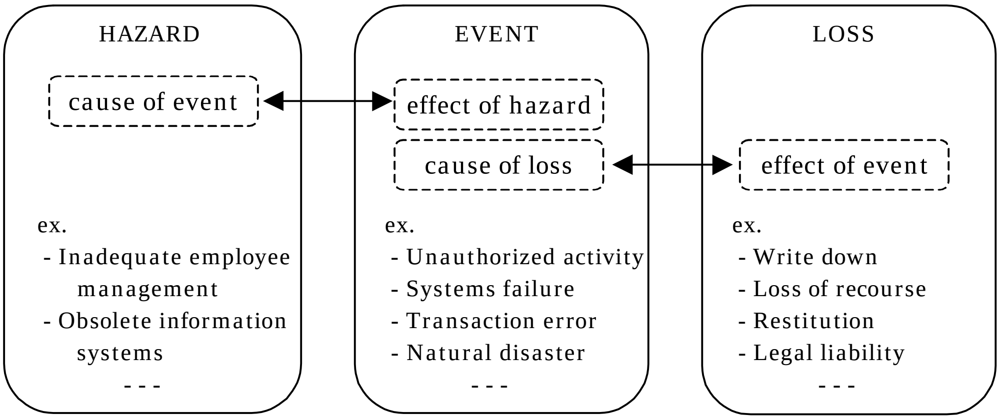
  Required capital = Σi Σj [f (frequency & severity distributions)]

3. Scope and categorization of operational risk

(1) Mechanism of loss occurrence

In order to define the scope of operational risk and specify the way to categorize operational risk, the mechanism of how operational losses would occur should be clarified. The authors propose that the process of the occurrence of operational loss could be described by a cause-effect relationship between <u>hazard</u>, <u>event</u>, and <u>loss</u>.

Chart 3-1: The process of loss occurrence



LOSS:	a P&L loss
EVENT:	a single incident that leads directly to one or more effects
HAZARD:	one or more factors that increase the probability of occurrence of an event

As shown in the chart, "loss" is effect of "event" while "event" is cause of "loss". Also, "event" is effect of "hazard" while "hazard" is cause of "event". In other words, every loss must be associated with an event that caused the loss, while every event must be associated with one or multiple hazard(s) that caused the event. For example, imagine a case where "a poor employee management induced a delivery failure, which resulted in a write-down." In this case, "a poor employee management" was regarded as a "hazard", while "a delivery failure" and "a write-down" correspond to "event type" and "loss type", respectively.

In developing the way to categorize operational risk, the authors examined types of hazard, event, and loss, and reached the following proposals:

- Define the scope of operational risk based on the matrix with both "event type" and "loss type" dimensions.
- Categorize operational risk based on "event type" dimension for the purpose of risk measurement in the Internal Measurement Approach.
- Identify both "event type" and "loss type" when recording loss data.

(2) Scope of operational risk

A common industry definition of the scope of operational risk is as follows: "The risk of direct or indirect loss resulting from inadequate or failed internal processes, people and systems or from external events." Although it is not clear whether "internal process, people, system, and external event" correspond to hazards or event type, this statement tries to broadly define the scope of event types that should be addressed in the regulatory framework of operational risk capital charge. It is noted that the scopes of credit and market risks are defined in a similar way. Namely, when determining whether a loss is included in the scope of credit or market risk, it is needed to examine type of the event that caused the particular loss. The following examples help us understand this concept:

Case 1: a reduction in the value of a bond due to a change in the market price.

Case 2: a reduction in the value of a bond due to the bankruptcy of the issuer

Case 3: a reduction in the value of a bond due to a delivery failure.

In these cases, "effect" of the events, or loss types, were "write down" of the bond. By focusing on event type dimension, however, a bank could identify whether the loss should be included in the scope of market, credit, or operational risk.

(3) Loss data recording

When recognizing the occurrence of an operational loss, a bank needs to measure the loss amount and record the loss event in the bank's loss database. Although a detailed explanation on the structure of the database will be described later in this paper, the authors would like to emphasize at this point that both the event type and the loss type should be identified and recorded in the database. The following chart shows an example of the matrix of event type and loss type dimensions.

Chart 3-2: Example of event and loss type matrix

Effect-base Loss Type / Event Type	Write-downs	Loss of recourse	Restitution	Legal liability	Regulatory & compliance (inc. taxation)	Loss or damage to assets
Unauthorized activity						
Theft and fraud						
- - -						
- - -						
Event types will be finalized soon						
- - -						
- - -						
- - -						
- - -						

The scope of operational risk:
"The risk of direct or indirect loss resulting from inadequate or failed internal processes, people and systems or from external events."

It is noted that, there are some cells in the matrix where operational losses might not occur. Supervisors plan to develop standardized guideline on how to measure the loss amount for each of the cells in the matrix, in order to promote consistency across banks in terms of loss measurement. Please also see Annex 1 and Annex 2 (to be released soon) for more detailed mapping of loss types and event types.

(4) Risk measurement

In the Internal Measurement Approach, operational risk would be divided into not only a number of business lines but also a number of event types, so that the scheme can better address differing characteristics of operational risk in each cell.

While both event type and loss type should be identified when recording loss data, it is proposed that operational risk is categorized based on <u>event type</u> for the purpose of <u>risk measurement</u>. This is because event types can be identified objectively in a consistent manner across banks. Although causality (or hazard) analysis may be appropriate for the purpose of <u>risk analysis</u> as it allows banks to examine the ways to manage and reduce operational losses, the recent industry survey showed that causal modeling of operational risk is still in a developing stage at this point. Of course, it is not intended to discourage banks to further improve analytical tools based on causality dimensions.

4. Structure of Internal Measurement Approaches

(1) Feature of the Internal Measurement Approach

The primary objective of introducing the Internal Measurement Approach in the evolutionary framework is to give a bank an option to use a scheme that is risk sensitive and comparable among banks but not too much complicated. To achieve this objective, the Internal Measurement Approach provides individual banks with discretion to use internal loss data to reflect a bank's own risk profile, while the method to calculate the required capital is uniformly set by supervisors to preserve simplicity and comparability across banks.

