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Educational Note

IFRS 17 Risk Adjustment for Non-Financial Risk for Property and Casualty Insurance Contracts

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Educational Note

IFRS 17 Risk Adjustment for Non-Financial Risk for Property and Casualty Insurance Contracts

Committee on Property and Casualty Insurance Financial Reporting

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MEMORANDUM

To: Members in the property and casualty insurance area

From: Steven W. Easson, Chair
Actuarial Guidance Council

Sarah Ashley Chevalier, Chair
Committee on Property and Casualty Insurance Financial Reporting

Date: June 30, 2022

Subject: **Educational Note: IFRS 17 Risk Adjustment for Non-Financial Risk for Property and Casualty Insurance Contracts**

The Committee on Property and Casualty Insurance Financial Reporting (PCFRC) has prepared this educational note to provide guidance related to the measurement and presentation of risk adjustment for non-financial risk under International Financial Reporting Standard® (IFRS) 17 for property and casualty (P&C) insurers.

This educational note is written primarily from the perspective of Canadian actuaries and is not intended to duplicate any other guidance. Further information (guidance) can be found in the International Actuarial Association guidance and other Canadian Institute of Actuaries (CIA) documents.

Guidance from this educational note would be considered with the following CIA educational notes:

- CIA educational note *Application of IFRS 17 Insurance Contracts*; and
- PCFRC guidance on matters relating to IFRS 17.

This educational note is structured in sections as follows:

- Section 1 provides an introduction.
- Section 2 provides guidance related to transitioning from IFRS 4 to IFRS 17.
- Section 3 provides guidance related to general consideration related to risk adjustment for non-financial risk (RA).
- Section 4 provides guidance on estimating RA for insurance contracts issued using quantile methods.
- Section 5 provides guidance on estimating RA for insurance contracts issued using cost of capital method.

- Section 6 provides guidance on estimating RA for insurance contracts issued using margin method.
- Section 7 provides guidance on estimating RA for reinsurance contracts held.
- Section 8 provides guidance on considerations for catastrophe reinsurance.
- Section 9 provides guidance on combining approaches and methods.
- Section 10 provides guidance on quantification of the confidence level.

A preliminary version of the draft of this educational note was shared with the following committees for their review and comments, and presented to the Actuarial Guidance Council (AGC) in the months preceding its approval:

- Committee on Life Insurance Financial Reporting
- Committee on Risk Management and Capital Requirements
- Committee on the Appointed/Valuation Actuary
- International Insurance Accounting Committee
- Worker's Compensation Committee
- Group Insurance Practice Committee

A preliminary version of the educational note was also shared with the staff of the Accounting Standards Board (AcSB) to broaden consultations with the accounting community. Given that this educational note provides actuarial guidance rather than accounting guidance, the AcSB staff review was limited to citations of and consistency with IFRS 17. CIA educational notes do not go through the AcSB's due process and therefore, are not endorsed by the AcSB.

The PCFRC is satisfied it has sufficiently addressed the material comments received by the various committees and the AGC.

This educational note is the revised version of the *Updated Draft Educational Note: IFRS 17 Risk Adjustment for Non-Financial Risk for Property and Casualty Insurance Contracts* issued in September 2021; key changes from the prior version include editorial changes, updated references due to the issuance of the final educational note on *Application of IFRS 17 Insurance Contracts*, and:

- Clarification that when RA is determined at the unit of account level a combination of methods could be used not only a single method (Section 3.1)
- Additional detail added that the confidence level disclosure could be either a point estimate or a range (Section 3.6)
- Clarification that the cost of capital method does not need to reflect any regulatory framework nor the entity's actual capital (Section 5)
- Moved the section on Quantification of the confidence level using minimal capital test (MCT) from Section 10.3 to Appendix 3, due to the limited applicability of this section (Appendix 3)

The creation of this memorandum and educational note has followed the AGC protocol for the adoption of educational notes. In accordance with the CIA's *Policy on Due Process for the Approval of Guidance Material other than Standards of Practice and Research Documents*, this educational note has been prepared by the PCFRC and has received approval for distribution from the AGC on February 8, 2022.

The actuary should be familiar with relevant educational notes. Educational notes are not binding; rather they are intended to illustrate the application of the standards of practice. A practice that an educational note describes for a situation is not necessarily the only accepted practice for that situation nor is it necessarily accepted practice for a different situation. Responsibility for ensuring that work is in accordance with accepted actuarial practice lies with the actuary. As accepted actuarial practice evolves, an educational note may no longer appropriately illustrate the application of standards. To assist the actuary, the CIA website contains a reference of pending changes to educational notes.

Questions or comments regarding this educational note may be directed to to the Chair of PCFRC and this subcommittee (noted above) at guidance.feedback@cia-ica.ca.

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1. Introduction

IFRS 17 Insurance Contracts (IFRS 17) establishes principles for the recognition, measurement, presentation, and disclosure of insurance contracts. The purpose of this educational note is to provide practical application guidance on Canadian-specific issues relating to the IFRS 17 risk adjustment for non-financial risk (RA) for property and casualty (P&C) insurers. References to specific paragraphs of IFRS 17 are denoted by IFRS 17.XX, where XX represents the paragraph number.

The requirement for the RA, which is a defined term in IFRS 17 Appendix A, is set forth in IFRS 17.37, "An entity shall adjust the estimate of the present value of the future cash flows to reflect the compensation that the entity requires for bearing the uncertainty about the amount and timing of the cash flows that arises from non-financial risk."

Further clarification is provided in IFRS 17.B86–B92. These paragraphs emphasize that the RA relates only to non-financial risk. Insurance risk, lapse risk, and expense risk are listed as examples of risks that are included, whereas operational risks and market risks are excluded. IFRS 17.B91 clearly states that IFRS 17 does not prescribe the estimation technique(s) used to determine the RA, and IFRS 17.B92 notes that "an entity shall apply judgement."

IFRS 17.B91 states that the RA would have the following characteristics:

(a) risks with low frequency and high severity will result in higher risk adjustments for non-financial risk than risks with high frequency and low severity;

(b) for similar risks, contracts with a longer duration will result in higher risk adjustments for non-financial risk than contracts with a shorter duration;

(c) risks with a wider probability distribution will result in higher risk adjustments for non-financial risk than risks with a narrower distribution;

(d) the less that is known about the current estimate and its trend, the higher will be the risk adjustment for non-financial risk; and

(e) to the extent that emerging experience reduces uncertainty about the amount and timing of cash flows, risk adjustments for non-financial risk will decrease and vice versa.

The RA is explicitly included in the insurance contract liabilities and is disclosed per the requirements of IFRS 17.100–107 and IFRS 17.119.

Chapter 4 of the CIA educational note *Application of IFRS 17 Insurance Contracts* (Ed Note *IFRS 17 Application*) provides general guidance about the RA. The Ed Note *IFRS 17 Application* adopts without modification the *International Actuarial Note (IAN) 100 – Application of IFRS 17 Insurance Contracts* of the International Actuarial Association (IAA).

In this educational note, "approach" is used to denote an overall way of addressing the RA. In practice, "technique" and "method" are often used interchangeably, however in this educational note, "method" is used consistently to refer to the detailed process (including calculations) to determine and allocate (if necessary) the RA.

Within the IAA guidance, question 4.3 of the Ed Note *IFRS 17 Application* states (emphasis added):

> **This general guidance means that there is no single correct way for an entity to set the risk adjustment.** In general, some of the important considerations that will be relevant to how an entity determines its approach to estimating the risk adjustment will include, but are not limited to:
>
> - consistency with how the insurer assesses risk from a fulfilment perspective;
> - practicality of implementation and ongoing re-measurement; and
> - translation of risk adjustment for disclosure of an equivalent confidence level measure.
>
> **Therefore, a variety of methods are potentially available, although the ultimate choice depends on the extent to which the choice of method(s) conforms with the requirements of paragraph 37 and the five characteristics in paragraph B91, given the specific circumstances of the entity.** Potential methods include, but are not limited to, quantile techniques, such as the confidence level or Conditional Tail Expectation ("CTE"), or cost of capital techniques. The choice may also be influenced by the entity's risk management policies and practices.

Regardless of the estimation method, the actuary would ensure that the resulting RA represents the compensation the entity requires for accepting uncertainty in the amount and timing of the cash flows arising from non-financial risk (uncertainty related to non-financial risk). This educational note provides specific application guidance, as well as background and general information, to help inform Canadian actuaries when exercising judgment for derivation of the RA.

Equally important to the objective of this educational note is understanding what the educational note is not intended for. Consistent with IFRS 17, this educational note:

- does not prescribe which approach or method to use for the RA in the aggregate or for the RA by portfolio of insurance contracts[1] (portfolio) or group of insurance contracts[2] (group);
- does not include statistical detail of the methods;
- does not include detailed descriptions of how any given approach or method would be applied;
- does not contain an exhaustive list of the approaches or methods that may be acceptable for deriving the RA. For additional detail (including underlying statistical theory) regarding quantile methods, the cost of capital method, internal models, and diversification, all of which may be important for the actuary responsible for deriving

[1] IFRS 17 defines portfolio as "Insurance contracts subject to similar risks and managed together."

[2] IFRS 17 defines groups of contracts as "A set of insurance contracts resulting from the division of a portfolio of insurance contracts into, at a minimum, contracts issued within a period of no longer than one year…"

the RA, the actuary is referred to the basic education material of the actuarial societies as well as the IAA monograph titled *Risk Adjustment for Insurance Contracts under IFRS 17* (IAA *Risk Adjustment* monograph); and

- does not address the wording of the Appointed Actuary's (AA's) Expression of Opinion.

In writing this educational note, the PCFRC Risk Adjustment Subcommittee followed these guiding principles:

- Consider Canadian-specific perspectives rather than simply repeating international actuarial guidance.
- Develop application guidance that is consistent with IFRS 17 and applicable Canadian actuarial *Standards of Practice* and educational notes without unnecessarily narrowing the choices available in IFRS 17.
- Consider practical implications associated with the implementation of potential approaches and methods; in particular, ensure that due consideration is given to options that do not require undue cost and effort to implement.

2. Transition from IFRS 4 to IFRS 17

The valuation of insurance contract liabilities for fiscal years effective prior to January 1, 2023 are subject to IFRS 4, and are therefore guided by CIA Standards of Practice that were in effect at that time and related educational notes. As such, discussion in this educational note about processes under IFRS 4 (such as the use of margins for adverse deviations (MfADs)) pertain to Canadian accepted actuarial practice prior to the adoption of IFRS 17.

