Mémoire présenté devant le jury de l'EURIA en vue de l'obtention du Diplôme d'Actuaire EURIA et de l'admission à l'Institut des Actuaires

le 24 Septembre 2021

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Titre: Calibrating the Risk Adjustment for non financial risks under IFRS 17 for a Life & Health reinsurance portfolio

Confidentialité: Oui

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To

Georges Nitcheu

Thank you for believing in me

Abstract

IFRS 17 requires that obligations arising from insurance contracts are measured under the concept of 'fulfillment cash flows' which represent the present value of best estimate net cash flows plus an adjustment reflecting the inherent uncertainty in the timing and amount of actual cash flows. The latter, the "Risk Adjustment for non financial risks" or "RA", will be the focus of this thesis.

The technical requirements for the RA under IFRS 17 are principle-based but introduce certain minimum compliance requirements, notably with respect to linkage with the entity's own view of risk, as well as additional disclosure. The thesis will explore first the relevant technical requirements for the Risk Adjustment by providing a summary of different methodologies that will be, in a second part, leveraged to produce illustrative RA calculations for the European PartnerRe entity, focusing on the Life & Health business.

The first approach discussed in this thesis is the Margin for Adverse Deviation (MfAD) which will be used to derive PartnerRe's Risk Adjustment by calibrating margins that when applied, would best target and align with the entity's pricing view on the compensation of risk. We also propose a second method under the Cost of Capital approach leveraging the existing framework of Solvency II and producing a Risk Adjustment appropriate for the IFRS 17. However the two methods do not provide a confidence level for the resulting Risk Adjustment. To abide by this IFRS 17 disclosing requirement, we will use a probabilistic approach to derive the implied confidence level percentile for the entity's Risk Adjustment.

Keywords: Life & Health, IFRS 17, Risk Adjustment for non financial risks, calibration, margins, Cost of Capital, confidence level.

Résumé

IFRS 17 exige que les obligations découlant de contrats d'assurance soient évaluées selon le concept de «fulfilment cash flows» qui représente la valeur actuelle de la meilleure estimation net des flux de trésorerie augementé d'un ajustement reflétant l'incertitude inhérente aux dates de versement et aux montants des flux de trésorerie futurs. Cet ajustement, intitulé « ajustement pour les risques non financiers» ou *Risk Adjustment for non financial risks* en anglais, fera l'objet de ce mémoire.

Les exigences techniques pour l'ajustement pour risque sous IFRS 17 sont fondées sur des principes et non sur des règles prescriptives. Certaines exigences de conformité minimales sont néanmoins introduites dans la norme, notamment en ce qui concerne le lien avec la vision du risque propre à l'entité, et les informations supplémentaires que l'entité devra publier (*disclosure).* Ainsi, nous exposerons dans ce mémoire le contexte et la genèse de la norme IFRS 17 et les différentes méthodologies de définition du RA qui seront, dans une deuxième partie, exploitées pour produire des calculs de RA pour l'entité européenne de PartnerRe, avec une focalisation sur l'activité Vie & Santé.

La première approche discutée dans ce mémoire est la marge pour écart défavorable (MED) qui sera utilisée pour dériver l'ajustement du risque de PartnerRe en calibrant les marges qui lorsqu'elles sont appliquées, cibleraient et s'aligneraient le mieux à la vision de PartnerRe sur la compensation du risque. Nous proposons également une deuxième méthode selon l'approche du coût du capital tirant parti du cadre existant de Solvabilité II et produisant un ajustement pour risque approprié suivant les principes d'IFRS 17. Cependant, les deux méthodes traitées ne fournissent pas un niveau de confiance pour l'ajustement pour risque. Pour respecter cette exigence d'information d'IFRS 17, nous utiliserons donc une approche probabiliste pour définir le centile du niveau de confiance pour l'ajustement pour risque de l'entité.

Mots clés: Vie & Santé, IFRS 17, Ajustement pour les risques non financiers, calibration , marges, coût du capital, niveau de confiance.

Acknowledgments

I would like to thank my apprenticeship supervisor and members of the Life & Health Consolidation team, Antoine Rodriguez, Gearoid Moran, Amine Lbelhasse, besides Chloe Mateu and Ignatius Kotze from IFRS 17 Infrastructure team. Your support and your constant supervising have driven me to bring out the best in me, and for that I am grateful.

