Quantification of Operational Risk Using Scenario Data

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1. Objective of the Presentation

■ Presentation of Example Quantifications Using Scenario Analysis

——To provide a description of the common work shared by Japanese financial institutions (not to the extent of implying sound or best practice) to offer material for discussion at this workshop session.

▼Characteristics of the Japanese banks' scenario analysis / quantification of operational risk

1) Scenarios selected based on CSA, etc.
2) Scenarios developed through the discussions among business lines and the risk management function

—— Internal and external data are also referred to in 1) and 2).

3) The data above are combined with the internal loss data and input into the quantification model

—— Not only risk quantification but also quality management is stressed. As a result, many banks are developing many scenarios for high frequency and low severity losses as well as low frequency and high severity losses.

■ Pursuit of the macroscopic characteristics of the risks of Japanese financial institutions

—— "Less frequent large-scale losses" and "losses with external economic effectiveness" are integrated to capture the macroscopic risk profiles

2. Work Description

(1) Summary

Deeming major banks that quantify operational risk to constitute a single bank, we input the internal loss data (reported to BOJ) and the scenario data (the banks' scenarios) into the model (based on the loss distribution approach).

▼ Data Used for Quantification (scores are assigned with a score of 100 representing the real loss)

	Real Loss	**Scenario**	**Real Loss & Scenarios**
Number of data	100	40	140
Largest amount of loss	100	170 (massive earthquakes)	170
Expected loss during the year	100	300	400

(2) Aggregation of the Scenarios

- ■ We aggregate the banks’ scenarios for their quantification.
- ■ Both the “common scenarios” for all banks and the “independent scenarios” at each bank are used.

1) Common scenarios: earthquakes and system failures shared by all banks (Zengin system*, BOJ-Net, or a bank’s large-scale system failure spreading to all banks) are assumed (see the following pages).

   * Data telecommunications system of all Banks. The Zengin System connects banks on-line to conduct domestic inter-bank fund transfers, with the Bank of Japan acting as the settler of the funds.

2) Independent scenarios (See Page 8 onwards)

   <a> If the bank has definite scenarios → the bank’s scenarios are used.

   <b> If the bank has not developed scenarios or the details of the bank’s scenarios are unknown → the scenarios in <a> are scaled based on the total assets* (differences in the bank’s operations profile are not taken into consideration).

   * It does not make much difference if the number of employees or gross income is used instead of total assets.

■ Common Scenario 1 (Earthquakes)

Losses caused by historical earthquakes are estimated and scaled by the relevant banks' gross assets, then aggregated.

Description (year , magnitude of earthquake)	Frequency (once in X years)	Severity (largest =100)	Details
Earthquake in Tokyo	1,200	100	Earthquake greater than any of below is assumed.
Keian (1649, 7.1)	400 each	49	(Frequency) 8 large-scale earthquakes between 1600 and 1925 in Tokyo, Nagoya and Osaka are listed, assuming each will occur once in every 400 years. (Severity) <Buildings> The damage to the building, furniture and the opportunity cost due to interruption of business are calculated based on the earthquake intensity and quake resistance of the buildings. <Systems> Extra work cost, damage to the machines and equipment and the opportunity cost due to business interruption are calculated. Damage to the computer center and paralysis of the head office functions are assumed. <Other> Declines in the value of the loans (including impairment of the value of collateral) are not factored in.
Genroku (1703, 8.2)		85	
Ansei Edo (1855, 6.9)		55	
Meiji Tokyo (1894, 7.0)		47	
Great Kanto (1923, 7.9)		82	
Hoei (1707, 8.4)		57	
Ansei (1854, 8.4)		50	
Nobi (1881, 8.0)		55	
Tokyo (1926) - Aichi (1997) (61 earthquakes)	77 each	Average 0.4	(Frequency) Earthquakes occurred in 1926 – 97 (of intensity 5- or higher) (61) are listed, assuming each will occur once every 77 years. (Severity) as shown above.

<Reference> Government's assumptions of economic losses (July 2005)

	6 PM in winter; wind speed 3m/s	6 PM in winter; wind speed 15m/s
Economic losses	Approx. JPY94 trillion	Approx. JPY112 trillion
Direct loss	Approx. JPY50.1 trillion	Approx. JPY66.6 trillion
(Damage to buildings thereof)	(Approx. JPY40 trillion)	(Approx. JPY55.2 trillion)
Indirect loss	Approx. JPY43.7 trillion	Approx. JPY45.2 trillion

→ We compared the government's projections and our own rough calculations.

	The worst scenario in our calculations	"An inland earthquake in the metropolitan area" (the worst case scenario suggested by the government)
Earthquake assumed	Earthquakes greater than the Great Kanto Earthquake	A magnitude 7 class earthquake
Frequency	Once in 1,200 years	May occur several times in 100 years. This may include an earthquake which causes enormous losses in the metropolitan area
Amount of damage	JPY …	In total, twice or three times the value shown in the box to the left (direct damage would be 1-1.5 times the value shown to the left)

■ Common Scenario 2: Failure in the Zengin System

Based on the banks' scenarios shown below, we have assumed a scenario where "a failure occurs in the system commonly used by the banks included in the calculation once every twenty years, causing total damage of JPY 20 billion" (a failure of each individual bank's system is considered separately).

▼Some scenarios relating to system failure we referred

Frequency	Severity	Details
Once in several decades	JPY several billions	A failure in the accounting system or in the domestic network, which should take 12 hours for full recovery.
Once in several decades	JPY several hundred millions	1) A failure occurs in the communication infrastructure, or, 2) there is a flaw in the emergency handling procedures, causing interruption of the settlement operation for half a day. The compensation for damage paid to securities exchanges as clearing agents in charge of settlement of the government bonds is included.
Once in several decades	JPY several billions	Foreign exchange / settlement operations are not performed for a full day due to a system failure
Once every several years	JPY several hundred millions	A failure occurs in the Zengin System just after 9:00 am. The system recovers at around noon. However, the settlement operation is erratic during that day.

