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"X" Factor—Modified Select Factor Adjusted Mortality Rates

by Larry M. Gorski

My objectives in writing this article are to discuss three items: (1) the responsibilities of the appointed actuary under the revised NAIC Model Regulation commonly known as Regulation XXX, (2) the significance to the actuarial profession of responding to these new responsibilities, and (3) the analytical tools and procedures available to the actuary to discharge these responsibilities.

New Responsibilities

The revised NAIC Model Regulation commonly known as Regulation XXX provides the appointed actuary with the authority to select mortality rates for deficiency reserve purposes. The actuary can choose a set of "X" factors to modify prescribed mortality rates which have been adjusted by 20 year select factors identified in Regulation XXX. Besides having the authority to choose the "X" factors, the appointed actuary has the responsibility to opine on the appropriateness of the "X" factor modified select mortality rates whenever the actuary chooses an "X" factor less than 100%.

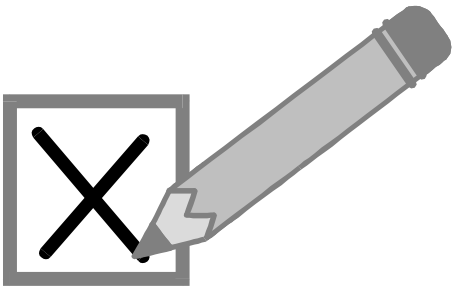
More specifically, Regulation XXX requires the appointed actuary to "opine as to whether the application of X meets the requirements of Section 5 B (3) . . .. It (the opinion) should reflect current expectations of future mortality, taking into account appropriate emerging experience." Section 5 B (3) of Regulation XXX specifies several conditions the "X" factors must meet and tests applicable to the "X" factor modified select factor adjusted mortality rates relative to emerging and expected mortality experience.

Based on language in Section 5 B (3), expected mortality experience is not to reflect mortality improvement beyond the valuation date. Regulation XXX breaks new ground with respect to statutory valuation work. Heretofore, the Standard Valuation Law has defined the method and assumptions that determine minimum reserves for life insurance statutory accounting and reporting purposes. The appointed actuary's work under the current regulatory framework has been to ensure that the reserves reported by the insurer meet the prescribed minimum standards. Under Regulation XXX, one element of statutory valuation work has been "deregulated."

The Challenge

As a regulator, I have heard on many occasions complaints about the artificiality and unnecessary conservatism of the current statutory valuation framework. If the appointed actuary is ever to be freed from the constraints of the Standard Valuation Law, the appointed actuary must take this new responsibility seriously.

I believe that determining the appropriateness of the "X" factor adjusted select mortality rates is a task amenable to actuarial analysis based on current education and training. In order to get a full understanding of this statement, the appointed actuary's responsibility under Regulation XXX should be contrasted with the work of the appointed actuary performing an Asset Adequacy Analysis of Reserves of a company selling sophisticated insurance products supported by complex assets. The cash flows of the insurance products are, at best, only dimly understood. The cash flows of some complex assets are also open to speculation. The appointed actuary also has to deal with questions dealing with the number and shape of interest rate paths to use, allocation of expenses, future investment and crediting rate strategies, and numerous other topics.



On the other hand, the challenge given to the appointed actuary in Regulation XXX relates to a single issue, the valuation mortality assumption. The analysis of mortality has always been one of the cornerstones of the actuarial profession. If the appointed actuary can't or won't step up to the plate and discharge this new responsibility using rigorous, statistically valid procedures, we may as well give up our attempt to bring rigorous analysis to the Asset Adequacy Analysis of Reserves.

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Tools and Procedures

What tools and procedures should the actuary use when providing the required opinion? Two cases need to be considered. First, in the situation where no experience is available, assessing the reasonableness of the "X" factors in light of expected experience can only be based on actuarial judgement. Without any experience, no other procedure is available.

Exposures (lives)	Mortality Rate
500	.001
500	.0015
500	.002
500	.003
500	.004
1000	.006
1000	.008
1000	.010
1000	.013
1000	.016
1000	.019
1000	.022
1000	.025
1000	.028
1000	.032
750	.036
750	.040
750	.045
750	.050
750	.055
750	.060
750	.065
750	.070
750	.075
750	.080
750	.090
750	.100

For the first year of valuation, the actuary chooses an "X" factor of .5 to be applied uniformly to all mortality rates.

Notice that this case does not include situations involving limited experience.

Once we get past this case, I believe that the appointed can utilize rigorous, statistically valid procedures to support his/her opinion. Whatever procedure is used, it must recognize the available, emerging company experience. This is the key. Hand-waving arguments are not acceptable substitutes for analysis.

Volume XXXII of the *Transactions of the Society of Actuaries* contains a paper titled "Testing for Significant Differences Between Actual and Expected Results." The paper discusses the problem in the context of a standard "hypothesis testing" exercise. The null hypothesis (Ho) is the hypothesis that "The given q's are the correct probabilities of termination."

While the example discussed in the paper comes from the field of disability income insurance, the ideas presented in the paper are surely applicable to the problem posed in Regulation XXX.

The paper dissects the hypothesis testing problem into five cases. In my view, the case most relevant to the task facing the appointed actuary is case four. Case four considers the situation when at least one q is distinct, the q's are neither all small (< 0.05) nor all large (>.95) and n (size of the population) is large.

