Actuarial Standards Board
Conseil des normes actuarielles

Memorandum

To: All Fellows, Affiliates, Associates, and Correspondents of the Canadian Institute of Actuaries and other interested parties

From: Conrad Ferguson, Chair
Actuarial Standards Board

Dominic Hains, Chair
Designated Group

Date: July 30, 2017

Subject: **Final Communication of a Promulgation of Prescribed Mortality Improvement Rates and Associated Margins for Adverse Deviations within the Practice-Specific Standards on Insurance Contract Valuation: Life and Health (Accident and Sickness) Insurance (Subsection 2350) and the Accompanying Promulgation**

Document 217079

Introduction

This final communication of promulgation introduces changes to the Promulgation of Prescribed Mortality Improvement Rates Referenced in the Standards of Practice for the Valuation of Insurance Contract Liabilities: Life and Health (Accident and Sickness) Insurance (Subsection 2350). It was approved for distribution by the Actuarial Standards Board (ASB) on July 27, 2017. Due process has been followed in the development of this final communication of promulgation.

The ASB appointed a designated group (DG) to develop these promulgations. The ASB intends to review this promulgation every five years or sooner if circumstances warrant.

An initial communication regarding this promulgation was published on May 2, 2017, with a comment period ending on June 30, 2017.

Background

Life Insurance and Annuity Mortality

Subsection 2350 of the Standards of Practice provides, with respect to insurance mortality, the following:

2350.08 If the inclusion of mortality improvement reduces the insurance contract liabilities, then the resulting reduction would be no greater than that developed using prescribed mortality improvement rates as promulgated from time to time by the Actuarial Standards Board. If, at an appropriate level of aggregation, the inclusion of mortality improvement increases the insurance contract liabilities, then the actuary's assumption would include such improvement. The resulting increase in insurance contract liabilities would be at least as great as that developed using prescribed mortality improvement rates as promulgated from time to time by the Actuarial Standards Board.

With respect to annuitant mortality, subsection 2350 provides:

> 2350.12 The mortality improvement assumption would include a best estimate assumption and an associated margin. The margin for adverse deviations related to the mortality improvement assumption is not restricted to the range of 5% to 20% noted in paragraph 2350.01. The actuary's assumption would include mortality improvement, the effect of which is to increase insurance contract liabilities, such that the resulting increase would be at least as great as that developed using prescribed mortality improvement rates as promulgated from time to time by the Actuarial Standards Board.

The promulgated prescribed mortality improvement rates from the 2011 promulgation were supported by a research paper published in 2010, based on Canadian population mortality data from 1921–2002. The intent was to periodically review the prescribed mortality improvement rates described in the promulgation. Canadian population mortality data from different sources is now available for calendar years up to 2015.

Since the promulgation, there have been many developments worldwide on mortality improvement models, and a number of mortality improvement tables have been published (for example the CPM-B table in Canada and the MP-2016 table in the United States). Many of these models are two-dimensional with mortality improvement rates a function of both calendar year and attained age, in comparison to the current prescribed mortality improvement rates that are a function of the attained age only.

In 2014, a new Canadian Institute of Actuaries Task Force on Mortality Improvement was created under the Member Services Council, with representatives from the life insurance, annuity, pension, and social security practices and academics. In 2017, the task force published a research paper documenting the development of a best estimate mortality improvement rates table applicable to the Canadian general population, MI-2017, using the most up-to-date Canadian population mortality data.

Comments Received

The DG received four responses to the initial communication, from one regulatory authority, one life insurance company, and two individual members. The responses included the following five issues:

Diversification

A number of comments were related to the lack of guidance on diversification and the fact that while additional guidance was provided during the webcast held on May 29, 2017, there should be more guidance in the final promulgation.

DG Response

The DG acknowledges that there was insufficient guidance on diversification included in the initial communication of promulgation. Additional guidance has been included in the final promulgation.

Mortality improvement rates at older ages

The DG received a comment asking to provide clarity on how to apply the margin for adverse deviations at the older ages where the base mortality improvement rate is 0 and the margin for adverse deviations is positive.

DG Response

In the calculation example for life insurance, the final promulgation was updated to clarify that the resulting mortality improvement rate of applying the margin for adverse deviations to the base mortality improvement rate can be negative.

