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Författare **Bengt von Bahr, Göran Ronge**

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Finansinspektionen
P.O. Box 6750
SE-113 85 Stockholm
[Sveavägen 167]
Tel +46 8 787 80 00
Fax +46 8 24 13 35
finansinspektionen@fi.se
www.fi.se

Traffic-light – extended with stress test for insurance and expense risks in life insurance

Summary

This memorandum comprises the basis for stress testing within the traffic-light method. The memorandum includes the stress of those parts of the technical provisions that comprise insurance risks, i.e. mortality, morbidity and lapse risks. Expense risk is also considered.

Background and purpose

Finansinspektionen is now developing a stress test for insurance companies' entire operations that covers both assets and liabilities. The size of the changes in the risk assumptions will be chosen so that they represent approximately the 99.5 percent quantile for the possible outcomes over the term of one year. This memorandum describes how the risk assumptions in life insurance companies shall be stressed. For some assumptions, e.g. those that relate to long-term trend forecasts for mortality and morbidity, the size of these changes cannot be quantified in this manner. In these cases, the assumptions are based on CEIOPS work for Solvency II. Life insurance companies that have short-term illness and accident insurance classified as non-life insurance, report it in the same manner as other non-life insurance. Refer to parts of the special instructions for Traffic light – Non-life insurance. Non-life companies with annuities emanating from non-life insurance, report according to that special section in this memorandum.

Changed assumptions for life insurance

The assumptions refer to assumptions made in the valuation of technical provisions. The stressed provisions shall consist of

- Best provisions in accordance with the Prudent Person Principle
- An increase in the provisions on account of a reduction in the discount rate (the default alternative)
- An increase in the provisions on account of stressed risk assumptions

Best provisions in accordance with the Prudent Person Principle

“Best provisions according to the Prudent Person Principle” shall correspond to the expected value of the future discounted payments for the company’s insurance risks. The calculations shall be made with adequate actuarial methods without implicit general security loadings. Discounting should be made with a risk-free interest rate.

Reduction of the discount rate

The stressing of assumptions regarding the discount rate is presented in the instructions for the stress test for life insurance companies. This topic is not discussed in detail here.

Stressing of other risks

Instructions for stress tests relating to mortality risk, morbidity risk, non-life annuity risk and lapse risk, all of which are included under the term “insurance risk”, are presented below.

In addition, an expense risk is identified and reported separately.

Risks relating to short-term illness and accident insurance that are classified under non-life insurance but are managed by life insurance companies follow the regulations that apply to corresponding risks within non-life insurance companies.

Assumptions regarding political risks, for example fiscal risk, are classified as operating risks and not discussed here.

Mortality risk

Volatility risk

The best estimate of mortality outcome for the coming year may be defined as

$$BSU = \sum_i p_i R_i$$

aggregated over all insurances (or rather all insured lives) in all portfolios, where p_i is the best estimate of the one-year mortality probabilities and R_i is the best estimate of risk sums, both positive and negative.

The capital requirement for volatility risk is measured with the standard deviation for the outcome in the coming year, which is

$$Sd(BSU) = \sqrt{\sum_i p_i(1-p_i)R_i^2}.$$

If this sum is difficult to calculate, it may be approximated by

$$\sqrt{p(1-p)\sum_i R_i^2}, \text{ where } p \text{ is an average probability, or by } \sqrt{\frac{p(1-p)}{n} \cdot \sum_i |R_i|},$$

where n is the number of risks. In order to increase the precision of the estimate of p_i , it is possible to divide the portfolio into subpopulations with more homogeneous age compositions. The average probability shall preferably be weighted by the risk sum and may be determined from the data presented in the Actuarial Report.

The capital requirement for volatility risk is $2.58 \cdot Sd(BSU)$.

If the company has a stop-loss, cumulative or other types of long reinsurance (non-negotiable on a one-year-basis), the company may modify the above estimate of volatility risk. The modification shall be justified.

Note It may appear illogical in the calculation of the volatility risk to also include the outcome of the negative risk sums. The volatility risk should be a measurement of the size of positive deviations from the expected value, i.e. outcome that is larger than expected. Positive deviations may occur in two ways, either an exceptionally large number of positive risk sums or an exceptionally small number of negative risk sums occur. The volatility risk shall therefore be calculated on the basis of the entire portfolio of risk sums.

Parameter risk

The technical insurance provisions shall be estimated using the mortality assumptions that comprise the “best estimate according to the Prudent Person Principle”. These provisions are designated as *BA*. With respect to the choice of mortality assumptions, the following applies. The company shall apply assumptions regarding current and future mortality to its portfolio on the basis of experience from its own and similar insurance populations. For this purpose, the company may apply suitable parts of results concerning mortality for different insurance populations emanating from the report published by DUS-kommittén, the Swedish Research Council for Actuarial Science under the Swedish Insurance Federation. For annuities emanating from non-life insurance, the common mortality assumptions used among insurers may be used.

Some comparative estimates from mortality stressing are reported in Appendix 1. These show that a general factor *reduction* in mortality by approximately 20 percent corresponds to an increased expected lifespan for a 65-year-old (both male and female) of 2 years. Correspondingly, a factor *increase* in mortality

means that the probability that a 40-year-old dies before the age of 65 increases by 8-12%. CEIOPS uses similar techniques in Solvency II.