Section 9 of the educational note *Comparison of IFRS 17 to Current CIA Standards of Practice* provides a comparison of MfADs and RA:

> IFRS 17 requires the entity to adjust the present value of future cash flows to reflect "the compensation that the entity requires for bearing the uncertainty about the amount and timing of the cash flows that arises from non-financial risk" (IFRS 17.37).
>
> The corresponding concept in the current CIA Standards of Practice is the PfAD [provision for adverse deviations], which takes account of the effect of uncertainty of the assumptions and data in determining the liability.
>
> While the concepts are similar, there are important differences. One difference is that the IFRS 17 risk adjustment for non-financial risk only includes provision for non-financial risk, while PfADs cover uncertainty in both economic and non-economic assumptions.

Although the approach selected to derive the RA may, in the end, be similar to the approach used under IFRS 4, IFRS 17 requires the RA to reflect the compensation the entity requires for taking on risk as opposed to margins that cover adverse deviations.

If the actuary uses IFRS 4 MfADs as the starting point for calculating the IFRS 17 RA, then the actuary would assess the questions posed in Section 9.2 of the educational note *Comparison of IFRS 17 to Current CIA Standards of Practice*:

- Is the current level of PfAD consistent with the compensation the entity requires for bearing uncertainty?
- Are the diversification benefits included in current PfADs consistent with those that would be reflected in IFRS 17?
- How would the confidence level (to satisfy disclosure requirement of IFRS 17.B92) inherent in the current PfADs be determined?
- IFRS 17 requires reinsurance contracts held to be measured as separate contracts. How would the PfAD appropriate to the net liability be split between the direct and ceded contracts?
- Are any adjustments needed for pass-through features?

The CIA standards of practice relevant to IFRS 4 may provide insight for establishing margins under IFRS 17.[3] In the margin-setting process for a given group, the actuary would look to the risk exposure of the broader entity to consider whether there are potential diversification benefits to reflect in the entity's RA. (See Section 3.2.2.) As noted previously, IFRS 17 does not specify the estimation technique(s) used to determine the RA. Some Canadian actuaries may find it operationally efficient to continue to apply margins either to derive the total RA or to allocate the total RA between portfolios and/or groups. However, other considerations, such as the suitability of the margins to reflect an entity's requirement for compensation and the margins' associated confidence level, which is required for disclosures, would also be considered. Use of margins would be acceptable if the resulting RA satisfies the five characteristics defined in IFRS 17.B91. Note that existing Canadian IFRS 4 guidance for setting MfADs is based on similar considerations.

In practice, under IFRS 4, most Canadian entities are unlikely to have previously identified a specific metric or set of metrics that explicitly defines the compensation the entity requires for bearing non-financial risk. Such metrics or articulation of risk appetite, if they exist, would likely consider all risks including financial risks and thus not be directly comparable to the scope of the RA. Therefore, the actuary would need to justify how the selected margins and/or the resulting confidence level of the RA reflect the entity's compensation required for the uncertainty related to non-financial risk.

3. General considerations

3.1 Measurement approach

In supporting an insurer to achieve the requirements specified in IFRS 17.37, the actuary would (1) understand the compensation required by the entity for the uncertainty related to non-financial risk and (2) develop an RA that reflects such compensation. The compensation the entity requires is a subjective assessment of an entity's own risk appetite.

[3] Further detail contained in Appendix 1.

There is more than one way for an entity to develop a price for that risk. Questions 4.9 and 4.13 in the Ed Note *IFRS 17 Application* provide further general guidance. The answers to these questions refer to the entity's pricing as a potential reference point for measuring the entity's risk aversion and/or compensation requirements. The actuary would consider whether the compensation the entity requires reflects any pricing concessions due to competitive market pressure and/or price discounting in pursuit of aggressive market positioning. One view is that the actual pricing is a market observable evidence of the compensation the entity requires. An alternative view is that an entity may temporarily accept other than its theoretical steady-state compensation requirements, and that the RA would reflect the latter. Depending on the approach followed, the experience for a given group of contracts or portfolio may cause the assumptions underlying the compensation requirements of the entity to change over time.

Generally, entities require compensation for bearing the uncertainty, however, some entities might not require a compensation. To determine if a zero RA may be appropriate for such entities, in addition to the entity's risk appetite, their pricing and capital management policies/practices may be considered, as well as the contract boundary of the insurance contract and the policyholder's ability to transfer risk to another entity on renewal. If the group of contracts has a short contract boundary (the entity is able to recover deficits through future premiums, however these recoveries are outside of the contract boundary), or if the entity holds capital to support uncertainty in the future cash flows, a non-zero RA may be required. Where a zero RA is selected the actuary would ensure that there is sufficient documentation in place around this selection and the rationale for it, similar to cases where a non-zero RA is selected. Further guidance that may be useful for entities that do not require compensation for bearing uncertainty can be found in the educational note on the *Application of IFRS 17 Insurance Contracts for Public Personal Injury Compensation Plans*[4].

It is necessary that the RA at each reporting date satisfies the overall requirements of IFRS 17 for measurement, presentation, and disclosure of insurance contracts. In selecting a particular approach, the actuary would consider the accounting measurement requirements for the RA as well as the aggregated presentation and disclosure requirements. (Section 3.7 addresses RA requirements specific to the premium allocation approach (PAA).)

The unit of account for IFRS 17 is usually the group or a single insurance contract. In all the following sub-sections within Section 3, the unit of account could refer to a different group level whether it applies to the liability for remaining coverage (LRC) or the liability for incurred claims (LIC) calculations. For LRC, it refers to a group of insurance contracts (may be a single one), onerous or not, per IFRS 17.16. For LIC, it may refer to the same group of contracts in some particular situations but most of the time it refers to a portfolio.

3.1.1 Measurement requirements related to the RA – unit of account

The measurement requirements (and some presentation and disclosure requirements) are applied at the unit of account level. For the RA, the unit of account has the following implications:

[4] Canadian Institute of Actuaries *Educational Note: Application of IFRS 17 Insurance Contracts for Public Personal Injury Compensation Plans* (2022).

- The RA is determined on initial recognition and at each reporting date and reported for each group (IFRS 17.32 and IFRS 17.40).
- The RA for a group influences the measurement of the contractual service margin (CSM) and/or the loss component for the group at initial recognition (IFRS 17.38) and subsequent measurement (IFRS 17.B96(d)).
- For contracts initially recognized in a period, the RA is required to satisfy the grouping requirements of IFRS 17.16 (i.e., to identify onerous contracts) unless the PAA measurement is used in which contracts are assumed to not be onerous unless facts and circumstances indicate otherwise.

IFRS 17.24 allows the fulfilment cash flows (of which the RA is a part) to be determined at a higher level of aggregation than the group and then allocated to the relevant groups, provided that the allocations result in appropriate fulfilment cash flows in the measurement of the group.

3.1.2 Disclosure requirements related to the RA – aggregate/entity level

While the measurement requirements of IFRS 17 require an RA for each unit of account, most of the presentation and disclosure requirements of IFRS 17.78–109 are typically met at a more aggregated level, such as portfolio or entity level.

IFRS 17.117(c)(ii) specifically requires disclosure of the approach (which using the terminology of this educational note would also include method) used to determine the RA.

While the approach selected needs to reflect the compensation that the entity requires for bearing the uncertainty about both the amount and the timing of the cash flows arising from non-financial risk, there is no requirement to explicitly disclose these two components of the RA separately.

IFRS 17.119 requires disclosure of the confidence level corresponding to the reported RA. Depending on the approach and method used, the confidence level will be either an explicit input to the RA calculation or an implicit result of the calculation.

3.1.3 Selection of a measurement approach

The actuary may view the aggregate entity level perspective as the primary basis for determining the RA (perhaps driven by disclosure requirements or aligned at the level at which the entity thinks about compensation). With an aggregate approach, the actuary would need to allocate the total RA to the units of account to satisfy the IFRS 17 measurement requirements. Some of the methods described in this educational note are more aligned with an aggregate approach (e.g., quantile methods) than with an approach focused on the unit of account.

Alternatively, the actuary may develop the RA at the unit of account level to more directly facilitate the measurement requirements of IFRS 17. The margin method can be used for a unit of account approach. To the extent that the entity chooses to reflect the benefits of diversification in its RA, the margins would be developed such that they reflect diversification among the non-financial risks across the entity's units of account. Alternatively, where a single method may not be suitable, a combination of methods could be used at the unit of account

level to derive RA. The sum of the RA calculated at the unit of account level would be the entity's aggregate RA.

3.2 Diversification, allocation, and aggregation

The entity's perspective on diversification affects both the amount of the RA and the assessment of the confidence level of the RA. Diversification may arise from the different types of insurance risk (e.g., reserve, underwriting, and catastrophe), among portfolios, and among related entities. The mechanics of how the actuary reflects diversification benefits may differ depending on whether the actuary uses an entity level or unit of account approach.

The entity may consider the potential diversification among types of insurance risks when calculating the RA for the liability for incurred claims (LIC) even if an explicit RA is not calculated for the liability for remaining coverage (LRC) for contracts for which PAA is applied. In determining the RA, the actuary would consider the non-financial risks associated with future service (i.e., LRC) and past service (i.e., LIC).

3.2.1 Diversification and allocation in an aggregate approach

To the extent that an entity level perspective is taken as the primary approach, the aggregate risk distribution would reflect the entity's perspective of the benefits of diversification among its component risks. For example, the entity may assess the degree of diversification that it expects arising from underwriting risk, reserve risk, catastrophe risk, and between portfolios or groups, to the extent facts and circumstances warrant or management so chooses.

Incorporating diversification can be based upon statistical or empirical analyses, expert judgment, or causal relationship. The more uncertain the diversification benefit, the less likely such benefit would be fully reflected in the aggregate risk distribution. Two common methods used by actuaries to quantify the effect of diversification are correlation matrices and copulas.

The Insurance Bureau of Canada's *Handbook for Economic Capital Modelling* states the following about correlation matrices:

> Correlations are often used in explicitly modelling dependencies. Correlation is the degree to which statistical distributions (and thus risks) are [linearly] related to each other. Correlation must take a value between -1 (perfect negative correlation) and +1 (perfect positive correlation). A correlation matrix is simply a matrix in which the correlations between pairs of data are specified. Correlation matrices must be symmetric, which means that the correlation between risks A and B is the same as the correlation between risks B and A in the correlation matrix. Correlation matrices must also be positive semi-definite (PSD). For example, if a correlation of +1 is chosen between risks A and B and risks A and C, a correlation of -1 between [B and C] is not logical; this results in a non-PSD matrix.[5]

If using correlation matrices, the actuary would consider the confidence level of the RA to ensure that the correlation factors still apply at the selected confidence level. Furthermore, the

[5] The Insurance Bureau of Canada, Handbook for Economic Capital Modelling (2018), 153

correlation factors would be considered in the context of the entity's own circumstances; the use of a "one size fits all" correlation matrix may not be appropriate.