Symmetry between life insurance and annuities

One comment received shared some concerns over the principle of symmetry between life insurance and annuities, and that since the result of this promulgation is used in financial reporting, it would be sensible to allow some asymmetry in the valuation basis, considering the long term nature and profile of permanent life insurance products sold in Canada.

DG Response

The DG is comfortable with maintaining the symmetry in the final promulgation. The projected level of mortality improvement, after the application of the margin for adverse deviations, is not inconsistent with what has been observed historically since 1920, and the review of literature done by the Task Force on Mortality Improvement concluded that, very few, if any, experts suggest that there will be no mortality improvement in the future. In addition, the final promulgation is for a minimum valuation assumption, and the actuary can use a different assumption.

Use of stochastic models

One comment received highlighted that no stochastic model had been used for any work in the development of the new base table and margins for adverse deviations, and that one of the main sources used for the last promulgation was based on such a model.

DG Response

There are multiple models/methodologies that can be used to look at mortality improvement, including stochastic models. The practice worldwide in the last ten years or so has been closer to the methodology used by the Task Force on Mortality

Improvement and the DG. Any choice of model/methodology will always include some judgment. The comment included some examples obtained from a stochastic model calibrated by the commenter, and the DG felt that it was relatively close to the final promulgation.

Margin for adverse deviations over age 90

One comment received shared some concerns that the margin for adverse deviations reduces after age 90, and that at the minimum it should stay level.

DG Response

As indicated in section 4.3 of the research paper, the work done by the DG suggests that the margin for adverse deviations should reduce at old ages. Further, we floored margins at 0.2% at the very high ages recognizing that there is still uncertainty. The DG recommends no change in the final promulgation.

Criteria for the Adoption of Standards of Practice

The mortality improvement rate promulgation meets the criteria set out in section B of the ASB's Policy on Due Process for the Adoption of Standards of Practice.

1. It advances the public interest through the use of a consistent basis, reflecting emerging practice and experience, for establishing mortality improvement rates for all business, along with an appropriate margin for adverse deviations.
2. It provides for the appropriate application of professional judgement within a reasonable range. The prescribed mortality improvement rates are not the only rates available for use, but rather establish a minimum valuation basis for the business under consideration.
3. Use of the prescribed mortality improvement rates is practical for actuaries with relevant training.
4. The prescribed mortality improvement rates are considered to be unambiguous.

Effective Date

The effective date of this final promulgation is October 30, 2017. Early implementation is permitted.

CF, DH

Appendix: Prescribed Mortality Improvement Rates

This appendix describes the prescribed mortality improvement rates, for use in determining minimum valuation assumptions for future mortality improvement. As a support to this updated promulgation, the actuary is referred to the research papers published by the Task Force on Mortality Improvement and by the designated group, both in 2017.

The actuary would use appropriate judgment in the determination of a best estimate assumption and associated margin for future mortality improvement. As noted in paragraphs 2350.08 and 2350.12, the resulting insurance contract liabilities would be at least as high as those developed using the prescribed mortality improvement rates outlined in this appendix.

The provision for adverse deviations for mortality improvement risk would then be measured as the excess of the reported insurance contract liability over the insurance contract liability, inclusive of the reflection of the k/ex (insurance) or percentage of mortality rate (annuities) margin, resulting from the application of the actuary's best estimate assumption for mortality improvement.

Prescribed Mortality Improvement Rates

The prescribed rates are developed from a set of base mortality improvement rates and two mortality improvement scenarios as described below.

Annual Base Mortality Improvement Rates

The annual base mortality improvement rates would be applied for both life insurance and annuities, and were derived from the work done by the Task Force on Mortality Improvement, as per their research paper published in 2017. The annual base mortality improvement rates vary for females and males and also vary by attained age and by calendar year, but are the same for both smokers and non-smokers. The annual base mortality improvement rates are included in the Excel file below. Although the base mortality improvement rates are provided going back to 1970, only future mortality improvement rates projected after the valuation date are subject to this promulgation.

Link to Excel Document

Development of Prescribed Mortality Improvement Rates (Minimum Valuation Assumption)

In order to determine the minimum valuation assumption, the actuary would perform two valuations using the following mortality improvement scenarios. The first scenario would be expected to apply in situations where the reflection of mortality improvement decreases liabilities, and the second scenario where the effect is to increase liabilities.

