Milliman Research Report

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Application of a simplified method to calculate Solvency II risk margin to Japanese products

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1. BACKGROUND AND PURPOSE

New approaches to quantify required capital for insurers are emerging as discussed in the European Solvency II framework, U.S. principles-based approach (PBA), and various papers prepared by the International Association of Insurance Supervisors (IAIS) and International Actuarial Association (IAA). Many of these try to define required capital based on economic value of capital with market-consistent valuation, and in fact the Japanese Financial Services Agency (JFSA) referred to an intended plan to move to an economic-value-basis framework in *Regarding calculation of solvency margin ratio and other issues*, published in April 2007.

On the other hand, insurance liabilities are not traded in a normal market, and thus in order to conduct a market-consistent valuation, a mark-to-model method is used where a so-called risk margin[1] needs to be evaluated in addition to the present value of future cash flow discounted with risk-free rates to account for the uncertainty of the model assumptions. Several methods are introduced to calculate the risk margin. The cost-of-capital method is prescribed for the 4th Quantitative Impact Study (QIS4) of Solvency II and generally preferred in Europe from practical perspectives.

QIS4 defines risk margin as the cost of maintaining capital to support nonhedgeable (non-financial) risk at each year-end in the future. While liabilities need to be evaluated with a market-consistent method at the valuation date to calculate the required capital prescribed by QIS4, this calculation is not easy at all at each year-end in the future, especially if stochastic simulation needs to be conducted at the valuation date. To address this difficulty, some simplified methods are illustrated, but those were not developed considering the application to Japanese products.

This report briefly overviews those simplified methods, and then examines alternative simplified methods from practical perspectives by looking into examples of Japanese no-cash-value medical and single-premium endowment products with a focus on the calculation of future lapse risk.

1 The detail of risk margin can be found in: IAA (March 2008) *Measurement of Liabilities for Insurance Contracts: Current Estimate and Risk Margins*

2. RISK MARGIN CALCULATION UNDER QIS4

2.1. Theoretical method

QIS4 stipulates the risk margin to be calculated with a cost-of-capital method as the cost of maintaining capital at each year-end in the future to meet insurance obligation (solvency capital requirement, or SCR). More specifically, using a 6% cost-of-capital factor and risk-free rates as the discount rate, the risk margin is calculated as the present value of cost of capital in each year, which is SCR at the beginning of the year times 6%, as described below:

$$\text{Risk margin} = \sum_{t=1}^{\infty} \frac{6\% \times SCR(t\text{-}1)}{(1+i_t)^t}$$

The SCR used for the risk margin calculation should correspond only to underwriting risk, operational risk, or counterparty default risk regarding ceded reinsurance, which are generally considered nonhedgeable in the market. For the case of a life insurer, the underwriting risk is composed of subcategories such as mortality, longevity, disability, lapse, expense, and catastrophe.

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QIS4 defines, for example, lapse risk as the difference of net asset value, which is asset less liability, between that calculated with current assumptions and that under stress scenarios. The stress scenario should correspond to a value at risk (VaR) of 99.5% over a one-year observation period, and QIS4 stipulates to take the maximum of the following three cases for each policy:

- For policies whose technical provision at the time of lapse is more than cash value, the future lapse rates are set at 0.5 times the base case lapse rates.
- For policies whose technical provision at the time of lapse is less than cash value, the future lapse rates are set at 1.5 times as much as base case lapse rates.
- For policies whose technical provision at the time of lapse is less than cash value, 30% of the policies were immediately lapsed.

This comparison should be made policy-by-policy in theory (see QIS4 Technical Specifications: TS.XI.E.4). However, especially for the line of business that needs stochastic simulation to derive the technical provision, to a certain degree this may be done by constructing model points, following the simplified method described in the QIS4 Technical Specifications (TS.XI.E.10).

A calculation procedure would likely:

1. quantify lapse risk as of the current valuation date
2. project lapse risk as of each year-end in the future
3. aggregate lapse risk and other risks using the correlation matrices
4. calculate risk margin with the cost-of-capital method using current and future aggregated SCR

The second step is particularly difficult. This report examines a simplified method to project lapse risk for Japanese products.