Special thanks to Florian Gomez and Karl Fahy from Corporate Actuarial team for the invaluable guidance I received from them. Without their help I wouldn't have been able to write this thesis today.

I would also like to express my deepest gratitude to my university supervisors Pr. Catherine Rainer and Wassim Youssef for their availability whenever I needed their help.

To my beautiful family in Morocco and France, your encouragement and reassurance was all I needed to never give up. God bless you.

To my dear friends, thank you for being around during this peculiar times of the pandemic. You are my second family.

Summary

The International Financial Reporting Standards IFRS 17 Insurance Contracts is an accounting standard that will be effective on January 1, 2023 superseding IFRS 4 Insurance contracts. IFRS 17 establishes the key principles to be applied to all aspects of accounting for insurance contracts, thereby aiming to increase the usefulness, comparability, transparency and quality of financial statements.

In IFRS 17, the choice of the valuation method for provisions is based on the particularities of the insurance products held by an entity. There are three independent methods : The default method or *General Measurement Approach*, the *Premium Allocation Approach* and *the Variable Fee Approach*. For the default approach, the insurance liabilities are valued under the following components :

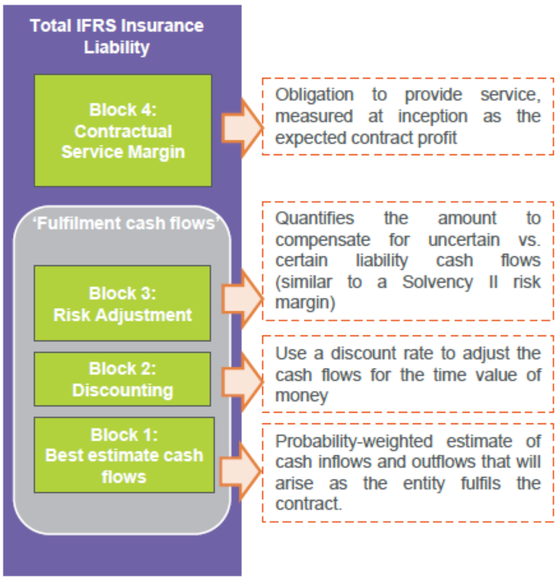

Figure 1: Initial calibration of the General measurement approach

The *Risk Adjustment for non financial risks* or simply *RA* represents one of the components through which the liabilities of insurance products are assessed under IFRS 17.

The RA is defined as *the compensation an entity requires for bearing the uncertainty about the amount and timing of the cash flows that arises from non-financial risk as the entity fulfils insurance contracts.* It is an influential factor that impacts the pricing of insurance contracts and how profit from insurance contracts is reported and emerges overtime.

The RA will be the focus of this thesis as it will introduce suitable computation techniques of the RA for the Life & Health activity, with a respect of the criteria proposed by the norm, namely the Margins for Adverse Deviation and the Cost of Capital approach.

Margins for Adverse Deviation (MfAD)

With the MfAD method, we study the possibility of calibrating a combination of margins by exploiting metrics from the *pricing frameworks*. These margins, when applied, should provide an amount that reflects the entity's risk aversion. In our case, this amount translates into the Present Value Cost of Capital (PV CoC): a pricing metric present at the level of each treaty that reflects the price of holding economic capital.

In other words, the idea is to calibrate margin assumptions to produce a risk adjustment amount consistent with the PV CoC such that:

$$Valuation\,(BE + RA\ Margins) - Valuation\,(BE)\ \simeq PV\ CoC$$

This technique produces a RA at the highest accounting granularity i.e. IFRS 17 GoC (Group of Contracts) when running the valuation models, which will have the calibrated margins as inputs.

Ideally, this calibration should be done for each IFRS 17 GoC. However, this level of granularity is far too high. Therefore, we propose to perform the calibration on a more aggregated and operationally practical level. We therefore choose the IFRS 17 Product Grouping (IFRS 17 (PR)) level of granularityIFRS 17 aggregation level at PartnerRe. To do so, we select, under certain criteria, a treaty (or treaties) that will represent each line of business (LoB) and on which the calibration exercise will be performed. The results will be applied to the remaining in-force business.

To illustrate this approach, we apply this calibration exercise to two IFRS 17 RPs: *Long Term Protection* represented by the LoB *Critical Illness* and *Longevity* (Longevity)

Depending on the nature of the LoB, the main non financial risks for which the margins should be calibrated are :
- Mortality Level Risk
- Mortality Trend Risk
- Lapse Risk
- Expense Risk.