The IAA *Risk Adjustment* monograph discusses copulas as follows:

> The joint distribution of a set of random variables contains all the information about their individual (marginal) distributions and dependence structure. Dependence is a property of their copula. Copulas allow one to deal with the dependence among random variables separately from their marginal distributions. The estimation of the multivariate distribution is decoupled into estimation of the marginal distributions, which is more robust, and the estimation of the dependence relationship, which may have scarce data on which to rely.[6]

The joint distribution is obtained by combining the marginal distributions and a copula function. For further information, see the IAA *Risk Adjustment* monograph.

The compensation the entity requires for non-financial risk would determine the confidence level at which the entity chooses to set its RA. The benefits of diversification reflected in an aggregate RA calculation are passed down to the unit of account via an allocation process.

The actuary may allocate the RA to the unit of account level directly (using a proportional or other method) or indirectly (by calibrating margins such that a unit of account calculation aggregated across all groups yields the same RA as the entity level calculation). In both direct and indirect allocations, the sum of the RA for all units of account would be equal to the aggregate entity level RA. Any allocation approach where the RA at the unit of account level meets the characteristics set out in IFRS 17.B91 could be reasonable.

If the overall RA is derived based on the cost of capital method or quantile method, the RA may be disaggregated by allocating based on:

- the indicated RAs solely based on each amalgamated group[7];
- the marginal impact of removing each amalgamated group on the indicated overall RA;
- an average of the first two approaches; or
- an alternative approach.

Allocation to a given amalgamated group based on the marginal impact is given by the amount of capital required for the entity, less the capital required for the entity if that amalgamated group was excluded. However, if these amalgamated groups are not aligned with the RA granularity required under IFRS 17, further allocations may be required using different approaches. Examples of the proportionate allocation are presented in the illustrative examples in Appendix 4.

[6] International Actuarial Association, Risk Adjustments for Insurance Contracts under IFRS 17 (2018), 89-90.

[7] Amalgamated group refers to the modelling classes within the cost of capital method and quantile method, these could be at the portfolio, group of contracts, line of business or other granularity.

The margin method described in Section 6 could be an appropriate basis of indirect allocation. Within this method, both quantitative and qualitative insights could be used to ensure that the allocation reflects the risk characteristics of the units of account.

While the proportional method and the marginal method are common approaches to allocate the RA, variants of these approaches or other approaches can be considered. Literature about capital allocation offers useful descriptions of these concepts. Multiple practitioners have independently developed and adapted variants of the marginal approach applied to simulation-based models, for example the Myers-Read[8], Ruhm-Mango-Kreps[9] or Euler approaches[10].

IFRS 17 prescribes neither the aggregation nor allocation methods. While this educational note includes descriptions and examples of some approaches and methods, it is beyond the scope of this educational note to provide an exhaustive list. The CIA published a research paper on *Risk Aggregation and Diversification* in April 2016; and more generally, the enterprise risk management section of the CIA website contains additional resources on aggregation and diversification.

3.2.2 Diversification and aggregation in a unit of account approach

When the RA is developed at the unit of account level, the entity's aggregate RA is equal to the sum of the RA for all units of account. The RA developed independently for one particular unit of account may or may not reflect the benefits of diversification with other units of account of the entity.

To the extent that diversification between different portfolios within an entity and/or diversification between related entities are considered in pricing, there would be clear support that reflecting similar diversification in the RA directly reflects the compensation the entity requires. If pricing does not account for diversification between portfolios and/or entities, then justification for including such diversification in the RA could prove more difficult and would depend on the particular facts and circumstances of the entity. Ultimately, the level of the RA for any given group is a matter of judgment, and the actuary would ensure that the resulting aggregate RA reflects the compensation the entity requires for uncertainty related to non-financial risk.

To the extent that the benefits of diversification are fully reflected in the assumed underlying probability distribution but are not fully reflected in the calculation of the entity's RA, the resulting confidence level of the RA would be higher than had the full benefits of diversification been passed down to the unit of account level. Expressed another way, the more conservative the view an entity takes in applying diversification at the unit of account level, the higher will be the resulting RA and its reported confidence level.

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[8] Ruhm D.L., Mango D.F., A Method of Implementing Myers-Read Capital Allocation in Simulation, CAS E-Forum 2003, pp 451-457 (accessed May 4, 2021).

[9] D'Arcy S., Capital Allocation in the Property-Liability Insurance Industry, *Variance*, vol. 5, issue 2, 2011, pp 141-157, (accessed May 4, 2021).

[10] Tasche D., Euler Allocation: Theory and Practice, CERN 2007 (accessed May 4, 2021).

3.2.3 Diversification between entities

Question 4.10 in the Ed Note IFRS 17 Application presents the perspective on diversification when a parent entity is composed of subsidiary entities.

> ... where insurance contracts are issued by one or more subsidiaries in a group, it is open to the reporting entity to assess the risk adjustments appropriate to contracts in each subsidiary independently of any support that the holding entity may provide or to reflect that support in its risk aversion and, hence, implicitly allow for diversification across part or all of the group.

The method used would be consistent from period to period and reflect how the level of risk is considered and managed by the entity.

The Transition Resource Group for IFRS 17 (TRG) has discussed the topic of diversification between entities in their May 2018 meeting; while TRG discussions are not official guidance they do provide practical information and background on issues. The TRG meeting notes are available as an IFRS® publication in "*Summary of the Transition Resource Group for IFRS 17 Insurance Contracts meeting held on 2 May 2018*."

3.3 Reinsurance held

Under IFRS 17, the RA on reinsurance held is normally reported as a positive asset. In effect, the reinsurance RA represents the risk ceded to the reinsurer. Reinsurance non-performance risk is reflected through a reduction in the present value of future cash flows, not through the RA, however non-performance risk may have an "indirect" impact on the RA due to a reduction of future cash flows on which the RA is based. Additional guidance on non-performance risk can be found in Section 6.4 of the educational note on *IFRS 17 Actuarial Considerations Related to Liability for Remaining Coverage in P&C Insurance Contracts*[11].

Under IFRS 17, insurance contract liabilities (including liabilities on reinsurance contracts issued) are reported separately from liabilities on reinsurance contracts held. Similarly, where explicit disclosure of the RA is required, the RA is reported separately for insurance contracts issued and reinsurance contracts held. In this educational note, "gross RA" refers to the RA included in insurance contract liabilities (including reinsurance contracts issued) and "ceded RA" refers to the RA included in assets for reinsurance contracts held. This concept is articulated in IFRS 17.64, which specifically requires an explicit RA for ceded reinsurance contracts:

> Instead of applying paragraph 37, an entity shall determine the risk adjustment for non-financial risk so that it represents the amount of risk being transferred by the holder of the group of reinsurance contracts to the issuer of those contracts.

This separation of gross and ceded RA may not always be intuitive. This issue is addressed in question 9.10 of the Ed Note *IFRS 17 Application*:

[11] Canadian Institute of Actuaries *Educational Note: IFRS 17 - Actuarial Considerations Related to Liability for Remaining Coverage in P&C Insurance Contracts* (2022).

A specific definition for the determination of the risk adjustment for reinsurance contracts held is provided that replaces the general definition in paragraph 37 used for insurance and reinsurance contracts issued in the standard. Under the definition for reinsurance held, the risk adjustment for non-financial risk represents the amount of non-financial risk being transferred by the holder of a group of reinsurance contracts to the issuer(s) of those contracts (paragraph 64).

The risk adjustment for the reinsurance held can therefore conceptually be thought of as the difference in the risk position of the entity with (i.e., net position) and without (i.e., gross position) the reinsurance held. As a result, the risk adjustment for the reinsurance held could be determined based on the difference between these amounts.

Another possibility to determine the risk adjustment for reinsurance held is to consider the cost of reinsurance as an indicator of the entity's view of the compensation that would be required to keep (i.e., not reinsure) the risk. Under this view, the cost of reinsurance would be an estimate of the risk adjustment for the reinsurance held.

For reinsurance held, because the risk adjustment for reinsurance held is defined based on the amount of risk transferred to the reinsurer, the risk adjustment for reinsurance held will either increase the reinsurance contract asset or reduce the reinsurance contract liability. This has the opposite effect from the risk adjustment on insurance contracts issued. For example, the release of the risk adjustment on reinsurance contracts held in a reporting period will reduce reported profit rather than increase.

The RA reflects the compensation the entity requires for uncertainty related to non-financial risk and would be determined for gross insurance contract liabilities and ceded insurance contract assets. Ultimately, the key concepts underlying the RA are:

- The gross RA (i.e., pertaining to insurance contracts including reinsurance contracts issued) represents the compensation for non-financial risk that the entity requires for issuing those contracts, and
- The ceded RA (i.e., pertaining to reinsurance contracts held) represents the non-financial risk transferred from the entity to the reinsurer(s).

Any method that respects these concepts would generally be acceptable. However, in very unusual circumstances, the indicated ceded RA could be negative, however, it is important that the selected RA on reinsurance held reflects the transfer of risk to the reinsurer(s); the entity would not transfer negative risk and the ceded RA would not be negative. A negative ceded RA is usually an indication that an adjustment to an assumption is needed, or that there is insignificant risk transfer; the ceded RA may be floored at zero, if there are sufficient justifications to support it. For more detail on reinsurance held methods, refer to Section 7.

Reinsurance is a hedge against the risk in the insurance contract. Theoretically, where the price of reinsurance is proportional to the level of risk being hedged (i.e., ceded) from the entity's

perspective and where the majority of portfolios and years of claims reserves are subject to the same ceded percentages, then the ceded RA may be proportional to the gross RA (depending on the potential effect of diversification). The gross RA would be unaffected by the presence of reinsurance unless the reinsurance hedge affects the level of compensation required on the insurance contract; for example, some insurance contracts may not be issued if reinsurance cannot be secured on them.

An entity's reinsurance portfolio may contain a mix of proportional contacts (at potentially different ceding percentages by portfolio and/or by year) as well as excess of loss or other forms of reinsurance contracts. From the entity's perspective, when the price of reinsurance is not proportional to the level of risk being hedged, the ceded RA may not be proportional to the gross RA. The cost of the reinsurance may be viewed as evidence of the price the entity is willing to pay to be relieved of risk and therefore indicative of the entity's compensation requirements related to the uncertainty of the risk being ceded.

3.4 Discount rate

IFRS 17 provides no direction regarding the discounting of the RA. IFRS 17.B90 states: "[t]he risk adjustment for non-financial risk is conceptually separate from the estimates of future cash flows and the discount rates that adjust those cash flows." Furthermore, IFRS 17.B92 states: "[a]n entity shall apply judgement when determining an appropriate estimation technique for the risk adjustment for non-financial risk."