The stressing is implemented by calculating the provisions with other mortality assumptions as follows:

- The one-year mortality probability is increased by 20% in all ages
- The one-year mortality probability is reduced by 20% in all ages

Of these two stressings, the company shall choose the one which gives the highest provisions. This is denoted by SA .

The capital requirement for parameter risk is $\max(SA - BA; 0)$.

The capital requirement for mortality risk is calculated with a root-square formula from volatility risk and parameter risk.

Morbidity risk

Morbidity risk refers to the insurance risk within long-term illness insurance and waiver of premium insurance.

Volatility risk

The best estimate of the morbidity outcome for the coming year may be defined as

$$BSU = \sum_i p_i P_i - \sum_j q_j Q_j - \sum_k r_k R_k ,$$

where the first sum includes all insurances except ongoing cases of illness, the second all ongoing cases of illness prior to the end of the qualifying period and the third all cases of illness in payment.

p_i is the best estimate of the one-year probability of illness incidence and P_i is the corresponding estimate of the risk sum.

q_j is the best estimate of the probability that the illness will terminate within one year for those cases of illness that are in the qualifying period and Q_j is the corresponding estimate of the released risk sum.

r_k is the best estimate of the probability that cases of illness in payment will terminate within one year and R_k is the corresponding estimate of the released risk sum.

Note: In some companies, the illness is first registered when payments will begin. In such cases, the above qQ terms may be approximated or placed in pP terms.

Insurances that include benefits with varying qualifying periods should be divided into corresponding portfolio components.

The volatility risk is measured with the standard deviation for the outcome in the coming year, which is

$$Sd(BSU) = \sqrt{\sum_i p_i(1-p_i)P_i^2 + \sum_j q_j(1-q_j)Q_j^2 + \sum_k r_k(1-r_k)R_k^2}.$$

If these sums are difficult to calculate, they may be approximated in a similar manner as described in Mortality risk.

The capital requirement for volatility risk is $2.58 \cdot Sd(BSU)$.

If the company has a stop-loss, cumulative or other types of long reinsurance (non-negotiable on a one-year-basis), the company may modify the above estimate of volatility risk. The modification shall be justified.

Parameter risk

The technical insurance provisions shall be estimated using the assumptions that comprise the “best estimate according to the Prudent Person Principle”. The same principles apply here as for parameter risks in Mortality risk. These provisions are designated as BA . The stressing is implemented by applying the following other assumptions:

- increased one-year probabilities of illness incidence by 50%
- reduced probabilities by 20% at all times that the illness has terminated. If the company applies a run off function $\lambda(x,t)$, this shall be increased such that $[1 - \lambda(x,t)]$ is replaced by $0.8 \cdot [1 - \lambda(x,t)]$ for all ages x and durations t .
- the degrees of invalidity (the relationship between actual leave of absence due to illness and full-time leave of absence due to illness), igr , is increased such that $(1-igr)$ is replaced by $0.8 \cdot (1-igr)$

These provisions are designated as SA .

The capital requirement for parameter risk is $SA - BA$.

Appendix 2 shows the aggregated morbidity outcomes for life insurance companies during the years 2002-2005 in accordance with the Actuarial Report. This data partly verifies the stress test levels that are currently recommended.

The capital requirement for morbidity risk is calculated with a root-square formula from volatility risk and parameter risk.

Annuities emanating from non-life insurance (“non-life annuities”)

Volatility risk

The best estimate of the non-life annuities outcome for the coming year may be defined as

$$BSU = \sum_i p_i R_i$$

aggregated across all non-life annuities, where p_i represents the best estimates of the one-year mortality probabilities and R_i is the best estimate of (negatively released) risk sums.

The volatility risk is measured with the standard deviation for the outcome in the coming year, which is

$$Sd(BSU) = \sqrt{\sum_i p_i (1 - p_i) R_i^2}.$$

If this sum is difficult to calculate, it may be approximated in a similar manner as described in Mortality risk.

The capital requirement for volatility risk is $2.58 \cdot Sd(BSU)$.

Parameter risk

The technical insurance provisions shall be estimated using the assumptions that comprise the “best estimate according to the Prudent Person Principle”. The same principles apply here as for parameter risks in Mortality risk. These provisions are designated as BA .

The stressing is implemented by calculating the provisions with a mortality assumption such that the one-year mortality probability is 20% lower in all ages.

These provisions are designated as SA .

The capital requirement for parameter risk is $SA - BA$.

The capital requirement for non-life annuity risk is calculated with a root-square formula from volatility risk and parameter risk.

Lapse risk

The purpose for introducing lapse risk in the stress test is to see if the company has enough capital to cover losses because of

1. lapses, which imply that policy holders through surrenders or transfers have the right to receive more capital than has been estimated in the calculations of liabilities and bonuses,
2. lapses, which imply that the remaining capital in the company intended to give contributions to cover expenses is reduced,
3. lapses, which imply that future income, intended to cover mainly acquisition costs already occurred, will be severely reduced.