Representative treaties must abide by certain conditions, the most important one is that its pricing must reflect the most up-to-date pricing view of the entity.

Thus, the following outlines the calibration steps :

A. Split In-force business into segments with similar risk characteristics
B. Select deals for calibration
C. Perform the calibration exercise
D. Validation of calibration results

The calibration of the margin assumptions is the result of an iterative process where the margins are tested one by one and for each risk. We then test the combinations of these margins to define the best one. These margins must vary in a more or less small range, as the purpose of the AR is to quantify the risk of mis-estimating non-financial assumptions rather than covering non-financial risks.

Conclusions regarding the method

Margin calibration has the advantage of being a simple and operationally practical method for defining an AR at a level of granularity as fine as *IFRS 17 GoC*.

As with any calibration exercise, validation of our results is a necessary step, especially since the calibration was done at an aggregate level resulting in less precision in the results. The actual impact is difficult to quantify until all the evaluation models have been run. Nevertheless, the evaluation models were run for a few treaties. We used them for a partial validation of our calibrated margins.

A drawback of this method is that re-calibration may be necessary in the future to maintain the appropriate link between the PV CoC and the margin assumptions. This re-calibration may be due to changes in assumptions in the pricing framework (discount rates, diversification factors, non-financial assumptions etc.) or due to changes in the risk profile of the entity for example.

Exploiting Solvency II framework for the IFRS 17 RA

The Solvency II directive has been in force since 2016. A major implementation effort has been made by all European insurers who have invested a lot of resources and time in the production of Solvency II calculations and reports.

The economic valuation under IFRS 17 has many points of convergence with Solvency II. Consequently, and in order to avoid duplicating the production work for both IFRS 17 and Solvency II, we propose a second method which exploits the Solvency II calculation methodologies in order to adapt it to the IFRS 17 Risk Adjustment.

SII Risk Margin Vs IFRS 17 RA

When we compare the risk allowances in both SII and IFRS 17, the key differences are :

-Solvency II Risk Margin is prescribed, while the IFRS Risk Adjustment is principles-based i.e. there is no prescribed method
-IFRS 17 requires separate Risk Adjustments for the gross liability and reinsurance held (ceded), while Solvency II has a single Risk Margin based on the net of reinsurance position.
-The BEL as defined in IFRS 17 is similar to the BE of the Solvency II (current and probability-weighted estimate of the cash flows resulting from insurance contracts issued by the insurer). However, the differences lie within the flows taken into consideration and the discount rates used.

-The risks included in RM are all insurance risk, credit risk, operational risk and non-hedgeable risks whereas the scope of IFRS 17 RA risks is only insurance and non financial risks.

Using the Cost of Capital approach as in Solvency II with the same aggregation scheme, the formula for the RA at **a given level of aggregation** becomes :

$$RA = CoC_{IFRS17} . \sum_{t \geq 0} \frac{CR(t)}{(1 + r_{t+1})^{t+1}}$$

Where :

-CoC_{IFRS17} : A calibrated Cost of Capital rate that represents the compensation required

-CR : The Capital Requirement at the given aggregation level after t years

-r_{t+1} : Interest rate curves built under IFRS 17

We choose to calculate our RA at Grouping Product (GP) aggregation level[1] by using the mapping that relates PartnerRe's internal SII management LoBs to IFRS 17 GP. Thus :

$$RA_{entity} = \sum_{Internal\_LoB} RA_{Internal\_LoB} = \sum_{IFRS17\_GP} RA_{IFRS17\_GP}$$

The capital requirement would be adjusted to reflect the following considerations :

•Remove the capital components related to risks other than the non-financial risks

• Basis calculation :

Two sets of calculations : on a gross basis and on a net basis. The purpose of the second set is helping us define the quantum of RA dedicated to the retrocession.