Consequently, the use (or absence) of discounting and the method of determining discount rates, if applicable, are at the discretion of the entity. More than one discounting method is possible. Regardless of the discounting method chosen, the actuary would maintain a consistent method between reporting periods.

Changes in discount rates will affect the current value of the RA if the derivation of RA requires the use of discounting. Under IFRS17.81, the entity is not required to bifurcate the change in RA into its component pieces (i.e., change in undiscounted provision for non-financial risk vs. change in effect of discounting). If not bifurcated, the entire change in RA is presented as part of the insurance service result, and the entire change in RA related to future services adjusts the CSM or loss component.

3.5 Time horizon

The appropriate time horizon for calculating IFRS 17 RA is the lifetime of the uncertainty in the insurance contract cash flows.

Actuaries using an internal model[12] for determining the RA would be aware that there may be no link between the confidence level corresponding to the RA and the confidence level underlying the internal model. For example, the result of an internal model calibrated to cover

[12] The term "internal model" is often used interchangeably with "economic capital model." The International Association of Insurance Supervisors states: The term "internal model" refers to "a risk measurement system developed by an insurer to analyse its overall risk position, to quantify risks and to determine the economic capital required to meet those risks." Internal models may also include partial models which capture a subset of the risks borne by the insurer using an internally developed measurement system which is used in determining the insurer's economic capital.

risks at a confidence level of value at risk (VaR) 99.5 percentile over a one-year horizon is conceptually very different than an RA calculation calibrated to a lifetime horizon. The RA would generally be calculated at a lower percentile over a longer time horizon than the economical capital resulting from the internal model, and thus the two amounts would not likely be comparable. For an actuary to use an internal model for determining the RA, the internal model would need to be re-calibrated to reflect any differences in time horizon and confidence level.

When using a cost of capital method, the capital amounts supporting the non-financial risk and held over the lifetime of the insurance contract cash flows would be estimated. Conceptually, insurance contract lifetime cash flows that were selected for such modelling may correspond to a certain confidence level. Alternatively, the amount of capital held in each period may be based on a certain confidence level of the distribution of the present value of the remaining contract cash flows. The RA would reflect the capital amount held and the return required on the capital.

3.6 Disclosure requirements

3.6.1 Disclosure of reconciliations

General IFRS 17 disclosure requirements are outlined in IFRS 17.93 through IFRS 17.132. Elements specific to the RA include the requirement to disclose a reconciliation of the movement in the RA from the opening balance to the closing balance (IFRS 17.100 for PAA and IFRS 17.101 for general measurement approach (GMA))[13] and the requirement to disclose significant judgements and changes in judgments used in the calculation of the RA (IFRS 17.117). Disclosures required by the Office of the Superintendent of Financial Institutions (OSFI) and the Autorité des marchés financiers (AMF) are expected to be more granular than those required by IFRS 17. For example, experience by coverage for automobile insurance policies is expected to be required.

3.6.2 Disclosure of the confidence level

Disclosure requirements for the confidence level are noted in IFRS 17.119:

> An entity shall disclose the confidence level used to determine the risk adjustment for non-financial risk. If the entity uses a technique other than the confidence level technique for determining the risk adjustment for non-financial risk, it shall disclose the technique used and the confidence level corresponding to the results of that technique.

It is reasonable to infer that IFRS17.119 refers to the entity's aggregate RA, and it would be at the discretion of the entity to disclose the confidence level of RA at lower granularity levels (e.g., portfolio or group) in addition to the overall entity level. Disclosure of the confidence level as either a point estimate or range would be acceptable.

[13] Disclosures required by OSFI and AMF are expected to be more granular than those required by IFRS 17. For example, experience by coverage for automobile insurance policies is expected to be required by OSFI and AMF.

With respect to the determination of the confidence level, question 4.18 in the Ed Note IFRS 17 Application states:

> In order to determine confidence levels, only a portion of the probability distribution would be needed. If that probability distribution is not explicitly derived as part of the measurement process, some method or model might be needed to estimate the percentiles of that combined portfolio distribution of the fulfilment cash flows at the amount which includes the risk adjustment. The extent of the analysis needed for such estimation is likely to require judgement.

Potential methods for the determination of the confidence level range from full stochastic modelling to a relatively simple assumption about the shape of the underlying probability distribution.

Determining the confidence level corresponding to the RA may be operationally burdensome; nevertheless, the confidence level is a required disclosure under IFRS 17. Therefore, the actuary would need to assess the practicality, cost, and effort associated with the selected method. In particular, it is possible that parameterization of a full stochastic model may require so many assumptions that the accuracy of the resulting confidence level becomes spurious. In many situations, a more simplified approximation method may provide an equally reasonable estimate of the confidence level at much less cost and effort. The degree of rigour is an entity-specific decision.

Regardless of the method selected, the actuary would be aware that the quantification of the confidence level is an estimate, given the unobservable nature of the full probability distribution of the present value of the cash flows. The actuary would make users of the information aware that the quantification is based on certain methods and assumptions and take care to apply those methods and assumptions consistently from period to period.

Disclosure requirements specific to PAA are described in Section 3.7.

3.7 Risk Adjustment under premium allocation approach

An estimate of the LRC calculated under the GMA includes an RA, whereas an estimate of the LRC calculated under PAA does not, unless the group is onerous. Regardless of whether the LRC is calculated under PAA or GMA, the LIC requires an explicit RA. The fact that the treatment of the RA differs for the LRC and the LIC may complicate the calculation and/or disclosure of the confidence level required by IFRS 17.119.

For an entity using PAA, an explicit RA calculation for the LRC is not required for financial reporting purposes for groups that are not deemed onerous. Under the PAA, contracts are assumed to be non-onerous unless facts and circumstances indicate otherwise; these facts and circumstances may include an estimate of the RA, however it is not explicitly required by the standard. If facts and circumstances indicate that the group is onerous, then the entity is required to calculate the fulfilment cash flows that relate to the LRC, which includes calculating the RA to determine the loss component. If the calculations confirm that the insurance contracts are onerous, the entity is required to separately disclose the LRC excluding any loss component and the loss component; disclosure of an explicit RA amount, however, is not

required. If the calculations confirm that the contracts are not onerous, the only disclosure required is the LRC excluding loss component under PAA.

The LIC comprises the fulfillment cash flows related to past service[14]; the estimates of future cash flows are adjusted to reflect the time value of money (and the financial risks related to those cash flows) and the compensation that the entity requires for bearing the uncertainty about the amount and timing of the cash flows that arises from non-financial risk. As a result, for the determination of LIC with non-zero future cash flows, a calculation of the RA is always required. Disclosure requirements for the LIC specify a split between the RA and the LIC excluding the RA at the entity level. The RA may need to be available at a lower level of aggregation than the entity level. Entities will have to consider the level of disaggregation that is appropriate to achieve the general disclosure objective in IFRS 17.93.

For entities where the primary (or only) measurement approach for the LRC will be PAA, the actuary may seek a method to estimate the RA for testing onerous contracts that maximizes operational efficiency. The actuary may consider the volatility associated with the LRC, but in situations where the RA is mainly driven by volatility in the cash flows associated with claims activity and where the cash flows associated with premium activity for the LRC are not subject to volatility, the RA required for the LRC of onerous groups may be approximated by making use of the RA derived for the LIC.

The requirement to reflect diversification applies regardless of the entity's selected measurement approach (i.e., GMA vs. PAA). Thus, the considerations described in Section 3.2 apply for entities adopting PAA. Regardless, the calculations may be more challenging as the RA may not be explicitly calculated for the LRC.

4. Quantile methods

As noted previously, this educational note does not contain an exhaustive list of methods nor does it contain detailed statistical background and descriptions. The actuary is referred to the IAA *Risk Adjustment* monograph, which was developed explicitly for purposes of IFRS 17.

4.1 Introduction

Quantile methods, including VaR and CTE, use distributions of the fulfilment cash flows to determine the RA for a given probability. One key advantage of a quantile method performed at an aggregate level is that it directly satisfies the IFRS 17 disclosure requirements regarding confidence level corresponding to the RA. The IAA *Risk Adjustment* monograph states: "A key advantage of the quantile techniques is that the mathematics enable risks to be represented graphically which creates ease and convenience in understanding the result. A disadvantage is that if misrepresented, it may introduce spurious accuracy."

Assessment of the confidence level corresponding to the RA would generally require underlying assumptions of the risk distribution. Given a risk distribution, both VaR and CTE can be calculated. It is important for the actuary to recognize that a VaR calculation may not capture

[14] While the LIC is often described as always being measured under the GMA, for groups of contracts where the LRC is measured under PAA, there are some differences in the measurement and disclosure requirements for LIC as well. See IFRS 17.59(b) and IFRS 17.97-109 for further details.

the risk for a particularly skewed distribution of cash flows, which are common for certain P&C risks, and thus may not be an appropriate method to use. For further discussion of the use of VaR and CTE for RA, the actuary is referred to the IAA *Risk Adjustment* monograph.

This section provides a high-level overview of possible methods to generate a risk distribution and describes how quantile methods (including VaR and CTE) are applied to determine the RA. Detailed theoretical background information and implementation guidance for quantile methods are beyond the scope of this educational note.

4.2 Generating a distribution

To generate a distribution of the underlying future cash flows, different methods may be considered:

- Apply a suitably skewed probability distribution (e.g., lognormal or gamma distribution) to projected future cash flows;
- Monte Carlo simulation;
- Bootstrapping; and
- Scenario modelling.

Each of these are described briefly below. The actuary would consider how well the selected method measures the non-financial risk associated with timing and amount of future cash flows, and may consider making adjustments if these are not fully reflected. In modelling insurance risk stochastically, the actuary may consider parameter risk, process risk, and model risk. For further information, the actuary is referred to the IAA *Risk Adjustment* monograph.

4.2.1 Probability distribution for present value of cash flows

Under IFRS 17, the actuary would estimate an unknown variable (i.e., fulfilment cash flows), which conceptually is derived from an analysis of the full range of possible outcomes of the contractual cash flows. In practice, however, it may be extremely difficult to observe the full range of possible outcomes or the underlying probability distribution that defines the full range of possible outcomes. The actuary may therefore assume the shape of the underlying probability distribution. For example, the actuary may assume a lognormal or gamma distribution, both of which exhibit skewness. There are many other distributions that may appropriately represent the characteristics of an entity's cash flows; however, it is beyond the scope of this educational note to provide an exhaustive list.

4.2.2 Monte Carlo simulation

Non-financial risks can be modelled stochastically. The Monte Carlo method may be used to repeatedly simulate a random process for relevant risk variables (such as reserving, underwriting, and catastrophe risk) covering a wide range of possible situations. In general, thousands of simulations are typically generated under the Monte Carlo method to reduce sampling variability. The actuary is able to derive a probability distribution based on the resulting simulations of the entity's aggregate risks. This enables the RA to be set at the target percentile level of the observed distribution.