Comparison between the lists of approaches to regulatory capital for credit and operational risks brings a clear view on the necessity of the Internal Measurement Approach between the Standardised Approach and the Loss Distribution Approach. As for the framework for credit risk capital charge, firstly there is the current accord. Secondly, there is the Standardised approach, in which external credit ratings will be used. Thirdly, there is the Internal Ratings Based (IRB) approach, in which individual bank's internal credit assessment will be used. And finally, there is the Credit Risk Modeling approach as a future option. In this context, the Internal Measurement Approach for operational risk is positioned as equivalent of the IRB approach for credit risk, in a sense that both approaches allow banks to use their own estimation of parameters, namely elements to produce Expected Loss, while supervisory scaling factors are applied in deriving the capital charge from these estimated parameters.

Chart 4-1: Overview of approaches

- Credit Risk

Names	Current Accord	Standardised approach	Internal Ratings Based approach	Credit Risk Modeling approach

- Operational Risk

<table>
<tr><td rowspan="2">Names</td><td colspan="2">Top-down approach :
(Allocate a certain proportion of current capital to ope. risk)</td><td colspan="3">Bottom-up approach :
(Estimate operational risk based on <u>actual internal loss data</u>)</td></tr>
<tr><td>Basic Indicator approach</td><td>Standardised approach</td><td>Internal Measurement approach</td><td>Loss Distribution approach</td><td>Modelling approach</td></tr>
<tr><td rowspan="2">Business lines and risk types</td><td rowspan="2">Single business line</td><td>Multiple business lines</td><td colspan="3">Multiple business lines and event types</td></tr>
<tr><td colspan="2">Standardised by supervisors</td><td colspan="2">Bank discretion</td></tr>
<tr><td>Structure</td><td colspan="3">Σ { Coefficient * Indicators }</td><td colspan="2" rowspan="4">Estimate Opeational VaR based on frequency and severity distributions</td></tr>
<tr><td rowspan="3">Parameters to be input</td><td rowspan="2">One exposure indicator (EI)</td><td colspan="2">Multiple EIs by business line</td></tr>
<tr><td></td><td>PE, LGE and RPI</td></tr>
<tr><td colspan="3">Standardised by supervisors</td></tr>
</table>

(2) Method of capital calculation

Under the IMA, a bank's required capital for the operational risk would be determined based on the following procedures. (Elements of the capital calculation will be explained in more detail in the following sections.)

- The bank would estimate an Expected Loss Amount (ELA) of each cell in the matrix of business lines and event types. In estimating ELA, the bank would supply an Exposure Indicator (EI) for each business line, and would estimate Probability of loss Event (PE) and Loss Given Event (LGE) for each of business line and event type combinations. The product of EI, PE, and LGE produces the ELA.
- The required capital for each business line and event type combination would be calculated by multiplying the ELA and the gamma (γ) factor. The gamma factors may be different across business lines and event types, but the same gamma factors will be applied across firms.
- It is also proposed to use Risk Profile Index (RPI) as an adjustment factor to capture the differing risk profile of loss distribution of individual banks. The overall capital charge for the bank is the simple sum of all the resulting products. This can be expressed in the following formula:

$$\text{Required capital} = \Sigma i\ \Sigma j\ [\gamma(i,j) * ELA(i,j) * RPI(i,j)]$$
$$= \Sigma i\ \Sigma j\ [\gamma(i,j) * EI(i,j) * PE(i,j) * LGE(i,j) * RPI(i,j)]$$

(i is the business line and j is the event type)

Chart 4-2: Example of capital charge calculation process under the Internal Measurement Approach

		event type A	event type B	event type C	event type D	Total
Business line A	Expected Loss (= EI*PE*LGE)	8	10	6	6	30
	Gamma Factor	5	2	5	10	
	RPI	1.0	1.0	1.6	0.7	
	Capital Charge	40	20	48	42	150
Business line B						100
:	:					:
Total						600

(3) Categorizations of business lines

It is proposed that the same of business line categorization would be used under both the Internal Measurement Approach and the Standardised Approach. By having consistent business lines in both approaches, banks are encouraged to progress towards more advanced approaches on a business line by business line basis. It is intended that such framework provides a bank a proper incentive to invest in developing internal systems, including loss database, step by step on a business line by business line basis, based on cost-benefit analysis or materiality of each of its business lines. Although the regulatory framework would specify the standardized business lines, it should be noted that banks could keep their current business lines as they are when applying the regulatory framework. What they need to do is "mapping" of their business activities from their own business lines into the standardized business lines. The chart below shows an example of the standardised business lines. Please also see Annex 3 for a more detailed mapping of business lines (to be released soon).

Chart 4-3: Example of business lines

Investment banking	Corporate finance
	Trading & sales
Banking	Retail banking
	Commercial banking
	Payment & settlement
	Agency services
Others	Asset management
	Retail brokerage
	(Insurance)

(4) Decomposition of ELA

The most significant feature of the Internal Measurement Approach compared to the other two basic approaches is that the Internal Measurement Approach allows banks to use its internal loss data to estimate ELA, which in turn serves as a primary input for the capital charge calculation. To calculate the ELA, banks are required to provide EI, PE, and LGE.

$$ELA(i,j) = EI(i,j) * ELR(i,j)$$
$$= EI(i,j) * PE(i,j) * LGE(i,j)$$

EI: Exposure Indicator

ELR: Expected Loss Ratio

PE: Probability of loss Event

LGE: Loss Given Event

Exposure Indicator:

- Exposure Indicator (EI) is the proxy for the size of operational risk exposure. It is proposed that the same EI will be used under both the Standardised Approach and the Internal Measurement Approach for each business line. Therefore, types of EIs must be carefully chosen so that an EI for a certain business line would have a significant positive correlation to operational risk of the business line.

ELR, PE and LGE:

- The expected loss ratio (ELR) represents the ratio of the expected loss amount to the EI. The ELR is further decomposed into Probability of loss Event (PE) and Loss Given Event (LGE). These parameters are defined in such a way that the product of EI, PE, and LGE produces the ELA.

Please see Annex 4 (to be released soon) for the authors' preliminary proposal on the definition of EI by business line. Numerical examples shown below explain the relationship between these parameters.