2.2. Simplified methods

QIS4 illustrates some simplified methods for risk-margin calculation, because it is difficult to calculate future SCR with the theoretical method. These were developed considering small insurers in Europe, and thus may not be necessarily convenient for Japanese insurers. For example, the QIS4 Technical Specifications (TS.II.C.26) illustrates a method utilizing modified duration. In this context, the modified duration would not be the one to quantify interest-rate sensitivity, but the ones

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A straightforward method that is easy to apply among the simplified methods is the one described in the QIS4 Technical Specifications (TS.II.C.28), which runs off SCR as of the valuation date in proportion to certain drivers.

Simplified methods illustrated for QIS4 may not work well with Japanese products.

to quantify each risk. However, the calculation of such modified durations is not straightforward and they are not measures that Japanese insurers usually calculate, either.

A straightforward method that is easy to apply among the simplified methods is the one described in the QIS4 Technical Specifications (TS.II.C.28), which runs off SCR as of the valuation date in proportion to certain drivers. This was also illustrated for QIS3.

For lapse risk, the difference between cash value and technical provision derived with current assumptions is illustrated as a driver. Another candidate could be the technical provision itself. However, if this simplified method were used, especially for no-cash-value products, the relative size of cash value and technical provision with current assumptions could reverse partway through a certain policy year, which would make it difficult to apply in a practical scene. This is Method 1 in the sample calculation described later.

2.3. Possible simplified methods in Japan

As described above, simplified methods illustrated for QIS4 may not work well with Japanese products; for example, they could not adequately run off the initial lapse risk because the relative size of cash value and technical provision with current assumptions could reverse partway through a certain policy year. To address this issue, this report examines alternative methods described below that are simplified but closer to the theoretical method; they utilize the cash-flow projection results and are thus a little bit more complex than simply running off the initial amount.

2.3.1. Case where liability valuation can be done only over a deterministic scenario

If a liability valuation can be done only over a deterministic scenario, the following would be one of the simplified approaches:

- Using an actuarial projection model, project liability cash flows for three cases by using the base lapse rate and 1.5 times and 0.5 times as much of base lapse rates.

- Calculate base-case technical provision at each future year-end as present value of liability cash flow discounted with risk-free rates.

$$MVL_{base}(t) = \sum_{k=t+1}^{\infty} \frac{CFL_{base}(k)}{(1+i_k)^{k-t}}$$

- Calculate technical provision at each future year-end in the case lapse rates thereafter were changed to 1.5 times or 0.5 times as much as the base-case rates as the product of present value of liability cash flow discounted with risk-free rates where lapse rates were altered to 1.5 times or 0.5 times as much, and the ratio of base-case units in force at the time to those where lapse rates were 1.5 times or 0.5 times as much.

$$MVL_{lup}(t) = \frac{LivesInforce_{base}(t)}{LivesInforce_{lup}(t)} \sum_{k=t+1}^{\infty} \frac{CFL_{lup}(k)}{(1+i_k)^{k-t}}$$

$$MVL_{ldown}(t) = \frac{LivesInforce_{base}(t)}{LivesInforce_{ldown}(t)} \sum_{k=t+1}^{\infty} \frac{CFL_{ldown}(k)}{(1+i_k)^{k-t}}$$

- At each year-end in the future, consider the maximum of the following as lapse risk:
  - difference of technical provisions between that in the base case and that in the case lapse rates thereafter that were 1.5 times as much
  - difference of technical provisions between that in the base case and that in the case lapse rates thereafter that were 0.5 times as much
  - (cash value – base-case technical provision) × 30%

$$Lapse_{up}(t) = Max[0, MVL_{lup}(t) - MVL_{base}(t)]$$

$$Lapse_{down}(t) = Max[0, MVL_{ldown}(t) - MVL_{base}(t)]$$

$$Lapse_{mass}(t) = Max[0, CV(t) - MVL_{base}(t)] \times 30\%$$

$$Life_{lapse}(t) = Max[Lapse_{up}(t), Lapse_{down}(t), Lapse_{mass}(t)]$$

Notations used in the equations above:

- MVL(t): technical provision as of the end of the year *t*
- CFL(t): liability cash flow in the year *t*
- LivesInforce(t): Units in force as of the end of the year *t*
- CV(t): Cash value as of the end of the year *t*
- Lapse(t): Lapse risk as of the end of the year *t* in each case
- $Life_{lapse}(t)$: Lapse risk as of the end of the year *t*
- Base, lup, and ldown mean base, lapse-up, and lapse-down cases respectively.
- In the above formulae, discounting is described as if cash flow emerged at the year-end in convenience, but it is actually done considering actual timing when the cash flow emerges.