4.2.3 Bootstrapping

The IAA *Risk Adjustment* monograph describes bootstrapping as follows:

> This is a resampling technique where historical observations are used to create stochastic scenarios. Rather than a hypothetical distribution, this technique relies on historical information as potential future observations. As an example, to estimate the variability of the sample mean in the original data set, sampling with replacement to generate multiple future populations may create an appropriate distribution of sample means. For non-life insurance reserves, this approach has also been used to generate the probabilities of uncertain outcomes. However, in many applications some sort of normalization would be appropriate to remove such factors as seasonality, or adjust for exposure. This technique has merit because it may more closely resemble what historical data has shown can happen. This method also does not restrict the recognition of heavy tails or other observations that depart from theoretical distributions. However, it may be a poor approximation for small samples and it relies heavily on the fact that each sampled variable is independent from another. Another disadvantage is that the variability of outcomes for future cash flows may not be adequately represented by historical observations in a particular data set, particularly for low frequency, high severity outcomes or other unusual events.[15]

4.2.4 Scenario modelling

Scenario modelling is mentioned as an alternative method in Question 4.14 of the Ed Note *IFRS 17 Application* for reflecting qualitative risk characteristics "provided suitable extreme scenarios are included." Instead of different assumptions applied to each risk, a combination of assumptions or a scenario reflecting multiple non-financial risks may be applied to the underlying insurance contracts. In practice, however, the actuary may have difficulty calibrating appropriate scenarios for purpose of the RA.

Financial condition testing (FCT)[16] is one example of scenario modelling. FCT is a process of analyzing and projecting trends in an insurer's capital position given its current circumstances, considering adverse scenarios that are severe but plausible. The materiality threshold for an FCT analysis is generally higher than the materiality associated with a liability calculation for financial reporting purposes. Therefore, the actuary would be cautious in applying the methods used to complete an FCT analysis for the determination of an RA.

4.3 Measuring risk

Once a distribution is generated, both VaR and CTE can be calculated or observed.

4.3.1 VaR

The VaR method can be summarized in the following three steps:

[15] International Actuarial Association, Risk Adjustment for Insurance Contracts under IFRS 17 (2018), 74.
[16] Effective January 1, 2020, FCT replaced dynamic capital adequacy testing (DCAT). See Section 2500 of the *Standards of Practice* for further information.

1. Entity determines the target confidence level at which it determines its compensation required (e.g., xth percentile).
2. VaR is determined such that the probability of the present value of actual cash flows being less than VaR is x%.
3. RA is then determined as VaR at xth percentile less the mean of present value of probability-weighted cash flows.

The VaR method is similar to the method frequently used for economic capital calculations (such as own risk and solvency assessment, ORSA). An entity's existing VaR methods may be applied to the calculation of RA. There are, however, important differences including:

- Risk profile – Economic capital typically includes all risks faced by the entity, whereas the RA only reflects non-financial risk.
- Time horizon – Economic capital tends to be calculated over a one-year time horizon, whereas the time horizon for the calculation of the confidence level of the RA would reflect all cash flows within the contract boundaries (i.e., the lifetime horizon, where lifetime is limited by the contract boundary). The entity may, if it so chooses based on its own compensation requirements, determine the level of the RA based on one-year shocks, but the associated confidence level would be calibrated against a lifetime horizon.
- Comparability – Economic capital is often calculated at a higher percentile (e.g., 99.5%) over a one-year time horizon. The confidence level of the RA would generally reflect a lower percentile over a longer time horizon. As such, the two amounts are generally not directly comparable.

4.3.2 CTE

The CTE method can be summarized in the following three steps:

1. Entity determines the target confidence level at which it determines its compensation required (e.g., xth percentile).
2. From the probability distribution, an entity can determine:
    A. conditional mean of the present value of future cash flows given that the present value exceeds the target percentile; and
    B. mean of the present value of probability-weighted cash flows.
3. RA is then determined as the difference between A and B.

Question 4.14 of the Ed Note *IFRS 17 Application* does not explicitly mention a CTE method. However, it mentions that "… using a suitably skewed probability distribution is another approach." To address skewness, an appropriately skewed probability distribution and/or CTE method may be applied.

4.4 Aggregation and allocation

Once the aggregate percentile level and resulting aggregate RA are derived from a quantile method, the actuary would allocate the RA to the groups per the requirements of IFRS 17.24 and perhaps to more granular levels for the purpose of determining initial groups per IFRS 17.16 and IFRS 17.47. As noted previously, IFRS 17 does not prescribe the allocation method. Possible solutions range from simple proportional allocation to more sophisticated weightings based upon analyses of the component risks.

Alternatively, instead of producing a distribution of the future cash flows for the entire entity, the VaR or CTE may be calculated for each non-financial risk and then aggregated using a correlation matrix. See further details about allocation in Section 9.

5. Cost of capital method

5.1 Introduction

In a cost of capital method[17], the RA is based on the compensation that the entity requires to meet a target return on capital. The *IAA Risk Adjustment monograph* states that "This technique for risk adjustments is based on the concept that an entity will determine its risk preference based on the entity's selection of a capital amount appropriate for the risks that are relevant to IFRS 17 measurement objectives … such amounts are not defined based on regulatory capital adequacy nor based on the entity's actual capital. The IFRS 17 measurement objectives are stated in terms of the entity's requirements, rather than any external requirements". In the cost of capital calculation, three elements are required:

1. projected capital amounts, which are used to determine the level of non-financial risk[18] during the duration of the contract;
2. cost of capital rate(s), which represent the relative compensation required by the entity for holding this capital; and
3. discount rates, which are used to obtain the present value of future compensation required. The actuary may use similar discount rates for the RA calculation as are used for other IFRS 17 calculations (such as discounting the LIC).

This method has the benefit of being conceptually close to the definition of the RA and potentially allows allocation of the RA at a more granular level assuming a more granular allocation method for capital amounts. On the other hand, the cost of capital (CoC) method may be operationally complex, as the projection of capital requirements and its underwriting projection are an input to the RA calculation.

Whereas the general formula for the CoC is simple, there are a variety of ways to determine its components. A practical method to determine the compensation required by the entity is the

[18] In theory, the capital would cover the various risks that an insurance entity faces such as, but not limited to reserve risk and underwriting risk, market risk and general operational risk. The capital amount subject to the CoC method for RA determination would stem from non-financial risks and usually correspond to the capital assigned to reserve risk and underwriting risk.

method used for pricing purposes (i.e., the way an entity determines compensation in its day-to-day operations). Alternatively, an entity may prefer to define the compensation required on a more theoretical basis. Both methods are discussed in this section.

In addition to the CoC calculations described below, there are simplified ways in which the CoC concept could be applied to estimate the RA. One such example is presented in Appendix 2.

5.2 General formula

The general formula for the RA based on a cost of capital method is:

$$\text{RA} = \sum_t \frac{r_t \, x \, C_t}{(1+d_t)\text{^}t}$$

where,

- C_t is the average capital amount for the period t;
- r_t is the selected cost of capital rate for the period t;
- r_t x C_t is the compensation amount required by the entity for the period t; and
- d_t is the selected discount rate(s) for the period, reflecting a yield curve, if appropriate.

Considerations for defining C_t and r_t are discussed in the following sections.

5.3 Capital (C_t)

As noted, a practical approach for a given group of insurance contracts is to determine the capital requirement with the capital model used for pricing purposes. Other capital models, such as the regulatory capital model (e.g., minimum capital test (MCT)) of the entity or an internal model, may be used as long as such model is consistent with the view of the entity regarding compensation. In selecting a capital model, the actuary would consider the entity's risk appetite with respect to capital, which may be expressed as an internal or operating target.

The actuary would use a regulatory capital model or internal model with caution as these models may not be appropriate to calculate the entity's capital requirement for RA purposes. (See Sections 3.5 and 4.3.1 for further details.)

Furthermore, the capital requirement would be adjusted to reflect the following considerations:

- Removal of the capital component(s) related to risks other than the non-financial risks in scope of the RA (such as market risk or general operational risk);
- Diversification if not specifically addressed in the capital model being used; and
- Consideration of risk-sharing mechanisms (e.g., reinsurance and Facility Association) reflected in the estimates of future cash flows.

The actuary would derive a method to allocate the capital requirement (initially determined by considering the diversification at an aggregate level) to the most granular level. At a minimum, the actuary would allocate the capital requirement by group to meet IFRS 17 requirements. Literature includes other capital allocation methods, such as the pro rata, continuous/discrete marginal, and the Shapley method, none of which are described in this educational note.

5.4 Cost of capital rate (r_t)

The cost of capital rate is traditionally determined as the weighted average rate of return on capital for an entity that considers all sources of capital minus the investment rate that could be earned on the assets supporting the capital. Among the sources of capital, the rate of return for common shareholders (or equivalent stakeholders) is the most complex to define.

A practical approach is to use target rates of return on capital by capital source and their respective weights that are consistent with management's view (i.e., used for pricing or as corporate targets). Target rates of return on capital may vary by portfolio, product, etc. Even if these rates of return are not supported by cost of capital theory, they may still represent the compensation required by the entity.

Alternatively, indications of cost of capital rates may be determined by the entity based on the following considerations:

- The rate of return on capital would depend on the entity's risk aversion.
- The amount of capital would reflect the level of risk (i.e., uncertainty). If the entity requires different compensation for similar risks in different portfolios, the difference would be reflected in the rate of return on capital rather than the amount of capital.
- The rate of return on capital may be defined as a rate that represents the profit required for a given quantity of risk (risk perceived by the shareholders). Then, this rate is applied to an amount of capital measured by a capital model. In theory, when the capital model used measures perfectly the risks perceived by the shareholders, it would be reasonable and practical to apply the same cost of capital rate to all lines of business, products and risks, etc. In practice, however, capital amounts measured by models are generally simplified measures of the underlying risks and it may be appropriate to adjust the rate of return on capital to compensate for this.
- The risk-adjustment is a pre-tax item yet target rates of return on capital are often-stated on an after-tax basis. The actuary would ensure that the calculations are internally consistent.

6. Margin method

Under a unit of account approach with a margin method, the actuary would select margins that reflect the compensation the entity requires for uncertainty related to non-financial risk. The "compensation the entity requires" would be quantified through the margin-setting process, which is not necessarily based on a specified confidence level.

For IFRS 17 disclosure purposes, the actuary would calculate the confidence level corresponding to the resulting RA (i.e., sum of the indicated RA resulting from the selected margins). The confidence level disclosure would be an output (not an input) of the process. To meet actuarial standards of practice for examining the reasonableness of a calculation's result, the actuary may choose to use a quantile method to compare with the RA resulting from the margins, taking into consideration the sufficiency and reliability of the data input and paying particular

attention to items such as the trend, mean, median, symmetry, skewness, and tails of underlying distributions.