• Diversification :

Ideally, the most suitable diversification should be done when having a correlation matrix to aggregate the CRs between internal LoBs (or IFRS 17 GP). If such resource doesn't exist, we propose the diversification to be addressed using the same SII correlation matrices of intra-life and life & health

The computation of the Risk Margin should be based on the assumption that the transfer of the portfolio insurance obligations for life and non-life activities is carried out separately, which won't be the case for RA as IFRS 17 permits Life/Non Life diversification in the Risk Adjustment [IFRS 17, B88(a)]

The SII RM of the Life& Health component, was compared to the IFRS 17 RA using both methods (MfAD and CoC approach by setting the CoC_{IFRS17} rate at 3%)

We also tried to calibrate the CoC_{IFRS17} rate for each IFRS 17 RP. The calibration is done in such a way as to have equal AR amounts between the two approaches. The purpose of this analysis is to form an idea about the level of compensation required from assessing the CoC_{IFRS17} rate only, but it is also a way to combine the results of the two techniques.

[1]An IFRS 17 level of aggregation in PartnerRe

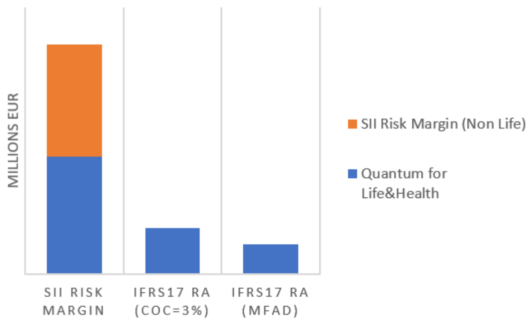

Figure 2: SII RM Vs IFRS 17 RA

-*The allocation of RA*

The calculation performed in aggregate across different IFRS 17 GPs is the result of a Top-down approach to derive the RA. However, the RA needs to be allocated to the IFRS 17 GoC to estimate the fulfilment cash flows for the group of contracts at initial recognition [IFRS 17, 24]. In that case, an allocation method is required. There are a few capital allocation methods from which we chose the scalar (pro-rata) allocation using PV claims as a reference measure.

-***Conclusions regarding the method***

This approach is very consistent with the IASB definition of Risk Adjustment. It is appropriate for complex or long-term risks such as those of the Life and Health business.

The formula of the cost of capital approach is simple; the difficulty lies in determining its components and their projections. We have chosen to use the Solvency II methodology to calculate the required capital. However, the use of prescribed correlation matrices remains a limitation of this approach that should be addressed.

The use of a Solvency II based methodology to calculate the capital requirements means a more conservative result. This is confirmed by comparing the results of the two methods, knowing that the MfAD method reflects a minimal risk compensation.

Confidence level disclosure

IFRS 17 has disclosure requirements regarding confidence level corresponding to the RA cited in [IFRS 17,119].

According to the paragraph, using any alternative method to the Confidence level technique (i.e. quantile techniques including Value at Risk VaR or Conditional Tail Expectation CTE) implies an additional work for disclosing the confidence level, which applies to our case. Indeed, the use of margins for adverse deviations or the Cost of Capital approach as a way to define the RA means we have to look for a method to disclose the confidence level. In that case, quantile technique can be used as a secondary method.

Furthermore, It is reasonable to infer that paragraph 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 anything less than an entity-level. We hence choose to disclose the confidence level of the RA at the entity level.

IFRS 17 does not specify whether the confidence level disclosure has to be on a gross or net basis, but the confidence level of the net RA is the one providing the most meaningful information.

Therefore, two methods were investigated :

<u>Calibration through the use of capital models</u>

The goal of this method is to leverage the company's economic or regulatory capital models in order to fit an overall distribution to the change in the PV of cash flows (PVCF) in such a way that the RA can be identified along the fitted distribution.

To do so, a specific percentile of the distribution defined from the Solvency regime (therefore we continue leveraging Solvency II regime), and the information about the underlying probability distribution of the PVCF is required. Unless a better fit is found, it might be reasonable to assume that the change in PVCF fits into a Normal distribution, or a suitably skewed probability distribution like the lognormal.

Having these two elements enables us to calibrate a distribution along which we identify the confidence level of RA. For both the Normal and lognormal ditribution, we calibrate their parameters so that :

- The median (or the mean) of the distribution is Zero

- The 99.5^{th} percentile of the distribution is the Capital requirement CR(0) readily calculated.

We obtain our confidence level from the fitted distribution once the calibration is done and the parameters are found.

It is important to note that this method is sensitive to the shape of the distribution. Comparing the confidence levels of the same RA from the two distributions, we see that they are different.