While the above method may appear to conduct a calculation similar to the theoretical method rather than a simplified calculation, it is practically feasible. As a side note, because it would be inefficient to run the actuarial model three times to project cash flow for the three cases, and do the same thing again for mortality risk quantification, it would be desirable to develop a program code to project units in force and cash flow for base and stressed-lapse and mortality-rates cases at a time.

This is described as Method 2 for the sample calculation described on page 7.

A possible simplified method would be to conduct the liability valuation in the same way as is done for the deterministic case under each scenario, which is part of market-consistent stochastic scenarios developed as of the current valuation date, and to assume the average over the scenarios as lapse risk.

2.3.2. Case where liability valuation needs to be done over stochastic scenarios

The basic procedure for the case where stochastic scenarios are necessary is the same as that for the case where only a deterministic scenario is necessary. However, in a stochastic environment, calculating lapse risk in the year *t* year-end in the future is complex. Theoretically it would be necessary to generate stochastic scenarios at each year-end to conduct a liability valuation. Considering that the purpose is to examine the runoff pattern of lapse risk, a possible simplified method would be to conduct the liability valuation in the same way as is done for the deterministic case under each scenario, which is part of market-consistent stochastic scenarios developed as of the current valuation date, and to assume the average over the scenarios as lapse risk.

$$MVL_{base}(t) = \frac{1}{n}\sum_{s=1}^{n}\sum_{k=t+1}^{\infty}\frac{CFL_{base}(k,s)}{(1+i_{k,s})^{k-t}}$$

$$MVL_{lup}(t) = \frac{1}{n}\sum_{s=1}^{n}\frac{LivesInforce_{base}(t,s)}{LivesInforce_{lup}(t,s)}\sum_{k=t+1}^{\infty}\frac{CFL_{lup}(k,s)}{(1+i_{k,s})^{k-t}}$$

$$MVL_{ldown}(t) = \frac{1}{n}\sum_{s=1}^{n}\frac{LivesInforce_{base}(t,s)}{LivesInforce_{ldown}(t,s)}\sum_{k=t+1}^{\infty}\frac{CFL_{ldown}(k,s)}{(1+i_{k,s})^{k-t}}$$

(Note that *n* is the number of scenarios.)

This is described as Method 3 in the sample calculation described on page 7.

This method, however, while feasible, may still have coding difficulty, especially in taking the maximum of the three cases after averaging each scenario's technical provision for each policy. If this stochastic method does not make material difference in lapse-risk evaluation, another option could be to simply use the runoff pattern of the base case (from Method 2).

3. ONE-CELL SAMPLE CALCULATION

This section provides an overview of the lapse-risk calculation for no-cash-value medical and single-premium endowment products (both nonparticipating) using the following three simplified methods described in the prior section by developing a one-cell model.[2]

Method 1-A: Lapse risk as of the valuation date derived with Method 2 runoff over the driver, which is the difference between cash value and technical provision under the deterministic base-case scenario.

Method 1-B: Lapse risk as of the valuation date derived with Method 2 runoff over the driver, which is units in force.

Method 2: Difference of technical provisions under the deterministic scenario between the base, lapse-up, and lapse-down cases.

Method 3: Difference of technical provisions under the stochastic scenarios between the base, lapse-up, and lapse-down cases.

In the above context, technical provision does not include the risk-margin piece. This is consistent with the QIS4 treatment that defines risk as the assumption change impact of the portion excluding risk margin (thereby avoiding circular calculations).

Various assumptions about the sample cell and projections are described in the appendix.

3.1. No-cash-value medical insurance

The table in Figure 1 describes the lapse risk of a no-cash-value medical insurance with Method 1 and Method 2.