Lapse includes paid-up policies, cessation of premium payments, surrenders and transfers. All these types of lapses can have effect on the stress test under item 3. above, while only surrender and transfers have effect on items 1. and 2.

Pure risk insurance and long-term morbidity insurance are not considered when calculating lapse risk.

Item 1 concerns probably only defined contribution pensions in occupational pension schemes and traditional individual life insurance. The company must calculate values for each policy where the surrender value (\ddot{A}) is greater than the retrospective reserve (V') and where the value \ddot{A} is basis for full or partial right to surrender. One should thus disregard from policies without right to surrender or transfer and those policies which at the actual moment has $V' > \ddot{A}$. The exposure U1 under Item 1 is the sum of the differences between \ddot{A} and V' for these contracts.

Item 1 is relevant even for non-mutuals where guaranteed life provisions plus risk absorbing bonus plays the same role as retrospective reserve V' . Otherwise an alternative calculation must be done with the same purpose, depending on policy conditions and bonus rules.

Existing fees for surrenders and transfers may reduce the exposure U1.

The basis for **Item 2** is the sum of all insurance capitals (retrospective reserves) for all policies with the possibility to surrender or transfer.

Item 2 concerns all savings products, such as occupational pensions and individual life insurance. Even unit linked products and so called deposit accounts must be included, because lapses among these may reduce the company's income to cover expenses.

The exposure U2 under Item 2 is obtained by multiplying the total basis by a standard loading 0,75 %, as this factor is considered an approximation of the expense fee, with which the insurance company reduces individual insurance savings.

Item 3 concerns, as item 2, only savings products, and measures an implicit or explicit claim through existing policies on both policy holders and agents/brokers, mainly regarding acquisition costs and other initial expenses. Salesmen cancellation responsibility may be taken into account. The item Deferred acquisition costs (DAC) from the balance sheet may be applied as a proxy for the exposure U3 under Item 3.

The total exposure for lapse risk is the sum of the exposures under the three above Items.

The capital requirement for lapse risk is determined as 20 % of the total exposure.

Total life insurance risk

The total life capital requirement for life insurance risk can now be calculated using the following correlation matrix

<i>Korr</i>	Mortality	Morbidity	Lapse
Mortality	1	0,25	0,25
Morbidity	0.25	1	0
Lapses	0.25	0	1

In the traffic light model, the total capital requirement is consolidated from all adequate risk factors.

Expense risk

The purpose for testing expense risk is that the company must be able to cover an increase of the fixed expenses for different reasons by 10 %. It is assumed that the company can reduce this increase of costs and/or increase the income within a period of 12 months. The stressing is thus assumed to have only a temporary effect.

This risk shall be reported separately and shall not be included under the term “insurance risk”.

The expense risk is measured by



K = the company’s annual fixed costs, defined as operating expenses plus claims adjustment costs minus acquisition costs.

The capital requirement for expense risk is calculated as $0.1 \cdot K$.

Expense risk and insurance risk (mortality, morbidity) are assumed to have a correlation coefficient of 50 % when calculating the total capital requirement in the traffic light model.

Appendix 1 Examples of stressed mortality assumptions

The following table presents a comparison of the stressing between QIS 2 and this memorandum for

$P(40,65)$ = the probability that a 40-year-old will die before the age of 65

$E(65)$ = the expected remaining lifespan for a 65-year-old

The starting point is the M90 mortality table and the stress tests have been implemented by multiplying the mortality intensity by a factor.

Factor	P(40,65)		E(65)	
	Female	Male	Female	Male
0.8	5.30%	7.98%	27.78	22.69
0.9	5.94%	8.93%	26.73	21.71
1	6.57%	9.88%	25.80	20.84
1.1	7.21%	10.81%	24.97	20.07
1.2	7.84%	11.73%	24.21	19.38
0.8855				+1 year
0.7854				+2 years
0.8932			+1 year	
0.7986			+2 years	
1.1050		+ 10%		
1.2124		+ 20%		
1,1031	+ 10%			
1,2081	+ 20%			

+1 year and +2 years indicates the increase in expected lifespan in relation to M90

+10% and +20% indicate the increase in probabilities for mortality and lifespan in relation to M90

Appendix 2

The following list was compiled from the reports included in the Actuarial Report from 2002-2005.

It includes reporting of long-term illness insurance and premium exemption insurance for all life insurance companies excluding Alecta.

	Ratio	2002	2003	2004	2005
Illness incidence	Results (risk premiums - (provisions for illness incidence + IBNR)) / risk premiums	-92%	-42%	-16%	13%
Run off	Result (actual run off – estimated run off) / estimated run off	61%	74%	81%	72%
Total	Total result / revenue (risk premiums + actual run off)	-38%	-5%	11%	26%

The table shows that the assumptions regarding illness incidence were significantly underestimated for the years 2002 and 2003. The values for 2001 demonstrate an even greater underestimation (but are not reported in the above table).

Even if the run off shows positive results, the table shows that a stress test of illness incidence should definitely be tested at a 50% level. Possible connections to improved run off shall not be assumed; rather the test level can be lowered.