Chart 4-4: Numerical examples of parameters

Transactions

	Number		Amount
	1	*	20
	1	*	30
	1	*	10
Total	3		60
Average			20

Losses

	Number		Amount
	1	*	10
Total	1		10
Average			10

Gross income	=	3
Asset size	=	600
Nuber of accounts	=	6

(Case 1) define EI based on “flow” of business activities:

- Example of business lines: Payment and settlement, etc
- Example of definition of parameters:

  EI = volume of transactions[4] = 60

  PE = the number of loss events / the number of transactions = 1 / 3

  LGE = average loss amount per event / average volume per transaction = 10/20
- Then, EI * PE * LGE = 60 * 1/3 * 10/20 = 10 = total loss amount

(Case 2) define EI based on “revenue” of business activities

- Example of business lines: Investment banking, etc.
- Example of definition of parameters:

  EI = gross income = 3

  PE = the number of loss events / the number of transactions = 1 / 3

  LGE = average loss amount per event / average gross income per transaction = 10/1
- Then, EI * PE * LGE = 3 * 1/3 * 10/1 = 10 = total loss amount

(Case 3) define EI based on “outstanding balance” of business activities:

- Example of business lines: Asset management, etc
- Example of definition of parameters:

  EI = value of assets under management = 600

  PE = the number of loss events / the number of accounts = 1 / 6

  LGE =average loss amount per event / average asset value per account = 10/100
- Then, EI * PE * LGE = 600 * 1/6 * 10/100 = 10 = total loss amount

As shown above, the ELA is basically decomposed into three elements, namely, EI, PE and LGE. However there may be event types that would lead loss effects without being associated with any transactions. For example, when measuring losses lead by the event type of “natural disaster”, it may not be appropriate to use “transaction amount” as the base of the risk exposure. Therefore, for such event types, it is proposed to directly calculate the ELR rather than decomposing it into PE and LGE. In this case, the definition of parameters will be developed as follows. (These examples are described using the same numerical examples as used above).

(Case 1)

- EI = volume of transactions = 60
- ELR = total loss amount / volume of transactions = 10 / 60

---

[4] If comprehensive data that covers all business activities of the firm over a certain time period is not available, sampling data could be used, subject to minimum standard and supervisory review process.

- EI * ELR = 60 * 10/60 = 10 = total loss amount

(Case 2)

- EI = gross income = 3
- ELR = total loss amount / gross income = 10 / 3
- EI * ELR = 3 * 10/3 = 10 = total loss amount

(Case 3)

- EI = value of assets under management = 600
- ELR = total loss amount / value of assets under management = 10 / 600
- EI * ELR = 600 * 10/600 = 10 = total loss amount

It is noted that exposure indicators based on asset size may bring about the problem of double counting of credit and operational risks, because asset size is also used as the base of the capital charge for credit risk. This problem will become critical especially when asset size is used as the exposure indicator for retail and commercial banking business lines under the Standardised Approach. If the capital charge for operational risk under the Standardised Approach would be calculated based on a certain percentage of asset size in these business lines, this would just generate a replication of the capital charge under the current accord. Therefore, considering that the capital charge for operational risk was introduced in order to capture risks unrelated to credit risk, asset size should not be used as the base of exposure indicators.

(5) Internal estimation of parameters

When a bank estimate PE and LGE for each of business line and event type combinations, historical data of its internal losses should be used as a primary input. Supervisors plan to develop a set of standardized rules for the process of parameter estimation, which include methodologies on how to exclude an extreme sample or how to ensure a safety buffer in the statistical estimation.

In addition to historical data, it is proposed to adjust estimation of PE and LGE by using external loss data and quality assessment so that these parameters can be estimated in a “forward-looking” way.

Adjustment by external data:

If the bank could obtain a statistically significant number of loss events, it can be regarded that the historical average of PE and LGE can be approximately equal to “true” mean of PE and LGE. However, there may be a situation where a bank could not obtain enough number of internal loss data that would allow a statistically robust estimation within a certain business line and event type combination. This situation could happen because, for example, a bank with better risk control would experience a smaller number of loss events. In this case, the bank needs to combine its internal data and "the industry wide loss data" to have robust estimations of PE and LGE. (Further discussion on the industry wide loss data will be developed later in this paper.) Again, supervisors would plan to standardize rules on how to incorporate the industry wide loss data in the calculation process[5]. For example, a simplified formula as follows could be used.

$$PE = w * PE_{(internal)} + (1-w) * PE_{(industry)}$$

PE : PE that will be used as input for capital calculation

$PE_{(internal)}$: PE calculated based only on the bank's internal loss data

$PE_{(industry)}$: PE calculated based on the industry wide loss data

In the formula above, "w" is a weighting factor, which will be specified by supervisors. The parameter "$PE_{(industry)}$" should be equal to the average of PE within the industry, which will also be specified by supervisors. While these supervisory parameters should be figured out at least before the time of the final agreement of the New Capital Accord, these parameters might be revised as the industry and supervisors develop more robust loss database. It is also proposed to set a minimum level, or "floor", of PE and LGE parameters, in order to ensure the conservativeness of the resulting capital charge.

It is noted that the concept of "extrapolation of <u>the expected loss</u> using the industry wide loss data" and the concept of "extrapolation of <u>the unexpected loss</u> using the industry wide loss data" should not be confused with each other. The former is the one that is discussed in this section. In other words, at an individual bank level, information derived from the industry wide loss data will be used not to draw a tale of the distribution but to complement the estimation of the mean of the distribution. Extrapolation of a tale of the distribution is addressed in the process of calibrating gamma factors by supervisors, which will be discussed in the next section. That is, as gamma factors are determined using the industry wide loss data so that the resulting capital charge would cover a certain confidence level, the capital charge could be considered to cover an extreme loss event which may not always be experienced by each individual bank.

---

[5] When estimating PDs under the Internal Ratings Based approach to credit risk, banks will be allowed to use external data by rating agencies, such as Moody' sand S&P, in combination with their internal default data, subject to supervisory review. Rules for internal estimation of operational risk parameters could be developed along the line with the rules for the credit risk IRB.

Adjustment by quality assessment:

For example, suppose a bank has made a significant investment to improve its internal risk management systems. In such situation, its historical mean of PE and LGE might not appropriately predict its future PE and LGE. This is the primary motivation to incorporate the adjustment by the quality assessment in the regulatory capital charge. It is noted that a similar concept is also adopted in credit risk measurement. For example, it is proposed that probability of default (PD) for the Internal Ratings Based approach to credit risk must be estimated in a forward-looking way[6]. In order to keep comparability across banks and ensure level playing field, it is needed to develop rigorous criteria on how to incorporate quality assessment in the regulatory capital calculation. Supervisors plan to further discuss this issue with the industry.