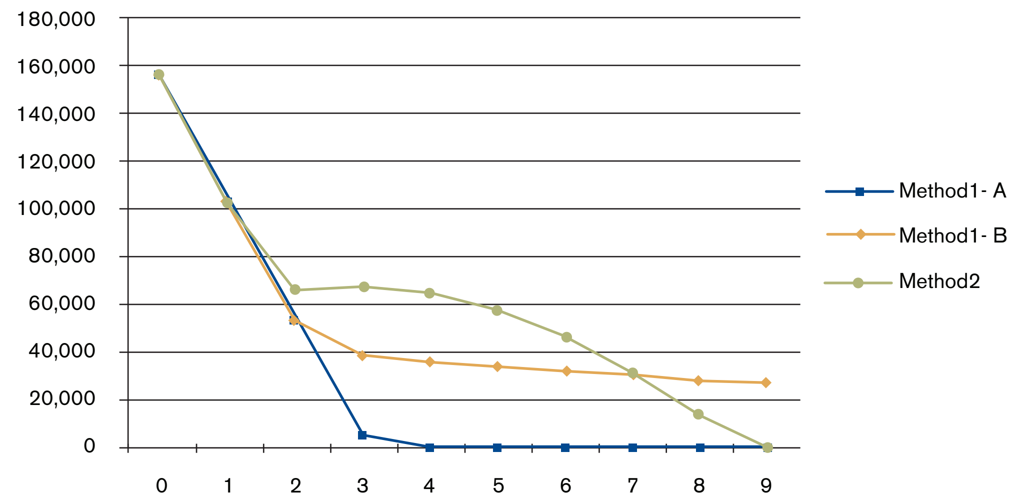
FIGURE 1: LAPSE RISK OF NO-CASH-VALUE MEDICAL INSURANCE SAMPLE CELL (UNIT: YEN)

	2008/12/31	2009/12/31	2010/12/31	2011/12/31	2012/12/31
TECHNICAL PROVISION	-517,658	-340,581	-174,188	-18,194	128,363
CASH VALUE	0	0	0	0	0
TECHNICAL PROVISION– CASH VALUE	-517,658	-340,581	-174,188	-18,194	128,363
UNITS IN FORCE	10,000	9,379	8,790	8,231	7,701
LAPSE RISK (METHOD 1-A)	155,297	102,174	52,256	5,458	0
LAPSE-UP RISK	0	–	–	–	–
LAPSE-DOWN RISK	45,789	30,126	15,408	1,609	-11,354
MASS-LAPSE RISK	155,297	102,174	52,256	5,458	0
LAPSE RISK (METHOD 1-B)	155,297	102,174	52,256	37,691	35,261
LAPSE-UP RISK	0	–	–	–	–
LAPSE-DOWN RISK	45,789	42,946	40,250	37,691	35,261
MASS-LAPSE RISK	155,297	102,174	52,256	5,458	0
LAPSE RISK (METHOD 2)	155,297	102,174	65,111	66,912	64,039
LAPSE-UP RISK	0	0	0	0	0
LAPSE-DOWN RISK	45,789	58,230	65,111	66,912	64,039
MASS-LAPSE RISK	155,297	102,174	52,256	5,458	0

- Mass-lapse risk was calculated as Max[0, (Cash value – Technical provision) × 0.3] for all methods.
- Method 1 calculates only lapse-down risk, which is positive as of the valuation date.

2 Milliman MG-ALFA® was used.

FIGURE 2: LAPSE RISK OF NO-CASH-VALUE MEDICAL INSURANCE SAMPLE CELL



Japanese medical insurance generally has a large profit margin and its economic-value-basis technical provision tends to be negative in early policy years.

Japanese medical insurance generally has a large profit margin and its economic-value-basis technical provision tends to be negative in early policy years. The issue date of the sample cell is July 1, 2007; as shown in the table in Figure 1, the technical provision is negative up to the 2011 year-end and turns positive from the 2012 year-end. As a result, following Method 1-A where initial lapse risk is simply run off over the driver of *Technical provision–cash value*, the lapse risk becomes zero after the sign is reversed and the runoff pattern is not very meaningful.

Under Method 1-B, where units in force is the driver, lapse-down risk shows a smooth decreasing pattern. However, the fact is that lapse risk could be increasing for the first few years as shown under Method 2. In addition, while lapse risk should become zero after premiums are paid up because the lapse rate assumption is 0% at that point, if units in force were the driver, lapse risk would run off over the insurance period (whole life). Considering these observations, units in force is not an adequate driver.

