Inadequacy of LIASB Mortality Reserves

by

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Mortality Reserve Standard

The Life Insurance Actuarial Standards Board (LIASB) has issued Actuarial Standard 3.01 - Capital Adequacy Standard in November 1996. The purpose of the Standard is to provide for reserves against adverse fluctuations in experience so that obligations to and reasonable expectations of policy holders, together with obligations to creditors, can be met.

For insured lives the mortality fluctuation reserve required is 10% (minimum margin) to 40% (high margin). The reserve held must not be less than the minimum margin but may exceed the high margin.

What is the probability that mortality fluctuation reserves in the LIASB range are sufficient?

Statistical Basis

For simplicity suppose that all policy sums assured are equal so that mortality fluctuations arise solely from fluctuations in claim numbers. This simplification understates the level of fluctuation.

The mortality fluctuation reserve must provide against two sources of fluctuation:

(i) systemic fluctuation i.e fluctuations in the mean of the mortality distribution function underlying the experience;

(ii) random fluctuation in claim numbers in a particular portfolio about the distribution mean given the mean.

Systemic fluctuation cannot be reduced by increasing the number of risks held. Random fluctuation expressed as the difference between the sample mean and the distribution mean is reduced by increasing the number of risks held.

Statistical theory is instructive. For a single life let $F(x|\mu)$ be the distribution of the probability of death for a given mean μ and let $G(\mu)$ be the distribution of $\boldsymbol{\mu}$ the mean probability of death. For presentational simplicity assume sufficient regularity in F and G for the existence of their densities $f(x|\mu)$ and $g(\mu)$. Let $\boldsymbol{X}$ be a random variable with value 0 or 1 as death does not or does occur; then $\boldsymbol{X}$ has the distribution $H(x)=\sum_{\mu} f(x|\mu)g(\mu)d\mu$. Let $\boldsymbol{S_n}$ be the sum over n random variables $\boldsymbol{X}$.

The Central Limit Theorems give the result that the distribution of $\boldsymbol{S_n}/n^{½}$ tends to $\sum_{\mu}\varphi(x|\mu)g(\mu)d\mu$ where $\varphi(x|\mu)$ is a "normal" distribution with mean μ. Note that when μ is fixed $g(\mu)$ is a point density and the distribution of $\boldsymbol{S_n}/n^{½}$ then tends to $\varphi(x|\mu)$, the common form of the Central Limit Theorem.

Australian Experience

To determine the required level of mortality fluctuation reserves when diversifiable risk is minimised suppose that every life in the Australian population is insured. Using the available data, i.e. the population mortality rates for the period 1901 to 1994, the standard deviation of the population mortality rate relative to the population mortality rate trend line is 6.5% of the current trend line rate. At the 99.9% confidence level, i.e. at 3 standard deviations, this gives a required mortality fluctuation reserve of 20% of expected claims to be held against the next year's possible fluctuation.

The minimum reserve required against undiversifiable risk for individual renewable term policies not participating in surplus and with no guarantee of future premium rates is 20% of expected claims for 99.9% probability of reserve sufficiency over a one year period.

A minimum can also be put on the reserve for diversifiable mortality risk. At 30 June 1996 the life insurance industry had in total 1,633,514 term policies in force. At an average mortality rate of about 0.2% 3,300 claims may be expected, with a standard deviation of about 57. At the 3 standard deviation level the reserve required is 5% of expected claims. The conclusion is that the minimum level of mortality fluctuation reserves is about 25% of expected claims over the whole life insurance industry.

For individual life offices the undiversifiable risk level is higher. For the offices with the largest numbers of policies the diversifiable risk reserves required at the 3 standard deviation level are 15%, 20% etc. Almost all life offices would require mortality fluctuation risk reserves of at least 40% to cover both undiversifiable and diversifiable mortality risk.

The LIASB range of 10% to 40% of expected claims appears quite inadequate. The above analysis suggests 40% would be a more appropriate minimum.

Minimum Profit Margin

If mortality fluctuation reserves against undiversifiable risk are held at the 3 standard deviation level it is informative to consider the probability of ruin inherent in a given profit margin. Suppose that a 2.5% probability of ruin is acceptable. The 2.5% level is consistent with the exit rate of life offices from the industry in recent years. Ruin theory formulae, using the distribution around the trend line of Australian population mortality, give a required profit margin of 4.3% of expected claims. A further contingency margin is required against diversifiable risk.

If reserves against undiversifiable risk are held at the 2 standard deviation level then the required profit margin rises to about 6% of expected claims using the same 2.5% probability of ruin. This higher profit margin still requires mortality fluctuation reserves of at least 35% for all but one life office.

Participating Business

Much group life death risk business is written on a profit sharing basis. A lower level of mortality fluctuation reserves may be justified in such cases.