■ Independent Scenario

<a> Banks that have already developed their own scenarios

→ The bank's scenarios for larger amounts of losses (except for those caused by earthquakes) are used without any adjustments.

(Scenarios Used)

BIS event types	Major scenarios (scenarios for larger amounts of losses)	
	number of scenarios	Examples
Internal Fraud	30	Fraud in the market trading functions, withdrawal of customer funds
External Fraud	3	Swindles, compromised online banking
Employment	5	Discrimination
Clients, Products	30	Lender's liability, inappropriate advice to customers, failure to explain the risks, etc
Physical assets	11	Terrorist attacks
Systems	12	Failure in the accounts transfer system, including interruption of the accounting system
Process	38	Failure in bond settlement (overseas), improper identity verification, error in cash transfer, etc
Total	129	

<b> Banks that have not developed any scenarios (120 in total)

→ Some scenarios from <a> are applied (scaled by the total assets).

(Examples of the scenarios used)

Frequency: Once in X years; Severity: scores are assigned with a score of 100 representing the largest amount of loss in the table

Event	Frequency	Severity	Description
Internal fraud	100	40	An insider steals a customer's bank card to withdraw money
	100	40	An insider steals and sells customer information
	5	17	Wrongful transfer of a customer's deposits
External fraud	20	100	Appropriation of loans by an outsider
	2	2	Compensation for cash card forgery and skimming
Employment	200	38	Discrimination
	100	16	Insufficient number of staff, and unpaid overtime wages
Clients, Products	5	20	Problems associated with securities broking
	5	4	Problems associated with sales of variable insurance policies
Physical assets	50	32	Damage to investment assets, terrorist attacks, etc
Systems	10	43	Confusion in foreign exchange / settlement operations due to system failure
	100	20	Partial failure of the shared system platform (which takes 12 hours to recover)
	100	20	Partial failure of the domestic network (which takes 12 hours to recover)
	5	12	Failure in the account transfer system
Process	100	40	Problems with customers associated with deposit instruments with options
	100	40	Omission in processing of incoming foreign remittances

(3) Real loss and scenario loss data input into the quantification model

■ Monte Carlo simulation (Loss Distribution Approach)

Frequency: Poisson distribution and
Severity: empirical distribution

We assume the frequency in the scenario data to be that of each scenario and the real loss data to be the actual results (for the monitoring period of 10 years)

■ Top of the house calculations

■ Calculations are made by
(a) Aggregating the real and scenario data,
(b) Aggregating calculations made separately for the real and scenario data.

3. Results of Risk Quantification

(1) Results of Quantification

For both the methods: (a) aggregating the real and scenario data, and (b) aggregating calculations made separately for the real and scenario data, we have quantified risks at the confidence levels of 99% and 99.9% (100,000 simulations).

— The scenarios increase the amount of risk (at a confidence level of 99.9%) by 1.3 and 2.0 times for (a) and (b), respectively.

— The risk is approx. quarter to half the amount risk by BIA (at a confidence level of 99.9%).

Scores are assigned with a score of 10,000 BIA risk

Data set	99%	99.9%	EL
(a) Calculations made for aggregation of the real loss and the scenario	2,300	3,400	700
(b) Aggregation of the result of separate calculations of the real loss and the scenario	3,000	5,100	700
(Breakdown) Real loss data	1,350	2,600	200
Scenario data	1,650	2,500	500
BIA amount (approximate)	10,000		

(2) Features

1) Massive losses have a large impact. (A remarkable feature when the empirical distribution is used)

2) The frequency also has a great influence on the results.

— There is a scenario where the effect is large due to the higher frequency, even though severity is smaller.

— A minute change in assumptions may sometimes effect a great alteration.

<Simplified examples> Calculation of data for a less frequent large loss (JPY100 billion) and 100 frequent small loss (JPY1 million; once in 10 years).

i. If, at a confidence level of 99.0%, the frequency of the large losses is decreased from 1) once in 50 years to 2) once in 100 years, the risk is reduced to approx. 1/5000.

ii. When a large loss occurs once in 100 years, if the confidence interval is raised from 99.0% to 99.9%, the risk increases 5000 times.

	99.0%	99.9%	EL
1) Once in 50 years	1000.1	1000.2	20.3
2) Once in 100 years	0.2	1000.1	10.1

3) The assumption of earthquakes occurring has a large influence on the amount of risk.

▼ Amount of risk with assumption of severer earthquakes (confidence interval of 99.9%)

	Amount of risk	Ratio to BIA
1) Original ((a) real loss + scenario)	3,400	34%
2) 1) + massive earthquake as assumed by the government	5,200	52%
3) In case of 2), if all massive earthquakes (once in 50 years) are of the level as assumed by the government	6,500	65%

— The amount of risk is largely increased, depending on the frequency or the severity of the earthquakes assumed. When the biggest earthquake scenario supposes that a magnitude 7 class earthquake occurs once in 50 years and causes damage similar to that of the massive earthquake assumed by the government, the risk becomes approx. 60% of the BIA, unless the other scenarios are altered.

4. Challenges

The method used in this example is quite basic both in terms of the scenario analysis and the quantification model.

- More precise estimate for each scenario
  — In particular, more precise estimates are possible and necessary for earthquakes.

- Verification of estimated frequency and severity
  — Are there any methods to supplement expert judgments? (For example, comparison with external data or the extreme value theory, etc.)

- Determination of the number and severity of scenarios
  — How should the number and severity of scenarios be determined, in line with the quantification model and the amount of existing data?