It could also happen that the size of lapse-up risk and lapse-down risk is reversed partway through a certain policy year, depending on assumptions. Method 2 could avoid these issues and thus would be more adequate, though a little more complex, to quantify the risk for Japanese medical insurance in this example.

3.2. Single-premium endowment

The table in Figure 3 describes the lapse risk of single-premium endowment insurance with Method 1, Method 2, and Method 3.

FIGURE 3: LAPSE RISK OF SINGLE-PREMIUM ENDOWMENT INSURANCE SAMPLE CELL (UNITS: YEN)

	12/31 2008	12/31 2009	12/31 2010	12/31 2011	12/31 2012	12/31 2013	12/31 2014
TECHNICAL PROVISION (CERTAINTY EQUIVALENT)	4,703,355	4,639,244	4,572,256	4,511,603	4,456,335	4,406,008	4,363,639
TECHNICAL PROVISION (STOCHASTIC)	4,704,908	4,640,810	4,587,896	4,539,775	4,495,012	4,452,033	4,412,149
DIFFERENCE FROM CERTAINTY-EQUIVALENT VALUE	1,553	1,566	15,639	28,172	38,678	46,024	48,510
CASH VALUE	4,603,352	4,564,575	4,525,302	4,485,748	4,446,154	4,406,452	4,366,617
TECHNICAL PROVISION – CASH VALUE	100,003	74,670	46,955	25,855	10,181	-444	-2,978
UNITS IN FORCE	5,000,000	4,895,767	4,792,656	4,690,886	4,590,688	4,491,964	4,394,660
LAPSE RISK (METHOD 1-A)	2,129	1,589	1,000	550	217	133	893
LAPSE-UP RISK	0	–	–	–	–	–	–
LAPSE-DOWN RISK	2,129	1,589	1,000	550	217	-9	-63
MASS-LAPSE RISK	0	0	0	0	0	133	893
LAPSE RISK (METHOD 1-B)	2,129	2,084	2,040	1,997	1,954	1,912	1,871
LAPSE-UP RISK	0	–	–	–	–	–	–
LAPSE-DOWN RISK	2,129	2,084	2,040	1,997	1,954	1,912	1,871
MASS-LAPSE RISK	0	0	0	0	0	133	893
LAPSE RISK (METHOD 2)	2,129	1,231	599	220	30	133	893
LAPSE-UP RISK	0	0	0	0	0	25	9
LAPSE-DOWN RISK	2,129	1,231	599	220	30	0	0
MASS-LAPSE RISK	0	0	0	0	0	133	893
LAPSE RISK (METHOD 3)	1,161	249	144	318	307	204	976
LAPSE-UP RISK	0	0	144	318	307	177	31
LAPSE-DOWN RISK	1,161	249	0	0	0	0	0
MASS-LAPSE RISK	0	0	0	0	0	204	976

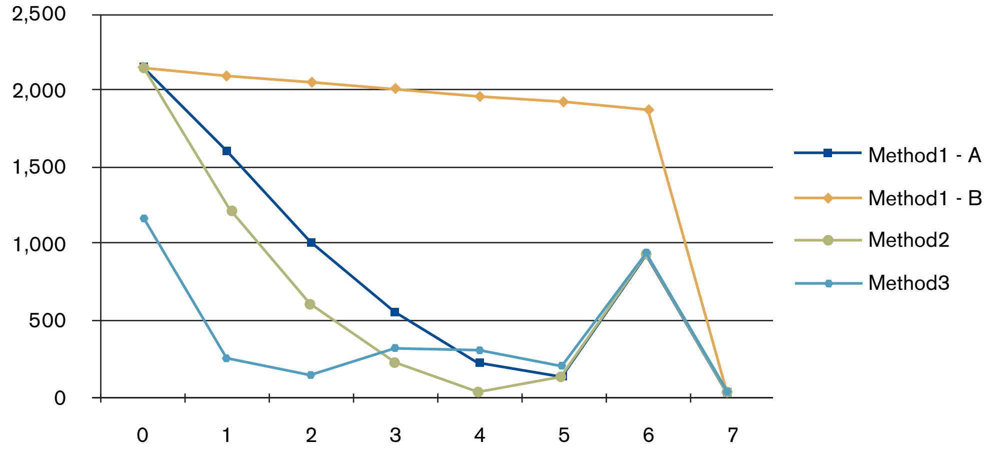
- Mass-lapse risk was calculated as Max[0, (Cash value – Technical provision) × 0.3] for all methods.
- Method 1 calculates only lapse-down risk, which is positive as of the valuation date.