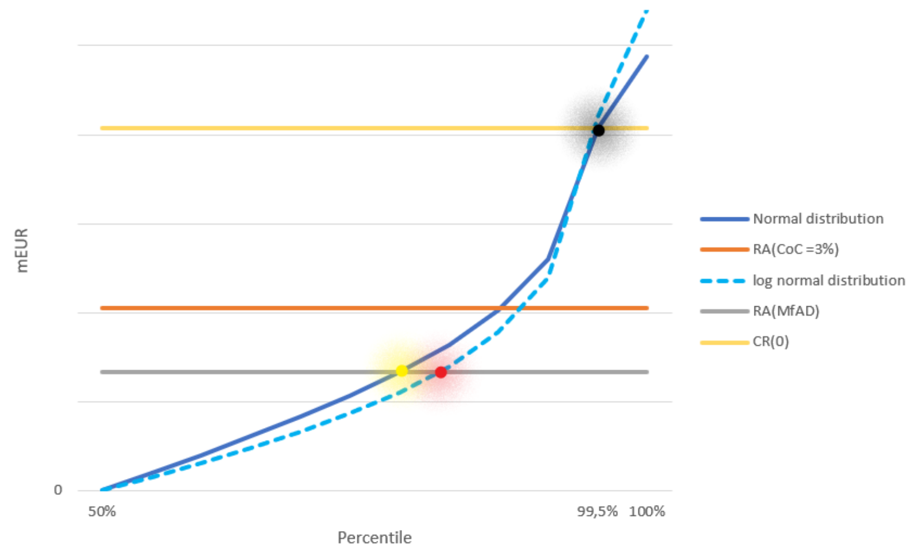

Figure 3: Mapping of Risk Adjustment to equivalent confidence level (Normal, lognormal for change in IFRS 17 PVCF)

Stochastic distribution of non-financial assumptions

Under this method, the distribution of the change in PVCFs is not assumed, instead, it is generated using a model for the underlying non financial risk factors. This method demands generating thousand scenarios and recalculating the change in PVCFs under each one and so is better suited to companies that have scenario-based internal models like PartnerRe.

Non-financial risks can be modelled stochastically. This would involve calibration of distributions of rates of mortality, mortality improvement, morbidity, lapse, and any other key drivers of insurance risk. Cash flows would be projected for multiple scenarios based on these stochastic input parameters. This enables the obtaining of a probability distribution of the entity's aggregate risks enabling the RA to be set at the target percentile level of the observed distribution.

To model insurance risks stochastically, the following risk components are considered:

- Level mortality
- Trend mortality
- Volatility : Risk due to random fluctuations
- Catastrophe: Risk due to one-time large-scale events

We leverage the use of full distribution that was available from the internal model which captures all the key risks mentioned above.

This allows us to use this distribution to define the level of confidence which, according to IFRS 17, should be calibrated to a liability life horizon. However, in order for the distribution used to be accurate, some modifications have been made to omit the market risk considered in some lines of business in the internal model.

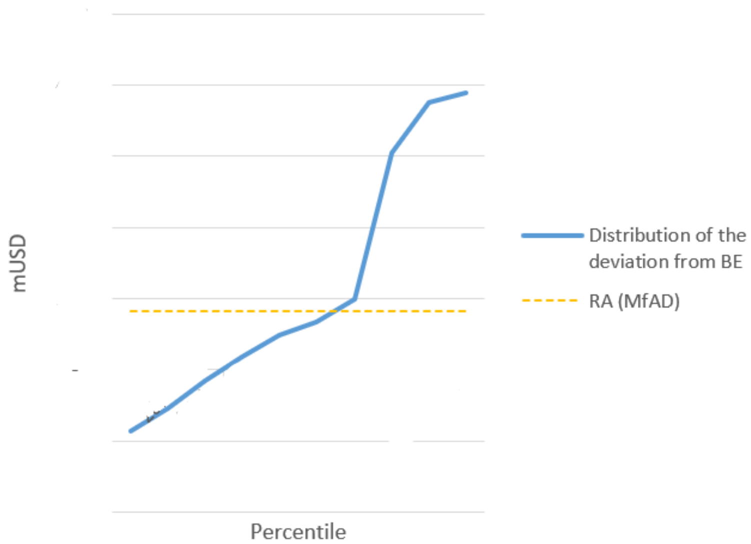

Figure 4: Distribution of NPV deviation from BE, net basis

Conclusion

IFRS 17 Insurance Contracts is a principles-based standard. It does not specify the methods for determining the risk adjustment or the level of aggregation to be used. This provides flexibility for the entity to choose appropriate methods that reflect its own risk aversion. In this thesis, we have proposed two methods : the margin assumption calibration and the cost of capital method.