7. Reinsurance held methods

The following sections regroup considerations specific to reinsurance held for each of the methods detailed in Sections 4 and 5.

Gross and ceded RA referred to in this section are defined in Section 3.3, with net RA being the net result of the two. These amounts can be determined in several ways, and it is the entity's choice to model any two of these quantities and to assess the third by addition or difference. The intent of this note is to outline the options available to the entity, not to prescribe a specific approach.

7.1. Quantile methods

If generating a distribution of the underlying future cash flows to assess the ceded RA, the actuary could choose between modeling directly from ceded data or calculating the RA as the difference between gross and net estimates at selected confidence levels. This choice could consider the credibility of the ceded data.

Using the difference between gross and net estimates has the operational advantage of using distributions that are generally readily available, or which can be produced using basic claims data. The actuary could decide to select different confidence levels for gross and net bases, which may reflect the different shapes of the distributions underlying the gross and net cash flows. The actuary may need to consider the entity's risk appetite framework when performing this assessment.

When using the difference between gross and net estimates for non-proportional coverages, situations may arise where the difference may not realistically represent the transferred non-financial risk. This could occur for coverages triggered by extreme events far in the tail, for which using VaR measure could result in a zero ceded RA for the selected gross and net percentile. The actuary is referred to the *IAA Risk Adjustment* monograph, Chapter 6, for a description of other acceptable approaches in such a case.

Regardless of the selected approach, the actuary would be mindful of the components not directly related to claims that might be included in the ceded or net data used, such as reduction in recoverables due to netting of reinstatement premiums. If the actuary decides to model RA at different confidence levels by specific types of treaties, the effect of any inuring reinsurance would also be considered.

7.2. Catastrophe models

Outputs from an external CAT model could provide useful information for the assessment of the ceded RA. If the output provided by the model is tailored to the entity’s book of business, the actuary could select a percentile directly from the given distribution if appropriate. The actuary could also leverage distributions provided by the reinsurer containing data other than that of the entity by scaling it to the entity’s loss profile. In doing so, the actuary could ensure the data is representative of the risk transfer.

7.3. Proportional scaling

In assessing the ceded RA for proportional coverages, the actuary could leverage the RA modeled for its direct business by scaling to the proportionally ceded portion, effectively resulting in the application of the same RA percentage to the present value of future cashflows of both direct and ceded business.

A proportional scaling approach could be taken for non-proportional coverages if enough evidence demonstrates that the ceded RA can consistently be expressed as a portion of the gross RA for these coverages, assuming the uncertainty of the amounts and the timing of their respective cash flows in gross and ceded amounts is similar.

When using this approach, the actuary could consider the effect of other provisions of the reinsurance contract when assessing the impact on non-financial risk arising from the reinsurance held agreement, such as ceding commissions, expense allowances and reinstatement premiums.

For non-proportional coverages, the RA ceded could also consider the effect of the retention and limit of such coverages. For instance, once the entity has reached its retention, the RA associated with the portion of ceded claims in excess of the retention could be equal to that of the gross business (retention plus ceded layer), so that the ceding entity retains a null net risk. This could likely be directly reflected when using a quantile method but could need to be accounted for if using proportional scaling. Additionally, if the entity's gross selected RA percentile results in fulfilment cash flows in excess of the limit of the reinsurance held contract held, the excess portion retained should be considered in assessing the total retained risk and associated RA. Regardless of the method used, considerations regarding the timing risk resulting from the lag in reimbursement by the reinsurer when the ceding entity pays first would have to be reflected, as it could result in a non-null risk even in the presence of a limit.

7.4. Cost of capital

Section 3.3 of this educational note discusses general considerations with respect to reinsurance held. A specific consideration in the cost of capital method is the need to develop cost of capital rates on a gross of reinsurance basis. For this purpose, it may be practical to use the cost of capital rate net of reinsurance. This is consistent with the considerations articulated in Section 3.3.

8. Catastrophe reinsurance

Uncertainty arising from catastrophes is usually associated with LRC, however it may impact the RA estimates under LIC if there is still uncertainty associated with catastrophe after the occurrence of the event. When determining the RA for insurance contract liabilities which have catastrophe reinsurance protection, the actuary may estimate the net RA separately from the ceded RA. The catastrophe reinsurance is usually purchased to provide protection against infrequent events. The expected ceded losses at a typical selected confidence level of the gross distribution may be zero. Hence, a quantile method may not generate a significant RA for a catastrophe treaty unless it is a working layer.

The coverage is usually purchased from entities with global diversification. The amount of additional capital required by a global entity, which is able to diversify exposures with multiple other regions, may be lower than the ceding company. Using the ceding entity's cost of capital and amount of capital required may result in a ceded RA that is greater than the expected profit priced into the catastrophe treaty, which could imply a reinsurance contract held with cash inflows expected to be greater than cash outflows.

Catastrophe reinsurance can be purchased for high percentile events (1 in 500-year return period earthquake protection for example). A cost of capital method using a required capital assumption selected at a lower percentile may fail to capture the compensation required for upper layers of the treaty. Where the catastrophe modelling is performed separately within the cost of capital method, assumptions may be selected to reflect these higher return periods.

One alternative may be to use a target profit margin method, similar to the one described in Appendix 2. Target profit margins may be estimated by comparing annual reinsurance premiums to modeled claims by layer, taking into consideration friction costs (ceding commissions) and administrative costs of reinsurers (and excluding the portion of the reinsurers' profit margin that may relate to other than non-financial risk). The average observed profit margins over an underwriting cycle may be used to set the estimated targets. Target profit margins may vary by expected return period, with higher margins for higher return periods. There will be times when the perception of risk transferred differs materially between the cedent and the assuming entity, which could result in an implied negative expectation of ceded profit from the ceding entities viewpoint. When the ceding entity's expectation of risk transferred would result in the implied expectation of a profit from the reinsurance contract held (present value of cash inflows greater than present value of cash outflows), and the underlying contract is not onerous, then the ceding entity may adjust their estimated reinsurance cash flows to eliminate this expectation.

9. Combining approaches and methods

The combination of multiple approaches and methods may take many forms. Question 4.23 in the Application of IFRS 17 Insurance Contract states:

> There is no requirement to use a single model or approach for all the business or all the risks. An entity may use a mix or blend of methods to set risk adjustments across different businesses provided such mix of methods makes appropriate allowance for diversification and is done in a way that can be reasonably disclosed and explained to external auditors and is relevant to users.

One possible way to combine methods under a unit of account approach is to use VaR for groups with less skewed distribution and the cost of capital method or margins for groups with highly skewed distributions, where the VaR does not provide a reasonable estimate of the RA. In this example, the actuary would still need to determine the overall confidence level for disclosure purposes. Moreover, the actuary would ensure that the aggregate RA from these different methods achieves the entity's compensation requirement for the uncertainty related to non-financial risk.

9.1. Aggregate/entity-level approach

Under an aggregate approach, the primary methods for calculating the aggregate RA are a quantile method and the cost of capital method. The margin method may be appropriate for an aggregate RA if a single margin can be selected to reflect the compensation the entity requires for bearing the risk associated with the underlying portfolios. In addition, margins may be used to allocate the aggregate RA to the unit of account level.

9.1.1. Aggregate approach using a quantile method

The actuary may allocate the aggregate RA using margins that are calibrated to ensure that the sum of the RA calculated at the unit of account level is equal to the aggregate RA calculated via a quantile method. Other allocation methods are also possible. In choosing a reasonable approach, the actuary has discretion to consider operational efficiency.

If using margins to allocate the aggregate RA the actuary may periodically review and recalibrate the margins. The actuary may choose to limit change in the margins outside of the periodic review cycle (which may be annually) to only those circumstances where the resulting confidence level corresponding to the RA drifts away from the target confidence level by more than a pre-defined threshold.

9.1.2. Aggregate approach using cost of capital method

Margins may be calibrated to replicate an aggregate RA derived from a cost of capital method. These margins could be a practical alternative to a principles-based cost of capital calculation, given that the latter may be very difficult to execute in production within typical financial reporting deadlines.

A cost of capital method may be a useful input into calibration of the level of the margins by portfolio. Margins may be developed to produce RA by portfolio that are proportional, or approximately proportional, to the capital requirements by portfolio. Actuarial judgment would dictate whether a goal of proportionality is appropriate given the facts and circumstances particular to the entity.

To comply with presentation and disclosure requirements, the confidence level corresponding to the resulting RA would be calculated.

9.2. Hybrid approach

There are hybrid approaches that incorporate the unit of account and aggregate perspectives from various RA methods (e.g., quantile, cost of capital, and margins). At the unit of account level a single method or a combination of methods may not be used.

One possible hybrid approach is described in this section.

First, assume that the entity's risk management policy specifies a target range for the confidence level corresponding to the aggregate RA. This target range would correspond to a range of the aggregate compensation the entity requires for the uncertainty related to non-financial risk.

Next, assume that the actuary calculates a total RA and its associated confidence level using margins established for each portfolio (or group) as a starting point, with adjustments for diversification.

To the extent that the sum of the RA produced by the selected margins do not result in an aggregate RA that is within the target range set out by policy, the margins would be re-calibrated to ensure that the entity level RA was within the range.

Given the uncertainties associated with estimating confidence levels and the dispersion in estimates of RA that may result from the use of different approaches and methods, this particular example in which a range of target confidence level is established by the entity offers an important operational advantage. Calibrating the RA within a sufficiently wide target range may lessen some of the concerns with the precision (or lack thereof) for confidence level calculations.

The actuary could follow a hybrid approach where the margin method would be combined with either the cost of capital method or a quantile method. As such, the actuary may calculate the aggregate RA based on a range of target cost of capital rates, and the margins would be calibrated accordingly.

10.Quantification of the confidence level

10.1. Quantile method as primary method

Where a quantile method is the primary method for determining the amount of the RA, there is no need for a separate process to calculate the confidence level corresponding to the RA. Given the requirement of a probability distribution to calculate the quantile method RA, the resulting confidence level of the selected RA would be directly available. Thus, a quantile method that is used as the primary method for calculation of the RA directly satisfies the IFRS 17 disclosure requirements in IFRS 17.119.

10.2. Quantile method as secondary method

If the primary method for determination of the RA is the cost of capital, the margin method, or some other method, then the actuary would need a secondary method to quantify the confidence level corresponding to the RA to satisfy the disclosure requirement. As noted in question 4.18 of the Ed Note IFRS 17 Application, this would usually require some information about the underlying probability distribution of the present value of future cash flows. The term "future cash flows" used throughout the remainder of this section is understood to be the present value of future cash flows.