While recognizing the necessity of quality adjustment, the authors also recognize the difficulty in developing the methodology to figure out the exact amount of capital adjustment associated with the quality assessment. This is the case not only in operational risk measurement but also in credit risk measurement. For example, suppose a bank has built up staff for defaulted loan management. It is expected that this strategy would improve the bank's recovery rate of defaulted loan compared to its historical average of the recovery rate. However, it is not easy to objectively quantify the exact figure of difference in the recovery rate between before and after the reorganization.

(6) Calibration of alpha, beta, and gamma factors

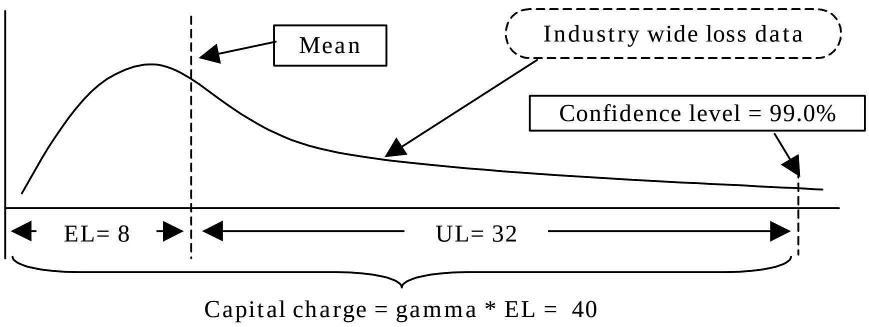
In the three measurement approaches (i.e. the Basic Indicator, the Standardised, and the Internal Measurement Approaches), supervisory vectors (alpha, beta, gamma factors) will be used to calculate the capital charge. More specifically, in the Internal Measurement Approach, supervisors will set forth gamma factors, which will be applied across banks to transform the ELA into risk or capital charge, for each of business line and event type combinations. In determining specific figures of alpha, beta, and gamma factors, supervisors will adopt two methodologies, namely, "a calibration method based on maximum-loss analysis (bottom-up approach to calibration)" and "a calibration method based on absolute-capital analysis (top-down approach to calibration)."

Firstly, in the calibration method based on maximum-loss analysis, supervisory vectors will be determined so that the resulting capital charge would cover the maximum loss

[6] It is proposed that " PD estimates must represent a conservative view of a long-run average PD" and " these estimates must be forward looking." See paragraph 270 of " Consultative Document, The New Basel Capital Accord."

amount per a certain holding period (e.g. 1 year) within a certain confidence level (e.g. 99%). To find appropriate gamma factors of the internal Measurement Approach that would ensure this capital coverage, supervisors plan to develop a industry wide distribution of operational losses and measure the ratio of the unexpected loss (UL) to the expected loss (EL) of the distribution. The following chart, which refers to the same numerical examples as is used in the previous sections, shows this relationship[7]. Please see Annex 5 (to be released soon) for more detailed explanations on how to calibrate the gamma factors using this method.

Chart 4-5: Statistical expression of capital charge



Secondly, in the calibration method based on absolute-capital analysis, supervisory vectors will be determined so that the resulting capital charge will correspond to a certain percentage of the regulatory capital charge under the current capital accord on average. As described in the consultation document of "the New Basel Capital Accord" issued in January 2001, the Basel Committee intends that the New Basel Capital Accord should at least maintain the current overall level of capital in the international banking system, while it also intends that a bank with better risk control would be rewarded by a reduction in the regulatory capital charge. To materialize this incentive structure in the evolutionary framework, supervisory vectors of the three measurement approaches should be figured out in such a way that, on average, a bank would be charged a lower regulatory capital when moving towards more advanced approaches. For example, it is proposed that "20% of the current regulatory capital" would be used as a basis for allocating capital charge to operational risk under the Standardised Approach, and that a figure smaller than 20% would be used as a basis for capital charge under the Internal Measurement Approach.

[7] In this paper, the capital charge is assumed to cover both EL and UL. Further analysis should be conducted to examine whether expected losses are provisioned in financial accounting, and they are taken into account in pricing strategy.

In this analysis, supervisors would plan to compare the actual level of absolute capital under the three measurement approaches using the actual data. More specifically, supervisors will collect the actual indicators and loss data in consultation with the industry, and apply the actual data to supervisory vectors (alpha, beta, and gamma factors) derived from the calibration method based on maximum-loss analysis. Based on this comparison, the supervisory vectors may be modulated so that there is an appropriate slope in terms of the capital charge under the three measurement approaches. For example, gamma factors would be adjusted if the calibration method based on maximum-loss analysis would produce gamma factors largely different from the factors produced by the calibration method based on absolute-capital-level analysis.

In collecting the loss data for this analysis, it is noted that supervisors should use not only loss data reported by those banks capable of collecting internal loss data but also publicly available loss data source which covers loss data from banks that cannot internally collect loss data. In other words, the group of sample banks should comprise not only those banks that will apply for the Internal Measurement Approach but also those banks that will not use the Internal Measurement Approach. This is because, the expected loss amount among banks with better risk control and internal loss data at hand, which may apply for the Internal Measurement Approach, is obviously smaller than the true mean of loss amount in the industry as a whole. Calibration of gamma factors using only loss data from those sophisticated banks may result in gamma factors that are biased toward larger figures. Supervisors will examine the way to incorporate publicly available loss data source in the calibration process in order to avoid such a biased calibration.

One another point to mention regarding the calibration of supervisory vectors is the necessity of correlation analysis between indicators and operational risks. As shown in the evolutionary framework, in the Basic Indicator and the Standardised Approaches, the capital charge is calculated by multiplying indicators, such as gross income and asset size, by alpha and beta factors, respectively. The industry wide loss data will also be used to check whether these indicators and operational losses are correlated with each other. If the degree of the correlation is not significant, alpha and beta factors should be determined on the basis of a conservative assumption.