1. Mortality improvement would be projected for all future years using the base mortality improvement rates as described above, reduced by a margin for adverse deviations, as described in table 1 below, adjusted for diversification. The margin for adverse deviations varies by attained age.

2. Mortality improvement would be projected for all future years using the base mortality improvement rates as described above, augmented by a margin for adverse deviations, as described in table 1 below, adjusted for diversification. The margin for adverse deviations varies by attained age.

As a first step, the prescribed mortality improvement rates selected would be the rates from the mortality improvement scenario producing the higher liability, determined at an appropriate level of aggregation. For this first step, it would be inappropriate to aggregate annuities with life insurance business.

When considering an appropriate level of aggregation for different insurance products, the actuary would consider different factors, such as

- The plan of insurance and its benefits provided;
- The socioeconomic profile of the insureds;
- The insurer's underwriting practice for the plan of insurance;
- The age distribution;
- The country of issue and residence; and
- The insurer's distribution system and other marketing practice.

The structure and impact of any reinsurance agreement would not be a reason alone to differentiate between products with a similar profile.

Diversification between death sensitive and death supported blocks of business

A second step would be for the actuary to consider diversification between 1) all aggregated death-sensitive blocks of business and 2) all aggregated death-supported blocks of business. When an insurer has both death-sensitive and death-supported blocks of business, the actuary could consider applying a diversification factor and using a lower margin for adverse deviations. Considerations for diversification would include:

- the blocks of business are of similar composition in terms of distribution by attained age, gender and country of issue and residence, similar access to emerging health care advances and of similar durations,
- the socioeconomic profiles of the underlying population of each block are similar.

The diversification factors would be between 0 and 50% of the margin for adverse deviations as described in Table 1 below and would not be higher than 50%. In addition to the considerations above, when determining the level of the diversification factors, the actuary would also consider whether liabilities of the blocks of business have sensitivities to changes in mortality improvement rates that are both similar, and opposite, in magnitude.

In any event, in considering the distribution by attained age, the resulting impact of adding or deducting the margin for adverse deviations adjusted for diversification to the base mortality improvement rates for purposes of determining the minimum valuation

assumption, would be to increase liabilities by an amount at least as high as the maximum of (increase in liabilities on the death sensitive blocks of business, increase in liabilities on the death supported blocks of business) using the margin for adverse deviations without diversification, for each age group where the actuary can justify the use of a diversification factor.

Example:

Assume a company that has both death sensitive and death supported blocks of business that can be split in two age groups, 65-69 and 70-74. The impacts on liabilities of applying the margin without diversification to the base mortality improvement rates in scenario 1 and 2 for each block of business are described below:

Age group	Scenario 1	Scenario 2
65-69 death sensitive	+500	-500
65-69 death supported	-1000	+1000
70-74 death sensitive	+800	-800
70-74 death supported	-800	+800

For age group 65-69, in addition to the considerations for diversification listed above, the actuary would choose a diversification factor such that the total increase in liabilities of applying the margin for adverse deviations adjusted for diversification to the base mortality improvement rates, for the blocks of death sensitive business and death supported business, would be at least 1000 (higher of +500 and +1000).

For age group 70-74, in addition to the considerations for diversification listed above, the actuary would choose a diversification factor such that the total increase in liabilities of applying the margin for adverse deviations adjusted for diversification to the base mortality improvement rates, for the blocks of death sensitive business and death supported business, would be at least 800 (higher of +800 and +800).

Calculation Example: Life Insurance, First Mortality Improvement Scenario

The following illustrates the calculation of the total mortality rate, including margins, for business in which the first mortality improvement scenario produces the higher liability at an appropriate level of aggregation. It is possible that the subtraction of the mortality improvement margin for adverse deviations to the base mortality improvement rate results in a negative mortality improvement rate.

For life insurance, the margin for adverse deviations for the mortality rate per 1,000 is k/e_x.