As noted previously, the distribution of future cash flows for P&C insurance is typically skewed. In the following example, a lognormal distribution is assumed for illustration purposes only. Lognormal distributions are commonly used in P&C insurance to model claim size, as the distribution is positively skewed and the random variables take on only nonnegative values. The purpose of the example is to illustrate how a quantile method may be applied. In practice, the actuary would select the distribution(s) that most adequately fits the entity's cash flows.

A lognormal distribution can be defined by its parameters (μ, σ), where the parameters represent the mean and standard deviation of the normally distributed variable log X and not that of X. Any point on the distribution can be identified if these two parameters are known. For lognormal distributions, the mean and standard deviation can be used to derive parameters (μ, σ).

Random variable X has a lognormal distribution with parameters (μ, σ) if, and only if, log X is normally distributed with mean μ and variance σ^2. Therefore, the lognormal variable X can be expressed as $X = e^{\sigma Z+\mu}$, where Z is the standard normal random variable. The lognormal cumulative distribution function is

$$F_x(x) = \begin{cases} 0 & \text{if } -\infty < x \leq 0 \\ \Phi\left(\frac{\log x - \mu}{\sigma}\right) & \text{if } 0 < x < \infty \quad (-\infty < \mu < \infty, \sigma > 0) \end{cases}$$

The continuous lognormal variable X has probability density function

$$f_x(x) = \begin{cases} 0 & \text{if } -\infty < x \leq 0 \\ \frac{1}{\sigma\sqrt{2\pi}x}\exp\left(-\frac{1}{2}(\log x - \mu)^2/\sigma^2\right) & \text{if } 0 < x < \infty \end{cases}$$

The best estimate liability (BEL) represents the mean or central tendency of the distribution. Ideally, the actuary would have a method to derive the standard deviation of the assumed distribution of future cash flows, but in practice this may be difficult. The practical problem is that it will likely be impossible to independently observe the standard deviation of the distribution of future cash flows.

One potentially reasonable approach is that the standard deviation of the distribution for specific portfolios can be derived from the insurance risk factors in the MCT. (See Section 9.3.) Using the standard deviation from the MCT and the BEL as the mean parameters, (μ, σ) can be derived by using the formulas below.

The mean, variance, and skewness follow directly:

$$E[X] = e^{\mu+\sigma^2/2}$$

$$Var[X] = \left(e^{\sigma^2} - 1\right)e^{2\mu+\sigma^2}$$

$$Sk[X] = \left(e^{\sigma^2} + 2\right)\sqrt{e^{\sigma^2} - 1}$$

The actuary may also explore other approaches to define the standard deviation. For example, the actuary may be able to turn to the entity's internal model if such model is sufficiently robust and can be recalibrated to reflect the time horizon and risk appetite required by the RA.

Appendix 1: Margins – Brief summary of IFRS 4 CIA Standards of Practice

Subsections 2250 through 2270 of the CIA Standards of Practice[19] provided guidance to actuaries in setting margins for adverse deviations prior to the effective date of IFRS 17. While no longer binding after the effective date of IFRS 17, this guidance might be helpful to actuaries in quantifying the degree of uncertainty in non-financial assumptions, and by extension quantifying the compensation for non-financial risk that the entity might require.

Under subsections 2250 through 2270, the range of margins for claims development was between 2.5% and 20% of the best-estimate assumption. Selections above this range would be appropriate in situations such as:

- unusually high uncertainty; and
- unusually low best estimate resulting in an unreasonably low dollar PfADs.

Selections below this range would be appropriate in situations such as:

- coverage that is reserved at the stop loss limit

Considerations for placement in the ranges would have been similar to those noted in IFRS 17.B91.

[19] Canadian Institute of Actuaries, *Standards of Practice* – Insurance (January 1, 2020), subsections 2250–2270.

Appendix 2: Simplified calculation of RA based on CoC method

Simplified CoC calculations, such as the example presented in this appendix, could be an alternative way to estimate the RA that allows insurers to use the general CoC concept. The example included in this appendix may provide a more intuitive way to estimate the RA for insurers that have a profit margin or combined ratio target instead of a target return on equity (ROE).

The basic concept is that the target profit margin is allocated between reserve risk, underwriting risk, and other risks that are not relevant to the RA.

The profit margin could be directly determined, in the case of an entity with a target profit margin or combined ratio, or calculated for an entity with a target ROE and premium to surplus ratio. A standard formula can be used to convert a target ROE and a premium to surplus ratio to a target profit margin. A simple formula using ROE, corporate income tax, investment income on surplus, and premium to surplus ratio is:

$$\text{Profit Margin on Premium} = \left[\frac{\text{Target ROE}}{\text{(1-Tax)}} - \text{Investment income as a \% of surplus}\right] / [\text{Premium to surplus ratio}]$$

Next, the total profit margin is split between underwriting risk, reserve risk, and other risks that are not relevant to the RA, based on the proportion of the capital allocated to each of these risks. The actuary may rely on ORSA or other processes used to allocate capital to reserve risk, underwriting risk, and other risks.

Using these types of calculations, the actuary would recognize that underwriting risk disappears once the coverage is expired and reserve risk diminishes over time as claims are settled. Thus, using amounts derived from the profit margin on premium, in order to estimate the RA:

- the LRC is assigned both the profit margin associated with underwriting risk and reserve risk; and
- given that the underwriting risk does not exist for the LIC, the LIC is assigned only the profit margin associated with reserve risk.

The RA amount associated with the LIC (i.e., premium multiplied by the profit margin associated with reserve risk) would wind-down in an appropriate manner to reflect the settlement of claims. Assuming that the reserve risk is correlated to the amount of claims that are outstanding and unreported, the actuary could calculate the present value of future cash flows at the beginning of each time period (i.e., the expected reserves) and then determine the present value of this stream of cash flows. As a result, the reserve risk profit margin unwinds as the present value of expected future claim cashflows unwinds. This is comparable to the rate at which the RA decreases in the traditional CoC calculations. The applicable profit margin is the RA at that point in time for the LIC.

With these calculations, the confidence level for the RA is based on the distribution of the present value of cash flows, which could be shaped significantly different for LIC versus LRC for some P&C coverages.

Some potential limitations of this approach:

- The proportion of capital allocated to each risk may vary by portfolio or group.
- The profit margin may vary by portfolio or group (different ROE targets and/or different premium to surplus ratios).
- The approach still requires a confidence level to be determined for disclosure purposes, which requires a distribution of the present value of cash flows.
- The approach requires the projection of cash flows for the unwinding of the reserve risk.
- Changes in the allocation of capital by portfolio or group, or by risk, over time, which may result as a change in mix or volume of business, could result in changes in indicated RA.
- Changes in profit margins objectives could result in changes in RA for prior policy years.

Illustrative example

Assume that an insurer has only one line of business that it prices with a 10% profit margin. Further assume that a robust ORSA model indicates that capital is allocated 50% for underwriting, 30% for reserve, and 20% for other risks (such as market risk and operational risk).

The profit margins associated with the different risk categories are 5% for underwriting risk, 3% for reserve risk, and 2% for other risks.

The LRC RA would then be calculated as 8% of premium (5% for underwriting risk plus 3% for reserve risk).

The LIC RA for a given policy year would start off at 3% of expired premium and decrease over time, which as a percentage of the present value of future cash flows could be a higher or lower value than the LRC RA.

Appendix 3: Quantification of the confidence level using MCT

The following approach could be considered by an entity that has no credible data to estimate the confidence level. The actuary would document this approach and may need to demonstrate that the approach results in a reasonable proxy for the entity. In addition, the actuary would take care to check the reasonability of the standard deviations based on the MCT factors considering the facts and circumstances of the entity and the reasonableness of the indicated LRC RA vs. that of the LIC RA.

This section refers to OSFI's MCT and the Branch Adequacy of Assets Test (BAAT). The description is also applicable to the MCT of the AMF.

A practical advantage of using the MCT as a calibration point is operational efficiency to leverage existing processes in the quantification of the confidence level. A potential disadvantage is that the estimated confidence level may not be appropriate for a particular entity as MCT requirements are determined/calibrated at the entire Canadian insurance industry level.

The insurance risk factors in the MCT consider claim liabilities and premium liabilities and are based on a review conducted in 2013. In the event that OSFI updates the MCT risk factors, the considerations underlying the revised factors would potentially change the results.

Per OSFI,

> To develop the new factors, OSFI undertook a variability analysis based on incurred and paid data to assess the insurance premiums and claims risks. For unpaid claims, OSFI performed a variability analysis between the estimated and the actual amount of losses using two methods: lognormal and bootstrap. For premium liabilities, OSFI's variability analysis was built based on pure loss ratio data, assessing variability in ultimate loss ratios by line of business for each accident year. A correlation study between lines of business was also performed to determine the level of diversification credit.[20]

The following are links to OSFI's documentation of the variability analysis:

- "Discussion Paper on OSFI's Proposed Changes to the Regulatory Capital Framework for Federally Regulated Property and Casualty Insurers" (May 2013)
- "Disclosure on OSFI's Review of Insurance Risk Factors" (December 2013)
- "Presentation: The Next Generation of the Minimum Capital Test - A Canadian Regulatory Capital Framework" (June 2013)

The risk factors were established at a confidence level of VaR 99.5% with an explicit adjustment for diversification. The factors were reduced by approximately 45% for claims liabilities and 11% for premium liabilities to account for risk diversification. Per OSFI Discussion Paper (May 2013),

[20] Office of the Superintendent of Financial Institutions, "Discussion Paper on OSFI's Proposed Changes to the Regulatory Capital Framework for Federally Regulated Property and Casualty Insurers" (May 2013), 14.

the "correlation study demonstrated that premium liabilities by lines of business are more correlated compared to claims liabilities; therefore, a lower diversification credit was applied."

Use of the MCT risk factor as the second point on the distribution requires the following considerations:

- The appropriate level of diversification when aggregating multiple lines and potentially LIC and LRC; the actuary would consider the entity's mix and volume of business.
- Adjustment for volatility due to size and other considerations relative to the "average" entity included in the OSFI review. For example, smaller entities tend to exhibit greater relative volatility than larger entities due to increased process and parameter risk, all else being equal.

With the assumption of a lognormal distribution and removing diversification based on the MCT factors, the following table[21] shows the indicated standard deviation by line of business for the LIC and the LRC. The standard deviations should correspond reasonably well with unpaid claims and premium liabilities. The MCT risk factors were scaled to the average of the four largest entities included in the OSFI review. The risk factors were also reduced by OSFI's estimate of the average MfAD for each line of business.

[21] In the event that OSFI updates the MCT risk factors the results shown in the table could potentially change and these values may become outdated.