What conditions must apply for a lower reserve level to be justified? For present purposes assume that premiums are net of expense loadings. The premium is equal to the sum of three components:

(i) the mean claims cost, plus
(ii) the contingency margin sufficient to give an acceptably low probability of ruin, plus
(iii) the profit share margin which may justify a reduced level of reserves.

A typical group life profit sharing arrangement rebates between 80% and 90% of the excess of premium net of expense loadings over actual claims. The excess is in some cases averaged over a number of years.

Commonly the distribution of the sums assured on lives in a group life scheme is skewed to the right with a relatively small number of large sums assured. From examination of a sample of such distributions each for a few thousand lives the distribution mode appears in practice to be as low as one half of the mean. Where the expected number of claims is small the actual claims amount experience approximates the mode of the distribution of aggregate claims cost. A significant adjustment is needed to estimate the distribution mean: the mode is a biased under-estimate of the mean.

The likely experience is then for the occurrence of periods of years where claims are less than the mean with the occasional year where claims significantly exceed the mean. Insurers must retain a part of the experience profit in low claims years to meet the excess cost in high claims years.

From group life quotations the aggregate of profit share and contingency margins appears to be around 15% of forecast claims. The forecast of claims reflects actual experience, which provides an estimate biased to the mode rather than to the mean of the aggregate claims cost distribution. Assuming that a 5% contingency margin is appropriate, the profit share margin available to reduce reserve requirements is about 10%. The 10% value is subject to the proviso that the estimation bias towards mode rather than mean is small. There is no general answer to the question implicit in the proviso: the answer depends on the skewness of the claims cost distribution, the expected number of claims and the resulting degree of bias inherent in use of the sample mean to estimate the actual mean.

However, the existence of the bias means that the profit share margin available to offset a reserve requirement is less than the 10% derived above. Even 5% seems generous given the bias observed in claims distributions even for several thousand lives insured.

The conclusion is that it may be possible to reduce the 40% minimum reserve requirement derived as appropriate to individual term insurance business, perhaps down to 35%. The general conclusion that LIASB mortality fluctuation risk reserve levels are generally insufficient remains valid.

Effect of Investment Strategy

There is no statistically significant correlation between fluctuations in mortality rates and fluctuations in the return of the stock market as measured by the performance of the All Ordinaries Accumulation Index. The minimum volatility combination of mortality and investment risk is therefore given by investment in government bonds or similar quality assets. The benchmark discount rate for liabilities is the yield on such an asset portfolio.

If investments are held in equities then additional investment fluctuation reserves are held to provide against the risk of fluctuations in asset values so that the same capital amount can be provided with certainty as would be provided by a bond portfolio. The extra return earned by investment in equities, which return is geared up on the mortality reserves, is required to adequately compensate the providers of the investment fluctuation reserves for the geared risk level borne. This is clear from the common accounting formula for geared returns. No increase in return is available to reduce the reserve against mortality risk.

If assets are shares then under LIASB Standard 1.01 the expected mortality claims should be discounted at the expected share yield. The geared up return on the share portfolio plus the roughly 5% return needed to give an acceptably low probability of ruin appear as the liability in respect of capitalised future profit.

It is permissible (see Standard 1.01 section 9 "Overview") to set the value of capitalised profit margins to zero if experience has become permanently worse. This correspondingly reduces the asset requirement. If there should be an adverse fluctuation in asset values eliminating the asset fluctuation reserve then remaining assets must be changed from shares to bonds. This reduces the discount rate to be used for valuing liabilities so that liabilities increase and reserves become inadequate. This insolvency is possible because the future profit margins may be set to zero. The option to do so provides the opportunity to hide incipient insolvency and is an unsatisfactory aspect of the Standard.

Conclusions

If the Central Limit Theorems are used to determine the level of reserves adequate to protect against fluctuations in mortality experience then, if the mean of the mortality distribution is treated deterministically so that all risk may be reduced by diversification, the LIASB reserve levels are adequate in respect of that diversifiable risk.

If the Central Limit Theorems are used to determine the level of reserves adequate to protect against fluctuations in mortality experience then, if the mean of the mortality distribution is treated stochastically so that allowance is made for both undiversifiable systemic risk and diversifiable risk, the LIASB reserve levels are inadequate in respect of the level of risk for both individual term policies and group life policies.

The profit margin needed to give an acceptably low probability of ruin is about 4% to 5% of expected claims. The bond interest rate used to discount expected future claims should be reduced by this profit margin to determine an adequate provision against future claims, i.e. a provision sufficient to allow the business to be reinsured if fluctuation reserves should be rendered inadequate by adverse fluctuations in experience.

The requirement to discount liabilities at the yield on assets rather then the rate appropriate to the liabilities means that it is possible to count the risk margin earned by investment in shares rather than bonds twice: first by showing share assets at market value being the present value of future equity returns; secondly by simultaneously using that risk margin to reduce the value of liabilities. This results in inadequate reserves which in the event of adverse fluctuations may cause insolvency.