Therefore, the calibration of alpha, beta, gamma factors should be determined simultaneously using the industry wide loss data. Here is the timeline currently considered by supervisors:

Stage 1: by the end of 2001

- Conduct a preliminary survey on indicators and loss data (by fall 2001)

- Establish a preliminary set of supervisory vectors, such as alpha, beta, and gamma

Stage 2: by the end of 2002

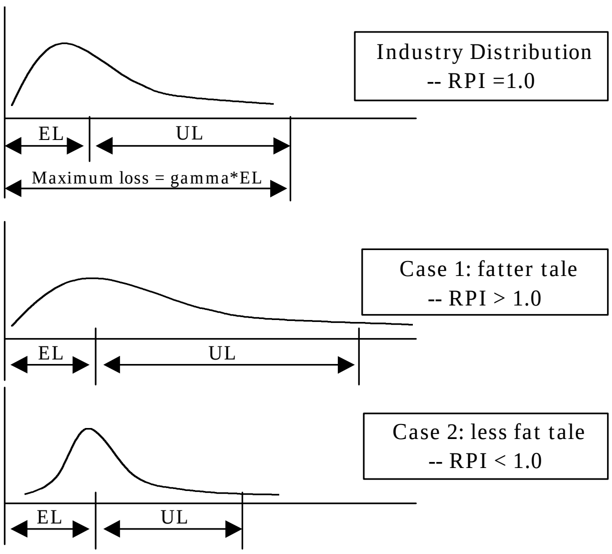
- Conduct more detailed survey on indicators and loss data
- Finalize the supervisory vectors, such as alpha, beta, and gamma

(7) Risk Profile Index

As explained in the previous sections, the structure of the Internal Measurement Approach assumes a linear relationship between the unexpected loss and the expected loss. Based on this assumption, supervisors plan to use an industry wide loss distribution to determine regulatory specified gamma factors, which will be applied across banks to transform the ELA into a bank's capital charge

However, the ratio of UL to EL of each bank may not always be the same as that of industry wide loss distribution used for determination of gamma factors. To make up for the weaknesses of the assumption of linearity, it is proposed to use Risk Profile Index (RPI) to adjust the capital. The RPI will be devised to reflect the ratio of UL to EL of the individual bank's loss distribution compared to that of the industry wide loss distribution. This feature is shown in the chart below.

Chart 4-6: Risk Profile Index



As shown in the chart, by definition, the RPI of the industry loss distribution is 1.0, as the γ term is determined using the industry wide loss distribution. On the other hand, the RPI for a bank with fatter tale distribution is larger than 1.0 (case 1), while the RPI for another bank with less fat tale distribution is smaller than 1.0 (case 2). The overall capital charge for a particular bank with RPI adjustment can be expressed in the following formula:

Required capital = Σi Σj [γ (i,j) * EI(i,j) * PE(i,j) * LGE(i,j) * **RPI(i,j)**]

(i is the business line and j is the event type.)

To ensure the comparability across banks, the formula to calculate the RPI of each bank would be standardized by supervisors.

(8) Formula to calculate the RPI

When measureing operational risk in a statistical method, a distribution of the severity of losses and a distribution of the frequency of losses would be analyzed. As the RPI is intended to materialize the essence of the risk sensitivity of such statistical analyses, a definitive formula of the RPI consists of two elements; namely, one that approximates the severity of operational losses and the other that approximates the frequency of operational losses. This is expressed as follows.

$RPI = K*(1+ RPI_1 * RPI_2)$

K: an adjustment factor, by which the resulting RPI for a bank with "average" risk profile is equal to 1.

RPI_1: an element of RPI that approximates the severity of operational losses

RPI_2: an element of RPI that approximates the frequency of operational losses

Firstly, RPI_1 is defined to capture the characteristics of the severity distribution of loss event. In practice, however, it may be difficult to capture the characteristics of the distribution of loss severity by directly observing the actual loss amount of each loss event, because the number of loss events may not be large enough. To solve this issues, the authors propose a formula that focuses on the distribution of the size of exposure indicators (EIs) instead of directly observing the loss severity, assuming that the distribution of EIs, such as transaction amounts, could be regarded as a proxy of the distribution of loss severity. For example, it makes intuitive sense to assume that a bank with a number of small and evenly distributed transactions is less risky than another bank with unevenly distributed large transactions. This concept has already been incorporated in banking practices as banks usually limit the amount of cash withdrawal from ATMs per a day for the purpose of controlling operational risk. While there exist several formulae that could devise this concept, the following formula shows an example.

$RPI_1 = c(\sigma / \mu)$

c : Constant

σ : Standard deviation of exposure sizes

μ : Average of exposure sizes

The formula is designed in such a way that the resulting RPI_1 of a bank with evenly distributed transactions is small. This concept intends to incorporate the current banking risk management practices. For example, by introducing the RPI based on the distribution of transaction amount, an "ex-ante" incentive to manage transaction amounts could be incorporated in the regulatory framework so that a single operational loss event would not result in a significant operational loss, preventing perverse incentive to regulatory arbitrage.

Secondly, RPI_2 is defined to capture the characteristics of the <u>frequency</u> distribution of loss event. This method assumes that the ratio of UL to EL would be a decreasing function in terms of the number of loss events. The following definition can be derived using a mathematical development with some assumptions[8].

$$RPI_2 = 1/\sqrt{n}$$

n: Number of loss events

In conclusion, RPI can be described as follows.

$$RPI = K*(1+ RPI_1 * RPI_2)$$
$$= K*(1+c*(\sigma /\mu) / \sqrt{n})$$

The authors plan to consult with the industry to solve practical issues to implement RPI_1 and RPI_2 in the regulatory framework[9]

(9) Loss database

As described in the previous sections, operational loss database will play a key role to implement the three measurement approaches at both individual bank level and the industry wide level. At individual bank level, a bank needs to develop an internal framework to collect internal operational loss data, as the data will be used as a basis for estimating parameters for capital calculation, such as PE and LGE. This framework includes both organizational structures necessary to report the data to a central unit and database system necessary to collect and store the data.

On the other hand, the industry wide loss database, which is developed based on a standardized definition of business lines and event types, will play a key role in two aspects. Firstly, <u>individual banks will use the industry wide loss data</u> to complement their internal loss data in estimating parameters. Secondly, <u>supervisors will use the industry wide data</u> when calibrating alpha, beta, and gamma factors of the three approaches. To conduct a preliminary calibration of supervisory vectors, supervisors

---

[8] This concept assumes that UL is defined as a multiple of the standard deviation and that the frequency distribution is a Poisson distribution. Please refer to " The Internal Measurement Approach to Operational Risk Regulatory Capital Charge, by Industry Technical Working Group on Operational Risk (ITWGOR), October 2000" for further analysis on this mathematical expression.

[9] For example, a bank needs to process a large number of transaction data to calculate the RPI_1, and

would plan to develop a preliminary industry wide loss database during the first half of year 2001. Most internationally active banks would be encouraged to participate in the process of developing the database. It could be expected that banks participating in the process of loss data collection for the calibration effort would form the first group of banks that would be approved to use the Internal Measurement Approach at the time of implementation of the New Capital Adequacy Framework.