Under these conditions, the author suggests to use the Normal Distribution approximation to the sum of n random variables, each distributed Bernoulli (Be[q]).

An alternative approach that I am considering as a benchmark for my review of the work done by the appointed actuary is based on Monte Carlo techniques. This method involves determining the distribution of expected deaths based on the "X" modified select factor adjusted mortality rates and the actual exposures. The distribution can be determined using Monte Carlo techniques. Once the distribution is determined, the appropriateness of the "X" factors can be determined by rejecting the hypothesis if the actual deaths fall beyond a specified point in the tail of the distribution of expected deaths (the rejection region).

An example will clarify the method that I am suggesting. Assume a population consisting of the following exposures and 20-year select factor adjusted mortality rates as follows:

Monte Carlo techniques enter into the method in the following way. For each age *x,* select a random number from the Binomial Distribution Bi[Ex,qx]. Call this random number Nx., the number of deaths at age *x*. Do this for each age *x* and add all of the N*x* to determine S (the number of deaths over all ages). Perform this process a sufficiently large number of times and, finally, determine the distribution of S. Reject the hypothesis (the appropriate "X" factor is 50%) if the actual number of deaths falls in the rejection region of the distribution of expected deaths.

Results

The following table below contains the results of applying both procedures to the sample data provided above. I performed the Monte Carlo simulations with k=100,200, 1500 trials.

For this example, the hypothesis testing region using either method is nearly the same and, for the Monte Carlo procedure, is independent of the number of trials. I will be testing the reliability of these observations using different sample populations. I believe that the two procedures will not produce comparable rejection regions in all cases.

Procedure	Quantiles 50%	75%	95%	99%
Normal Approximation	380	393	412	425
Monte Carlo (k = 100)	378	394	411	418
Monte Carlo (k = 200)	378	395	413	423
Monte Carlo (k = 1500)	380	393	412	427

Using the data in the table obviously implies that a decision as to a rejection region has been made. I feel that regulators should make this decision. Making this decision is no different than regulators adopting a mortality table with a specified margin. For purposes of completing this example, lets assume that the rejection is set at the 75% quantile. Hence if actual deaths exceeded 393 deaths, the assumed "X" factor of 50% would be rejected.

One question that obviously arises is whether the procedure that I have described adequately addresses the "limited experience" situation. The answer is "yes". The process of generating random outcomes from the population reflects the relative increase in the variance as the population decreases.
The following table below illustrates this point:

Population	Quantiles 50%	75%	90%	99%
A.	378	395	413	423
B.	4	5	7	8

Population A. is the sample population used above, while Population B. is the same except that it has been scaled down

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approach for VAGLBs that is similar to that used for GMDBs, possibly using a "keel" method which essentially projects the expected fund value at the bottom 85th percentile value period-by-period. One possibility for determining the C-3 factor is to use a similar approach, but with a 95th rather than an 85th percentile.

Life Practice Notes

Life Practice Notes on equity indexed annuities, variable annuities, life illustrations, and three on demutualization have been approved. Other practice notes are in development for XXX and reinsurance. It is expected that these practice notes, along with updated current practice notes, will be available in the future at the Academy's web site (*www.actuary.org*).

GAAP Developments

The AICPA task force on non-traditional long-duration contracts is in the process of developing a proposed Statement of Position that will provide guidance on the GAAP accounting, reporting and disclosure for many of the innovative insurance products that have hit the market in recent years. Currently there is divergent treatment within the industry. The focus is currently on interpreting existing standards. Many existing products were not around when the standards were developed, or are offered through a separate account but contain guarantees.

Highlighted products or product features include variable annuities with minimum guaranteed death benefits of guaranteed living benefits, equity indexed products (life and annuity), bonus interest rates, persistency interest rates, modified guaranteed life and annuity products (products with market value adjustments), and synthetic GICs.

A subgroup of the Committee continues to track developments with the International Accounting Standards Committee'. Current activity relates to the IASCs efforts to develop a set of global standards for cross-border security filings, including business combinations. A G4+1 position paper describes the purchase and pooling methods of accounting for business combinations, and introduces a third possible method, the fresh start method for special cases. The G4+1 clearly favors the purchase method. This approach appears to be more consistent with the general desire to move toward fair value reporting by the IASC, the FASB, and the SEC.

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Demutualization

The AIPCA anticipates issuing guidance in 1999 for mutual company reorganizations, including demutualizations and mutual holding companies.

The Committee will continue to follow these and other developments involving financial reporting as they develop. Progress will continue to be reported in future issues of *The Financial Reporter.*

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by a factor of 100. I used the Monte Carlo method with 200 trials. The means of the populations are the same but the tail of the each distribution is different. This is reflected in the ratio of the 99% quantile to the 50% quantile.

Concluding Remarks

While this article discusses two approaches to justifying the choice of the "X" factor, other equally valid approaches undoubtedly exist. If further research is done on this topic, the following issues should be considered:

1. If exposures are measured by units of inforce such as, per $1000 of insurance, how should the standard deviation of the mortality rates be calculated?
2. Can Monte Carlo studies be based on units of exposure other than lives?
3. Can the existence of reinsurance and/or the level of reinsurance costs and mortality charges be used to justify the choice of an "X" factor?
4. Should an Actuarial Standard of Practice be developed to address this topic?

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