For a constant age x, the total mortality rates to project over time, at the valuation date, are calculated as follows:

$$q_x^{VY} = q_x \ + \ {}^{k}/_{e_x}$$

$$q_x^{VY+1} = q_x \ \times \ (1 - (MImp_x^{VY+1} - MfAD_x \times (1 - DivF))) + \ {}^{k}/_{e_x}$$

…

$$q_x^{VY+n} = q_x \times \prod_{i=1}^{n}(1 - (MImp_x^{VY+i} - MfAD_x \times (1 - DivF))) + {}^{k}/_{e_x}$$

where:

q_x is the best estimate mortality rate, at age x, at the valuation date,

q_x^{VY} is the mortality rate, which includes prescribed mortality improvement and margins, at age x, at the valuation date in calendar year VY,

q_x^{VY+n} is the projected mortality rate, which includes prescribed mortality improvement and margins, at age x, at the valuation date in calendar year VY, for the calendar year VY+n,

$MImp_x^{VY+n}$ is the base mortality improvement rate at age x for the calendar year VY+n, where VY is the calendar year of the valuation date,

$MfAD_x$ is the mortality improvement margin for adverse deviations at age x,

DivF is the diversification factor, and

e_x is the curtate expectation of life at age x.

Calculation Example: Life Insurance, Second Mortality Improvement Scenario

The following illustrates the calculation of the total mortality rate, including margins, for business in which the second mortality improvement scenario produces the higher liability at an appropriate level of aggregation.

For life insurance, the margin for adverse deviations for the mortality rate per 1,000 is k/e_x.

For a constant age x, the total mortality rates to project over time, at the valuation date, are calculated as follows:

$$q_x^{VY} = q_x - {}^{k}/_{e_x}$$

$$q_x^{VY+1} = q_x \times (1 - (MImp_x^{VY+1} + MfAD_x \times (1 - DivF))) - {}^{k}/_{e_x}$$

…

$$q_x^{VY+n} = q_x \times \prod_{i=1}^{n}(1 - (MImp_x^{VY+i} + MfAD_x \times (1 - DivF))) - {}^{k}/_{e_x}$$

where:

q_x is the best estimate mortality rate, at age x, at the valuation date,

q_x^{VY} is the mortality rate, which includes prescribed mortality improvement and margins, at age x, at the valuation date in calendar year VY,

q_x^{VY+n} is the projected mortality rate, which includes prescribed mortality improvement and margins, at age x, at the valuation date in calendar year VY, for the calendar year VY+n,

$MImp_x^{VY+n}$ is the base mortality improvement rate at age x for the calendar year VY+n, where VY is the calendar year of the valuation date,

$MfAD_x$ is the mortality improvement margin for adverse deviations at age x,

DivF is the diversification factor, and

e_x is the curtate expectation of life at age x.

Calculation Example: Annuities

The following illustrates the calculation of the total mortality rate, including margins, for annuity business in which the second mortality improvement scenario produces the higher liability at an appropriate level of aggregation.

For annuities, the margin for adverse deviations, $Mort\ MFAD$, is a percentage of the mortality rate.

For a constant age x, the total mortality rates to project over time, at the valuation date, are calculated as follows:

$$q_x^{VY} = q_x \times (1 - Mort\ MFAD)$$

$$q_x^{VY+1} = q_x \times (1 - Mort\ MFAD) \times (1 - (MImp_x^{VY+1} + MfAD_x \times (1 - DivF)))$$

…

$$q_x^{VY+n} = q_x \times (1 - Mort\ MFAD) \times \prod_{i=1}^{n} (1 - (MImp_x^{VY+i} + MfAD_x \times (1 - DivF)))$$

where:

q_x is the best estimate mortality rate, at age x, at the valuation date,

q_x^{VY} is the mortality rate, which includes prescribed mortality improvement and margins, at age x, at the valuation date in calendar year VY,

q_x^{VY+n} is the projected mortality rate, which includes prescribed mortality improvement and margins, at age x, at the valuation date in calendar year VY, for the calendar year VY+n,

$MImp_x^{VY+n}$ is the base mortality improvement rate at age x for the calendar year VY+n, where VY is the calendar year of the valuation date,

$MfAD_x$ is the mortality improvement margin for adverse deviations at age x, and

DivF is the diversification factor.