It is noted that loss data pooling may entail issues related to privacy obligations and litigation risk. In order to provide a solution to these issues, supervisors could serve as a central data gathering point in data pooling efforts.

The authors believe that, at least in an early stage, standardization of the methods of data collection would promote the development of database in a consistent manner at both an individual bank level and the industry wide level. As a first step of these efforts, the authors propose a preliminary set of data items, which consist of “core” and “supplementary” elements. Banks are encouraged to record these data items of each of its loss events. It is intended that “core information” should include data items that are necessary for deriving the Expected Loss Amount.

Chart 4-7: Example of necessary information for each loss event

Core information	Supplementary information
• Reference number • Date of reporting • Date of occurrence • Business line (level 1) • Event type (level 1) • Gross loss amount by each loss type • Amount of recovery by each loss type (excluding insurance recovery) • The volume of transaction involved in the event	• Amount of insurance recovery by each loss type • Business line (level 2 & 3) • Event type (level 2 & 3) • Description of event, etc

It is noted that the list of data items described in the chart above is just an example of minimum requirement. Each individual bank is encouraged to add necessary elements based on its practical experience for the purpose of its own risk management.

Again, the industry wide loss data, which is developed on the foundation of loss data collecting effort at individual banks level, is a prerequisite for the calibration of the Basic Indicator, the Standardised, and the Internal Measurement Approaches.

5. Definitive formula

As explained so far, <u>the IMA basically assumes a linear relationship</u> between expected

there needs to be some sufficient number of losses to calculate the RPI_2.

loss and maximum loss, while adjustment by RPI is used to capture elements of non-linearity. One way to better address the nature of non-linearity of operational risk is to use a generalized function of PE, or f(PE), in exchange for the linear function of PE.

- Existing formula based on the linearity assumption:

  Risk $= \gamma * ELA * RPI$

  $= EI * [\gamma * PE] * LGE * RPI$

- An definitive formula with a generalized function of PE:

  Risk $= EI * f(PE) * LGE * RPI$

The generalized function f(PE) converts PE to Operational Risk Ratio (ORR). It can be interpreted that the existing formula is one example of the latter formula, where a linear function $[\gamma * PE]$ is substituted for f(PE) in order to make the scheme simple. Based on statistical analyses, the authors have found that the formula would generate precise approximation of economic risk by expressing f(PE) in the same way as "risk weight function" used in the Internal Ratings Based approach to credit risk[10]:

$$f(PE) = N(a_1 * G(PE) + a_2)$$

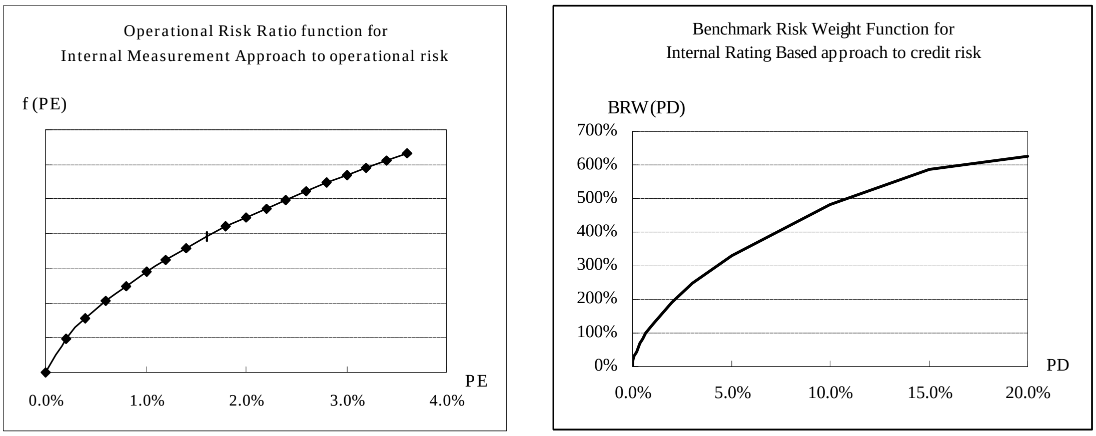
a_1 and a_2: constants

where N(x) denotes the cumulative distribution function for a standard normal random variable (the probability that a normal random variable with mean zero and variance one is less than to equal to x), and where G(z) denotes the inverse cumulative distribution function for a standard normal random variable (i.e. the value x such that N(x)=z). The following table shows the relationship between PE and f(PE) based on the formula.

[10] In the Internal Ratings Based approach to credit risk, a formula with the cumulative distribution functions is proposed by the Basel Committee to convert PD to risk weight as follows:

$$BRW(PD) = 976.5*N(1.118*G(PD)+1.288)*(1+0.0470*(1-PD)/PD^{0.44})$$

Chart 5-1: Graph to convert PE to Operational Risk Ratio (figures are just examples)



By using the operational risk function in exchange for the linear function, the structure of the Internal Measurement Approach would have more similarity to the structure of the Internal Ratings based approach to credit risk. The following chart shows the comparison of both structures

Chart 5-2: Elements of “operational risk IMA” and “credit risk IRB”

Operational risk of IMA (definitive formula)	Credit risk IRB
EI	EAD
f(PE)	f(PD)
LGE	LGD
RPI	GI

6. Insurance risk mitigation

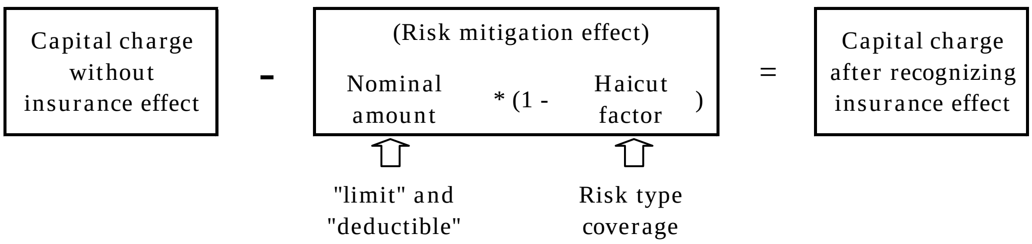
(1) Background discussion

In developing the methodologies to quantify insurance risk mitigation effects in the regulatory capital charge framework for operational risk, several issues must be taken into account. Firstly, the scheme must be comparable and simple so that the amount of capital reduction by insurance can be quantified without using any “modeling” methodologies. Secondly, the scheme must be risk sensitive. In other words, the reduction in the capital charge must be commensurate with the reduction in individual bank’s underlying risk. Thirdly, the framework must be designed in such a way that it would not induce moral hazard, adverse selection, or regulatory arbitrage. Keeping these issues in mind, the next section describes a concrete methodology to incorporate insurance risk mitigation effect in Pillar 1 capital charge.