The first approach has the advantage of being very practical to cover the full spectrum of IFRS 17 GoCs especially since the calibrated margins are directly applicable in the valuation models. The main limitation is the possible re-calibration in the future according to the evolution of the entity's risk profile.

The second approach builds on the existing Solvency II framework by adjusting it in accordance with the requirements of IFRS 17. This method reduces reporting time and calculation effort. The entity can also calibrate its cost of capital rate to reflect its risk aversion. The result of this method is more prudent given the conservative nature of the regulatory frameworks.

In addition, both methods do not provide a confidence level of the RA, so additional work is required to determine it. Internal capital models, if available, can be used to produce it, otherwise, it is possible to calibrate assumed distributions, this time using regulatory capital models.

Note de synthèse

The International Financial Reporting Standards IFRS 17 Contrats d'assurance est une norme comptable qui entrera en vigueur le 1^{er} janvier 2023 et remplacera IFRS 4 Contrats d'assurance. IFRS 17 établit les principes clés à appliquer à tous les aspects de la comptabilisation des contrats d'assurance, visant ainsi à accroître l'utilité, la comparabilité, la transparence et la qualité des états financiers.

En IFRS 17, le choix de la méthode d'évaluation des provisions est basé sur les particularités des produits d'assurance détenus par une entité. Il existe trois méthodes d'évaluation indépendantes : La méthode par défaut *General Measurement Approach*, la *Premium Allocation Approach* et la *Variable Fee Approach*. Pour l'approche par défaut, les passifs d'assurance sont évalués selon les composantes suivantes :

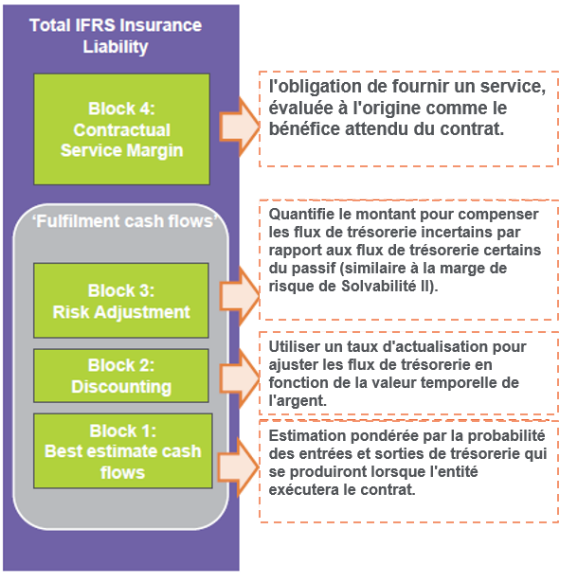

Figure 5: Calibration initiale de l'approche par défaut (GMA)

Le *Risk Adjustment pour risques non financiers* ou simplement *RA* représente l'une des composantes à travers lesquelles les passifs des produits d'assurance sont évalués selon IFRS 17.

Le RA est défini comme *la compensation dont une entité a besoin pour supporter l'incertitude concernant le montant et le calendrier des flux de trésorerie qui découlent du risque non financier*[IFRS 17,37]. Il s'agit d'un facteur influent qui a un impact sur la tarification des contrats d'assurance et sur la manière dont les bénéfices des contrats d'assurance sont déclarés et ressortent au fil du temps.

Le sujet de ce mémoire est le calibrage de cet ajustement pour risque. Nous présenterons des techniques de calcul adaptées à l'activité Vie & Santé d'un réassureur, à savoir l'approche des Marges pour Ecart Défavorable (MED) et l'approche du Coût du Capital (CoC), conformément aux exigences de la norme IFRS 17

Marges pour écart défavorable (MED)

Avec la méthode des MED, nous étudions la possibilité de calibrer une combinaison de marges en exploitant des métriques issues des *pricing frameworks*. Ces marges, lorsqu'elles sont appliquées, doivent fournir un montant qui reflète l'aversion au risque de l'entité. Dans notre cas, ce montant se traduit par la *Present Value Cost of Capital* (PV CoC): une métrique de pricing présente au niveau de chaque traité et qui reflète le prix de détention d'un capital économique.