Category	LIC				LRC			
	Standard deviation[22]	Percentile			Standard deviation	Percentile		
		65th	75th	85th		65th	75th	85th
Personal property	12%	4%	8%	13%	10%	3%	6%	10%
Commercial property	10%	3%	6%	10%	10%	3%	6%	10%
Aviation	18%	5%	11%	18%	13%	4%	8%	14%
Auto liability – BI	12%	4%	8%	13%	10%	3%	6%	10%
Auto – Pers. Acc.	12%	4%	8%	13%	10%	3%	6%	10%
Auto – Other	12%	4%	8%	13%	10%	3%	6%	10%
Boiler & machinery	15%	5%	9%	15%	12%	4%	7%	12%
Credit	18%	5%	11%	18%	13%	4%	8%	14%
Credit protection	15%	5%	9%	15%	12%	4%	7%	12%
Fidelity	18%	5%	11%	18%	13%	4%	8%	14%
Legal expense	20%	6%	12%	20%	13%	4%	8%	14%
Liability	20%	6%	12%	20%	13%	4%	8%	14%
Other approved products	18%	6%	12%	20%	13%	4%	8%	14%
Surety	18%	5%	11%	18%	13%	4%	8%	14%
Title	15%	5%	11%	18%	12%	4%	8%	14%
Marine	18%	5%	9%	15%	13%	4%	7%	12%

In its variability analysis, OSFI determined that a portion of the volatility depended inversely on the size of the entity and the remaining portion of the volatility was not dependent on the size of the entity, with the proportions varying by line of business. These proportions are not disclosed in the OSFI analysis. To the extent that individual entity characteristics differ from the average of the four largest entities contained in the 2013 OSFI analysis, the actuary would

[22] For some lines of business, the higher observed standard deviation on LIC compared to LRC could be explained by the significant proportion of claims paid in the first year, that may have a relatively low volatility. While a few lines of business (such as liability and aviation) do not have significant proportion of claim paid in the first year but have a higher standard deviation on LIC. For these lines, the above table represents the factors observed by OSFI without any adjustments.

adjust the volatility accordingly. Diversification would be included based on entity-specific considerations.

These calculations represent rough approximations of a lifetime 65th, 75th, and 85th percentiles (selected as examples not recommendations) based on the MCT. The findings in the preceding table represent an approximation in a context where an entity has no better information to derive a second percentile point on the distribution of the present value of future cash flows over a lifetime horizon and excludes the effect of diversification across lines of business and between the LIC and the LRC. It is important to note that the calibration of the MCT factors reflects a large entity's relative volatility. To the extent that these parameters are different in a particular entity's RA calculation, the actuary would adjust the percentile factors accordingly. Significant differences are possible.

Appendix 4: Illustrative example on risk adjustment calculations

Introduction and assumptions

In the example that follows, ten scenarios were developed, in which a total of three different methods are applied in the determination of the risk adjustment (RA), namely: quantile (confidence level), cost of capital, and margin. For each scenario, one of the three methods was used to estimate the RA and then comparable assumptions that would generate the same RA amount under each of the other two methods are estimated. For each method, there are multiple ways of setting assumptions. This example illustrates one way of doing so for each method.

The worksheets for long tail, short tail and total are all illustrated in the same way. References to the Excel workbook within this commentary refer to the same item on each of these worksheets.

The first four scenarios are based on a confidence level method, the next four scenarios are based on a cost of capital method, and the last two scenarios are based on a margin method.

Scenario Assumptions:

Assumption		Scenario									
		1	2	3	4	5	6	7	8	9	10
Yield curve/discount rate		2% for all years									
Confidence level percentile		75	75	90	90						
Cost of capital	Capital requirement percentile	99.0	99.9	99.0	99.9	99.0	99.9	99.0	99.9	99.0	99.9
	Risk diversification	0% for all other risks									
	Pre-tax cost of capital net of assumed investment income on surplus					5.0	5.0	10.0	10.0		
Margin factor (%)	Long tail									10	10
	Short tail									5	5

Calculations are performed first on an insurance contracts issued ("gross") basis, then on an insurance contracts issued less reinsurance contracts held ("net") basis, and then the implied reinsurance contracts held ("ceded") RA is estimated as the difference between the gross and net RAs. Two alternative approaches could be followed. The net and the ceded RAs could be explicitly calculated, and the gross RA would be the sum of the two. The gross and the ceded RAs could be explicitly calculated, and the net RA would be the difference between the two.

The allocation of the total RA to each portfolio uses each portfolio's undiversified RA indication as input. Several different methods were used to illustrate the potential impact of each method on the allocation.

Portfolio Assumptions:

1. Contracts have been combined into two portfolios, "long tail" and "short tail".
2. Only liability for incurred claims is considered in the example. We discuss what would be required to expand to include liability for remaining coverage later in the example.
3. Both claims and expense payments are included in the cash flows.
4. Reinsurance coverage is assumed to be as follows:
    a. Long tail non-proportional (excess of loss)
    b. Short tail proportional (20% quota share)
5. Assumptions are documented in the tabs "Long tail" and "Short tail"
6. The present value of remaining payments is based on a probability weighted mean (the actuary's best estimate) as follows:
    a. Long tail: $50 million gross and $40 million net of reinsurance
    b. Short tail: $10 million gross and $8 million net of reinsurance
7. Based on reserve volatility modeling (using a bootstrap or other method), the present value of remaining payments is determined to be reasonably well approximated by lognormal distributions, with standard deviations as follows:
    a. Long tail: $10 million gross and $5 million net of reinsurance
    b. Short tail: $3 million gross and $2.4 million net of reinsurance
8. Based upon the above means and standard deviations, using the method of moments, the underlying lognormal parameters assumed for each portfolio are as follows:
    a. Long tail:
        i. Mu of 10.800 gross and 10.589 net of reinsurance
        ii. Sigma of 0.198 gross and 0.125 net of reinsurance
    b. Short tail:
        i. Mu of 9.167 gross and 8.944 net of reinsurance
        ii. Sigma of 0.294 gross and 0.294 net of reinsurance
9. The rates at which the present value of remaining coverage for each portfolio decreases to zero are as shown in the example. Long tail takes 10 years to decrease to zero; short tail takes two years.
10. The two portfolios are assumed to be 25% correlated. This assumption is for illustrative purposes only.

It is worth nothing that distributions based on undiscounted future claim cash flows cannot be directly used to derive distributions that are fit to the present value of future claim cash flow, even with constant discount rates.

Calculation of risk adjustment on a gross and net basis

Confidence level method

The indicated undiversified RA for each portfolio can be calculated directly from the lognormal distribution, with the indicated undiversified RA being equal to the target confidence level less the mean (3b for each of long tail and short tail). In general, the aggregate distribution cannot be so easily directly calculated, and a Monte Carlo approach was followed in R (there is other software that is equally well suited to perform this) to estimate the aggregate distribution, from which the indicated RA was equal to the simulated value of the target confidence level less the mean (3b for total Monte Carlo).

Cost of capital method

For each portfolio, and in aggregate:

1. The undiversified required capital at T0 (time 0) (4b) was set equal to the selected risk appetite percentile (4a) of the selected distribution for each portfolio, or the simulated distribution in aggregate (3a), of the present value of future cash flows, less the mean of the present value of future cash flows at T0 (1a).
2. Any diversification with other risks was then applied (4c), to estimate the diversified required capital at T0 (4d).
3. For each portfolio, the beginning of year capital for each year (4g) was set equal to the remaining future cash flows as a proportion of T0 (4f) multiplied by the diversified required capital at T0 (4d). For the aggregate distribution, the beginning of year capital for each year (4g) was set equal to the selected risk appetite percentile (4a) of the simulated distribution (3a) adjusted for diversification (4c), less the mean of the present value of future cash flows (1a) at that point in time.
4. The cost of the required capital for each year (4h) was calculated by applying the selected cost of capital rate (4k first column) to the beginning of year capital for each year (4g).
5. The cost of capital for each year was discounted back to T0 (4j) using a discount factor (4i) based on the selected discount rate (4e).
6. The RA (4k second column) was equal to the sum of the discounted cost of capital for each year (4j).

Margin method

The selected margin (5a first column) was applied to the mean of the present value of future cash flows (1a) for each portfolio, resulting in a portfolio level RA (5a second column for each portfolio) and summed across portfolios to determine the aggregate RA (5a second column for

Total). For the purposes of this illustration, the same margins were assumed to be reasonable for both the gross and net bases.

Determination of confidence level

For scenarios in which confidence level was the basis of the RA, it is unnecessary to determine the confidence level as it is an input. For other scenarios, the confidence level can be estimated by determining for the total Monte Carlo simulated results where the total of the RA plus the mean of the present value of remaining cash flows (1a) falls on the aggregate distribution of the present value of future remaining cash flows at time 0 (3a).

Determination of comparable assumptions for cost of capital method

When a different method was used to estimate the RA, the risk appetite percentile was fixed at either the 99th percentile or 99.9th percentile for the cost of capital approach, depending on the scenario, in order to back into the required cost of capital.

Allocation of total risk adjustment to each portfolio

The allocation of the total RA to each portfolio used each portfolio's indicated undiversified RA or probability distribution as input. There were four different methods used:

1. Confidence level
    a. Using as inputs the implied RA for each portfolio, looking up the overall confidence level on the probability distribution of the present value of future remaining cash flows (3a), less the mean of the present value of future remaining cash flows (1a) at time 0, the overall RA was allocated proportionately to each portfolio.
2. Proportional
    a. Using as inputs the calculated RA for each portfolio, before diversification due to the other portfolio, the same proportional diversification benefit was applied to each portfolio, such that the RA of both portfolios equalled the aggregate RA.
3. Marginal
    a. Using as inputs the calculated RA for each portfolio, before diversification due to the other portfolio, the aggregate RA was compared to the other portfolio's RA to estimate the marginal contribution of each portfolio to the overall RA and the two marginal RAs were then prorated upwards to equal the aggregate RA.
4. Average of proportional and marginal
    a. Take an average of the second and third methods.

Calculation of the risk adjustment on a ceded basis

The ceded RA was set equal to the difference between the gross and net of reinsurance RAs. The calculation was performed both in aggregate as well as by portfolio. In this example, only one of the two reinsurance arrangements is on a proportional basis, consequently some of the approaches used in this example to allocate RA to portfolios result in different RA factors on a

gross and net basis for the short tail portfolio. Other approaches to calculate RA may result in the same percentage for both gross and net for a portfolio with proportional coverage.

It is important to review the reasonableness of the ceded RA for each portfolio or in aggregate, which may have implications to the selected assumptions of the gross and net RAs. If the net RA is greater than the gross RA then that is usually an indication that an adjustment to an assumption is needed. If a different approach is followed instead of the calculation of the gross and the net, then the remaining basis should be reviewed for reasonableness.