(2) Methodology

The process of determining the amount of risk mitigation by insurance is divided into three steps. Firstly, a bank would determine the amount of "capital charge without insurance effect" using a measurement approach in the evolutionary framework. Secondly, the bank would calculate the amount of regulatory recognition of capital reduction. In this step, the bank would firstly calculate "nominal" amount of capital reduction by applying a supervisory formula to "limit" and "deductible" amount of an insurance contract that the bank is engaged in. Then, based on event type coverage by the insurance contract, a supervisory "haircut" factor would be applied. Finally, the bank would determine the amount of "capital charge after the recognition of insurance effect" by simply subtracting the amount of insurance risk mitigation effect from the amount of capital charge without insurance effect.

Chart 6-1: Process of recognizing insurance risk mitigation effect

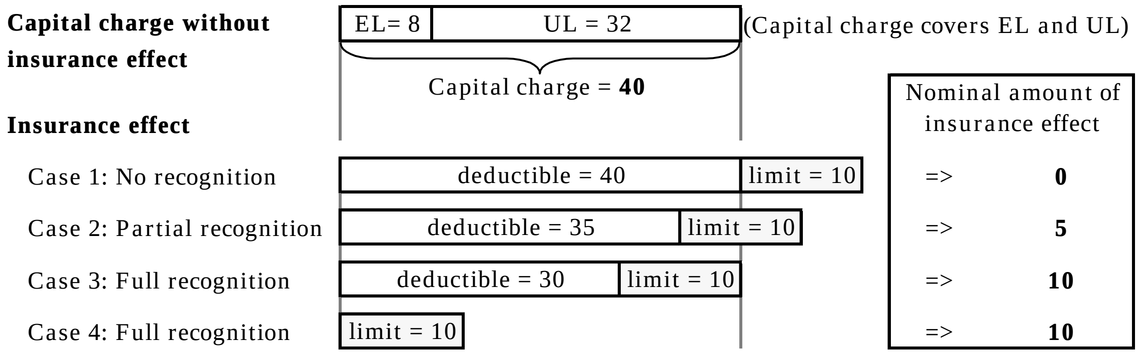


This methodology could be applicable not only to the Internal Measurement Approach but also to the Basic Indicator Approach and Standardised Approach. More precisely, in the context of the Internal Measurement Approach, the capital charge with insurance effect would be calculated by business lines and event types, while it would be calculated only by business lines in the Standardised Approach and by bank total basis in the Basic Indicator Approach. As the framework without the dimension of event types must result in a low level of precision, which is explained in the next section, much larger haircut factors may be imposed when applying the insurance risk mitigation effect under the two basic approaches from the conservative point of view.

(3) Nominal amount of capital reduction

The regulatory capital charge is basically set forth to cover the maximum loss within a certain confidence level (e.g. 99%). As such, the nominal amount of capital reduction is quantified by focusing on the degree to which risks within the confidence level is covered by the insurance contract. The following chart shows an example of how this calculation works, taking the same numerical example used in the previous sections.

Chart 6-2: Examples of nominal amount of capital reduction



In the charts above, the capital charge for business line (A) without insurance effect is calculated to be $40. By definition, this means that the bank needs to maintain at least a capital of $40 in order not to lose its solvency even in the worst case that would happen once in every 100 years. Suppose that the bank enter into an insurance contract that covers operational risks, and both "limit" and "deductible" are stipulated by annual aggregated basis. The basic rule of the scheme is that insurance coverage beyond the confidence level is not recognized as the nominal amount of capital reduction under Pillar 1 but will be assessed in the context of Pillar 2. In case 1, the bank has a right to claim insurance money equal to the loss amount minus the deductible amount ($40), but the limit of insurance money is set to be $10. In this case, as the insurance contract covers risks beyond the confidence level of 99%, the banks needs to continue to maintain $40 to avoid bankruptcy. As such, there is no recognition of capital reduction in this case[11]. On the other hand, in case 2, if the bank suffers a loss of $40, it can receive insurance money of $5. This implies that the bank only needs to maintain capital of $35, rather than $40, in order to avoid bankruptcy. Therefore, the risk mitigation effect by the insurance contract is regarded as $5. Finally, in cases 3 and 4, the insurance contract covers risks below the confidence level of 99%. Therefore, the bank would fully benefit from the insurance effect of $10[12].

(4) Haircut factor

If event types covered by an insurance contract would be exactly consistent with event types addressed by the capital charge framework for operational risk under Pillar 1, the

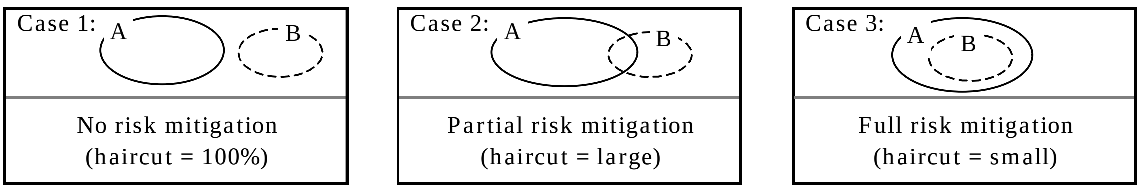
[11] The existence of deductible amount in insurance transaction could be comparable with the retention of subordinated portion in asset securitisation transactions.

[12] Insurance premium for case 3 may be much cheaper than case 4, reflecting differences in the expected amount of insurance payment between these two transactions. Although the authors propose the same capital reduction in these two cases in this paper, further analysis may be needed to incorporate the differences in inherent risk associated with these two cases.

nominal amount of insurance effect calculated in the previous section could be fully subtracted from the regulatory capital charge. But, in reality, there exist some event types that are not covered by the existing insurance products. There are two reasons to explain these practices. On one hand, some insurance products have not been developed simply because the market for operational risk insurance was emerged just recently and is still under development. It is expected that, once the market grows, an increasing number of products that would cover event types other than those covered by the current products will come into the market. On the other hand, there exist certain types of products which insurance companies may never bring to the market in order to avoid adverse selection. For example, insurance companies generally do not underwrite insurance contracts that would cover losses caused by criminal acts of the clients themselves.