Because single-premium endowment insurance has both death and living benefits and a short insurance period, the economic-value-base technical provision is not highly sensitive to non-economic assumptions, and thus risk margin for lapse and mortality risks could be relatively small. In fact, for the case of the sample cell in this report, while technical provision is around 5 million yen, which is close to the maturity benefit, lapse risk is at most several hundreds or thousands of yen.

As described in the appendix, a dynamic lapse assumption is set up for this sample cell, which makes a difference between the certainty-equivalent value of the technical provision (calculated with a deterministic risk-free-rate scenario) and the stochastic value. The sample calculation results show that the *difference from the certainty-equivalent value* is increasing as time passes. As cash-flow variability in later years is larger than that in earlier years, the present value of liability cash flow in later years, which includes only cash flow in later years, should show a larger difference from the certainty-equivalent value than what had been shown in earlier years.

It is generally understood that the time value of an option converges to zero as time passes. This is true if under a certain scenario the time value of an option is evaluated as the difference between the values using a deterministic risk-free-rate scenario at that point and the stochastic scenarios generated at that point. The sample calculation of this report tries to do this exercise stochastically, or tries to approximate so-called stochastic-on-stochastic calculation results by a regular stochastic simulation as a simplified method. *Difference from the certainty-equivalent value* in the above table is similar to the difference between the average option value that would be derived if the stochastic option valuation were repeated over multiple scenarios at each future point, and the value evaluated using the deterministic risk-free-rate scenario as of the valuation date (rather than that as of each future point), and thus it could be increasing as time passes, as described above.

FIGURE 4: LAPSE RISK OF SINGLE-PREMIUM ENDOWMENT INSURANCE SAMPLE CELL



Because single-premium endowment insurance apparently does not have large differences between the technical provision and cash value, from the above figure, it is not adequate to use Method 1-B to simply run off the initial lapse risk over units in-force. Method 1-A appears to capture well the run-off pattern under Method 2, unlike the medical insurance case. There is little difference among Method 1-A, Method 2, and Method 3, especially in the last two years before maturity, where mass-lapse risk is the largest. However, the sign of the difference between the technical provision and cash value is reversed just during these two years, which could make it inadequate to use Method 1-A, if mass-lapse risk were not the largest.

Comparing Method 2 and Method 3, first of all, lapse risk as of the valuation date is much smaller for Method 3. The technical provision under Method 3 is larger than that under Method 2, as it incorporates the effect of lapse-rates volatility, to a certain degree, because of interest-rate volatility via a stochastic simulation. It could be inferred that this would mitigate the effect of base-lapse-rates volatility compared to Method 2, which uses only a deterministic scenario.

Another observation is that from 2010 to 2012 (time 3-5 in Figure 4), lapse-down risk is the largest under Method 2, but lapse-up risk is the largest under Method 3, which leads to a different runoff pattern. As lapse rates change depending on interest rates, (the sign of) the effect of lapse-rates volatility on the technical provision could be different depending on whether it is evaluated deterministically or stochastically.

From the above observations, Method 3 would be more adequate, though more complex, than Method 2 for the insurance products evaluated stochastically. If lapse risk were small as seen in this example, using either method would not make material differences. However, if it could have a material impact for a certain product, one would like to consider a more adequate method such as Method 3.

4. CONCLUSION

This report examined methods to approximate lapse risk in future periods stipulated in QIS4 of the European Solvency II framework for sample cells of no-cash-value medical and single-premium endowment products.

While QIS4 illustrates some simplified methods—for example, quantifying lapse risk by running it off using technical provision less cash value as a driver—these approaches are not necessarily adequate for Japanese products. Although it is more complex, the method described in this report to directly quantify the variability of the technical provision in each future period, using the present value of (stochastically) projected future liability cash flows, could more adequately evaluate the risk amount. Only lapse risk is examined in this report, but a similar approach could apply to other risks such as mortality risk.