Numerical Example

The following table illustrates the development of projected mortality rates for males including prescribed mortality improvement and margins, for an annuity at the valuation date December 31, 2017. The highlighted cells contain the mortality rates that would be used for a male age 60 at the valuation date. For the example, it is assumed that the $Mort\ MFAD$ is equal to 5% and that $DivF$ is 20%.

x	q_x^{2017}	q_x^{2018}	q_x^{2019}	q_x^{2020}
60	q_{60} x (1 - 0.05)	q_{60} x (1 – 0.05) x (1 – (0.0178 + 0.005 x (1-0.2)))	q_{60} x (1 – 0.05) x (1 – (0.0178 + 0.005 x (1-0.2))) x (1 – (0.0172 + 0.005 x (1-0.2)))	q_{60} x (1 – 0.05) x (1 – (0.0178 + 0.005 x (1-0.2))) x (1 – (0.0172 + 0.005 x (1-0.2))) x (1 – (0.0165 + 0.005 x (1-0.2)))
61	q_{61} x (1 - 0.05)	q_{61} x (1 – 0.05) x (1 – (0.0177 + 0.005 x (1-0.2)))	q_{61} x (1 – 0.05) x (1 – (0.0177 + 0.005 x (1-0.2))) x (1 – (0.0170 + 0.005 x (1-0.2)))	q_{61} x (1 – 0.05) x (1 – (0.0177 + 0.005 x (1-0.2))) x (1 – (0.0170 + 0.005 x (1-0.2))) x (1 – (0.0164 + 0.005 x (1-0.2)))
62	q_{62} x (1 - 0.05)	q_{62} x (1 – 0.05) x (1 – (0.0176 + 0.005 x (1-0.2)))	q_{62} x (1 – 0.05) x (1 – (0.0176 + 0.005 x (1-0.2))) x (1 – (0.0169 + 0.005 x (1-0.2)))	q_{62} x (1 – 0.05) x (1 – (0.0176 + 0.005 x (1-0.2))) x (1 – (0.0169 + 0.005 x (1-0.2))) x (1 – (0.0162 + 0.005 x (1-0.2)))
…	…	…	…	…
95	q_{95} x (1 - 0.05)	q_{95} x (1 – 0.05) x (1 – (0.0077 + 0.004 x (1-0.2)))	q_{95} x (1 – 0.05) x (1 – (0.0077 + 0.004 x (1-0.2))) x (1 – (0.0075 + 0.004 x (1-0.2)))	q_{95} x (1 – 0.05) x (1 – (0.0077 + 0.004 x (1-0.2))) x (1 – (0.0075 + 0.004 x (1-0.2))) x (1 – (0.0074 + 0.004 x (1-0.2)))
…	…	…	…	…

Mortality Improvement Rates for Out-of-Canada Business

For markets other than Canada, the actuary would select appropriate mortality improvement rates (inclusive of margin) for both life insurance and annuities. These improvement rates would produce a total liability for each of life insurance and annuities that is at least as large as what would be produced using the prescribed rates used in Canada, unless experience indicates otherwise.

Mortality Improvement Rates for Accident and Sickness Insurance – Active Lives

The mortality improvement trends for accident and sickness insurance are expected to be the same for the active lives within accident and sickness insurance as for life insurance and annuities.

In order to determine the minimum valuation assumption, the actuary would perform two valuations using the same mortality improvement scenarios as for life insurance and annuity business, and applying the same considerations for aggregation and diversification.

Mortality Improvement Rates for Accident and Sickness Insurance – Non-Active Lives

The actuary may consider reflecting mortality improvement for non-active lives within accident and sickness insurance; however, the minimum valuation assumption for mortality improvement rates does not apply to the valuation of non-active lives. Non-active lives are lives that are currently receiving benefits and the portion of lives that are expected to be in receipt of future benefits as measured in an active life reserve.

Table 1: Margin for Adverse Deviations to Deduct from/Add to Annual Base Mortality Improvement Rates

(applies to both females and males, and to both smokers and non-smokers)

Attained Age	MfAD	Attained Age	MfAD
0 to 40	1.00%	61 to 90	0.500%
41	0.975%	91	0.480%
42	0.950%	92	0.460%
43	0.925%	93	0.440%
44	0.900%	94	0.420%
45	0.875%	95	0.400%
46	0.850%	96	0.380%
47	0.825%	97	0.360%
48	0.800%	98	0.340%
49	0.775%	99	0.320%
50	0.750%	100	0.300%
51	0.725%	101	0.280%
52	0.700%	102	0.260%
53	0.675%	103	0.240%
54	0.650%	104	0.220%
55	0.625%	105 to 115	0.200%
56	0.600%	116+	0.000%
57	0.575%		
58	0.550%		
59	0.525%		
60	0.500%		