In order to address the issue of the lack of event type coverage by insurance products, it is proposed to use "haircut" factors to adjust the amount of capital reduction. For example, if an insurance product covers most of event types that are defined to be included in the regulatory capital charge framework, haircut should be close to zero. On the other hand, if the insurance product covers only a small part of an event type, larger haircut factor should be applied. This feature is shown in the charts below. In the charts, area "A" represents an event type that is captured in operational risk capital charge framework, and area "B" represents an event type that is covered by insurance products.

Chart 6-3: Concept of haircut factor



In evaluating how much proportion of operational risk is covered by particular insurance products, a "risk map" is examined. The chart below shows an example of actual risk map, which is created by an insurance company to map its existing insurance products[13], based on generally accepted insurance contracts adopted by Lloyd's.

[13] This chart was drawn from a presentation paper made by Tokio Marine and Fire Insurance Co., Ltd. It is noted that the risk type map in the chart is just an example and the authors do not intend to apply this particular risk map to the regulatory framework. For example, effect-base loss type categories used in the risk map are a little bit different from the ones used in chart 3-2.

Chart 6-4: Example of risk map

Event Types \ Effect-base Loss Type		Write-downs	Loss of recourse	Defence cost	Legal liability	Regulatory & compliance (inc. taxation)	Loss or damage to assets
Process	Errors of employee						
People	Dishonest or fraudulent act of employee	BBB	BBB	BBB	BBB		
	Unauthorized activity	BBB/UT	BBB/UT	BBB/UT	BBB/UT		
	Employment practice			EPL	EPL		
System	Hardware failure						F
	Software failure						
	Telecommunication failure						
External	Property Damage - Natural disaster						F
	Property Damage - Miscellaneous						F
	Forgery and alteration	BBB	BBB				
	Computer Crime	CC	CC				
	Lawsuit			PI	PI		

*** : areas where the risk is covered by a specific insurance product

BBB: Bankers' Blanket Bond, UT: Unauthorized Trading Policy, EPL: Employment Practice Liability Policy, PI: Professional Indemnity Policy, CC: Computer Crime Policy, F: Fire Insurance Policy

As shown in the chart, the risk map has two dimensions, namely, horizontal axis represents effect-base loss types and vertical axis represents event types. It is a common practice that insurance products specify both loss type and event type as a condition of insurance payment. For example, Banker's Blanket Bond (BBB) would pay for operational losses that would result in "write-down" associated with "unauthorized lending."

In order to incorporate insurance products in the regulatory framework, there are two issues to be resolved. Firstly, supervisors would plan to establish "eligible criteria" to verify whether an insurance contract is recognized as an effective risk mitigation tool in the regulatory framework. It is intended to specify a list of event types, so called a "disqualifier" list, that the insurance contract must cover to be eligible. The criteria would also include those items that testify whether risks covered by the insurance are legally and economically transferred to the insurer (these items are called "clean break" rules). The clean break rules may include a certain items related to speed of insurance payment.

Secondly, supervisors need to calibrate specific figures of haircut factors for insurance products. Unfortunately, at this point, the authors have not reached to a position of proposing definitive figures of haircut factors. Although an ideal way to calibrate the haircut factors is to examine actual historical data on operational losses and insurance payments[14], the authors recognize the difficulty in collecting a robust set of data within a short timeframe because the market for operational risk insurance has emerged just recently. In this context, as a preliminary step in an early stage, supervisors may use a kind of pragmatic way in determining haircut factors for some of existing insurance products, such as Bankers' Blanket Bond, in consultation with both insurance and banking industry. The next step to be achieved is to modify and standardize the existing risk maps so that the map could be suitable for regulatory use. Supervisors would continue to have dialogues with the industry to develop the details of the framework during the first half of year 2001.

(5) Other key issues

In addition to the methodology of quantifying the risk mitigation effect, there are several issues to be discussed. Firstly, credit risk of insurer must be examined in order to avoid a situation where a bank engaged in an insurance is just replacing operational risk to credit risk of the insurer. To address this issue, for example, it may be appropriate to define that the insurer must be rated AA or above by external credit assessment institutions, such as Moody's and S&P, to be eligible for regulatory capital reduction. Secondly, there may be necessity of limiting the degree of capital reduction by insurance until the market develops and supervisors get satisfied with the effectiveness of insurance risk mitigation in practice. One way to ensure this is to set a "ceiling" above which the risk mitigation effect cannot be recognized. By introducing the ceiling concept, it is intended that the regulatory capital charge would not result in zero even if a bank would enter into an insurance contract with the nominal amount largely exceeding the bank's regulatory capital charge.

7. Conclusion

In the first half of the paper, the authors have articulated elements of the Internal Measurement Approach. The Internal Measurement Approach is risk sensitive because banks would use internal loss data as a key input into capital charge calculation process, while it preserves simplicity and comparability because the formula to calculate the required capital is standardized by supervisors.

In the process of implementing the Internal Measurement Approach, the authors underscore the importance of loss database. The database will play a key role not only at an individual bank level but also at the industry wide level. As an initial step in this

[14] Another way to calibrate haircut factors is to compare the cost of capital and the market price of insurance premium.

continuous effort, supervisors plan to develop a preliminary industry loss database in consultation with the industry during the first half of year 2001. In this effort, supervisors could serve as a central data gathering point. Then, using this database, supervisors will come up with a preliminary set of alpha, beta, and gamma factors of the three measurement approaches during the second half of year 2001. It is planned that calibration of supervisory factors will be finalized by the end of year 2002, based on a more detailed survey on indicators and loss data which will be conducted during year 2002.

The latter half of the paper described a methodology to quantify risk mitigation effect by insurance in Pillar 1 capital charge. Although the proposal described in the paper is preliminary, the authors recognize that developing a rigorous methodology to incorporate insurance effect is critical for the purpose of making the regulatory framework risk sensitive. Further analysis should be conducted to develop the details of the scheme, cooperating with professionals from both banking and insurance industries.

- Annex 1: Mapping of effect-based loss types: (to be released soon)
- Annex 2: Mapping of: event types (to be released soon)
- Annex 3: Mapping of business lines (to be released soon)
- Annex 4: Example of exposure indicators: (to be released soon)
- Annex 5: Calibration of gamma factors: (to be released soon)