When the economic-value-base technical provision is actually implemented for statutory or generally accepted accounting principles (GAAP), it is not adequate to apply European Solvency II requirements without any modifications. Needless to say, the target-risk level and calibration should incorporate a Japan-specific situation. At the same time, practical calculation methods that should work adequately for Japanese products also need to be developed. On the other hand, especially for recent medical products, the features of insurance products could vary significantly from one company to another. Accordingly, while principles are definitely necessary, as with European Solvency II and U.S. PBA, it will become increasingly more important for each company to develop practical methods that can most adequately capture the risk inherent with its own products.

Although it is more complex, the method described in this report to directly quantify the variability of the technical provision in each future period, using the present value of (stochastically) projected future liability cash flows, could more adequately evaluate the risk amount.

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APPENDIX:

DETAILED ASSUMPTIONS FOR THE SAMPLE-CELL PROJECTION

A-1 General assumptions

Valuation Date December 31, 2008

Unit expense Acquisition 100,000 yen per policy
Maintenance 10,000 yen per policy per annum

FIGURE 5: RISK-FREE RATES (ONE-YEAR FORWARD RATE IN THE ANNUAL EFFECTIVE BASIS)

2009 0.92%	2010 0.87%	2011 1.01%	2012 1.14%	2013 1.25%	2014 1.44%	2015 1.63%	2016 1.92%	2017 2.21%	2018 2.40%
2019 2.51%	2020 2.61%	2021 2.66%	2022 2.68%	2023 2.77%	2024 2.73%	2025 2.85%	2026 2.97%	2027 3.10%	2028 3.24%
2029 2.84%	2030 2.92%	2031 3.01%	2032 3.09%	2033 3.18%	2034 2.80%	2035 2.85%	2036 2.90%	2037 2.95%	2038 3.00%
2039 2.70%	2040 2.73%	2041 2.76%	2042 2.79%	2043 2.83%	2044 2.70%	2045 2.72%	2046 2.74%	2047 2.77%	2048 2.79%
2049 2.92%	2050 2.95%	2051 2.98%	2052 3.02%	2053 3.05%	2054 3.09%	2055 3.12%	2056 3.16%	2057 3.20%	2058+ 3.24%

- Derived from March 2008 swap rate yield curve for convenience
- Forward rates over 50 years are set equal to the one in the 50th year for convenience

A-2 No-cash-value medical insurance

Issue age	55
Sex	Male
Issue date	July 1, 2007
Insurance period	Whole life (terminal age: 110)
Premium period	Paid up at age 65
Premium mode	Monthly
Monthly premium	18,122 yen
Nonparticipating Benefits	Daily accidental / sickness hospitalization benefit: 10,000 yen Surgery benefit: 10, 20, or 40 times as much as the daily benefit Death benefit: 100,000 yen after premium is paid up Surrender benefit: 0 yen
Mortality	30%–80% of pricing mortality
Morbidity	Accidental hospitalization: 40% of pricing rates Sickness hospitalization: 60% of pricing rates Surgery benefit: 90% of pricing rates
Lapse	6% during premium paying; 0% after paid-up
Commission	30% of first year premium

A-3 Single-premium endowment insurance

Issue age	35
Sex	Male
Issue date	July 1, 2005
Insurance period	10 years
Single premium	4,530,744 yen
Pricing interest rate	1.5%
Nonparticipating Benefits	Death and maturity benefits: 5,000,000 yen Surrender benefit: Policyholder cash value (policy reserve evaluated with net level premium method using pricing assumptions)
Mortality	30% to 80% of pricing mortality
Lapse (base)	2%
Lapse (dynamic)	Lapse(base) × 1.5 (Index ≥ Pricing interest rate + 0.75% (=2.25%)) Lapse(base) × 0.5 (Index ≤ Pricing interest rate – 0.75% (=0.75%)) Index is set to one year forward rate for convenience
Commission rate	2% of single premium
Stochastic scenarios	Two-parameter HJM model is used to model interest rates (interest rates are floored by 0.01%.) Forward rates and swaption volatilities necessary to estimate parameters were obtained from Bloomberg as of March 2008 using multiple swaptions with different maturities. The number of scenarios used is 1,000.

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