En d'autres termes, l'idée est de calibrer des hypothèses de marges afin de produire un montant d'ajustement pour risque en accord avec la PV CoC de telle sorte que :

$$Valuation\,(BE + marges\ RA\ ) - Valuation\,(BE)\ \simeq PV\ CoC$$

Cette technique permet de produire un RA à la granularité de comptabilisation la plus fine i.e. *IFRS 17 GoC (Group of Contracts)* lors de l'exécution des modèles d'évaluation, qui auront comme entrées les marges calibrées.

Idéalement, ce calibrage devrait se faire pour chaque *IFRS 17 GoC (Group of Contracts)*. Cependant, ce niveau de granularité est beaucoup trop fin. Par conséquent, nous proposons d'effectuer le calibrage sur un niveau plus agrégé et opérationnellement pratique. Nous choisissons donc le niveau de granularité IFRS 17 Regroupement de Produit (IFRS 17 (RP))[2]. Pour ce faire, nous sélectionnons sous certains critères, un (ou des) traité qui représentera chaque ligne de business (LoB) et sur lequel l'exercice de calibrage sera effectué. Les résultats seront appliqués aux affaires en vigueur restantes.

Pour illustrer cette approche, nous appliquons cet exercice de calibrage sur deux IFRS 17 RP : *Long Term Protection* représenté par la LoB *Critical Illness* (Maladie redoutée) et *Longevity* (Longévité)

Selon la nature de la LoB, le calibrage est effectué pour les risques suivants :

- Risque de niveau de mortalité
- Risque de tendance de mortalité
- Risque de rachat
- Risque de frais

Ainsi, les étapes du calibrage sont :

A. Diviser les affaires en vigueur en segments présentant des caractéristiques de risque similaires

[2] Niveau d'agrégation IFRS 17 chez PartnerRe

B. Sélectionner les traités pour le calibrage
C. Effectuer l'exercice de calibrage
D. Valider les résultats

Le calibrage des hypothèses des marges est le résultat d'un processus itératif où les marges sont testées une par une et pour chaque risque. Nous testons dans un second temps les combinaisons de ces marges pour définir la meilleure d'entre elles. Ces marges doivent varier dans un intervalle plus ou moins petit, car le but du RA est de quantifier le risque de la mauvaise estimation des hypothèses non financières plutôt que la couverture des risques non financiers.

Conclusions concernant la méthode

Le calibrage des marges a l'avantage d'être une méthode simple et pratique sur le plan opérationnel lorsqu'il s'agit de définir un RA à un niveau de granularité aussi fin que *IFRS 17 GoC*.

Comme tout exercice de calibrage, la validation de nos résultats est une étape nécessaire, surtout que le calibrage s'est effectué à un niveau agrégé engendrant moins de précision au niveau des résultats. L'impact réel est difficile à quantifier tant que les modèles d'évaluation n'auront pas tous été exécutés. Néanmoins, les modèles d'évaluation ont été exécutés pour quelques traités. Nous les avons utilisés pour une validation partielle de nos marges calibrées.

Un inconvénient de cette méthode est qu'un recalibrage peut s'avérer nécessaire à l'avenir afin de maintenir le lien approprié entre la PV CoC et les hypothèses des marges. Ce recalibrage peut être dû au changement d'hypothèses dans la *pricing framework*(taux d'actualisation, facteurs de diversification, hypothèses non financières etc.) ou suite au changement du profil de risque de l'entité par exemple.

Exploiter le cadre Solvabilité II pour l'IFRS 17 RA

La directive Solvabilité II est en vigueur depuis 2016. Un gros effort de mise en œuvre a été déployé par tous les assureurs européens qui ont investi beaucoup de ressources et de temps dans la production des calculs et des rapports Solvabilité II.

l'évaluation économique sous IFRS 17 présente de nombreux points de convergence avec Solvabilité II. Par conséquent, et afin d'éviter de multiplier les travaux de production à la fois pour IFRS 17 et Solvabilité II, nous proposons une seconde méthode qui exploite cette fois-ci les méthodologies de calcul de Solvabilité II afin de l'adapter au Risk Adjustment d'IFRS 17.

Marge pour risque SII Vs IFRS 17 RA

Lorsque nous comparons les provisions pour risques dans SII et IFRS 17, les principales différences sont :

-La marge pour risque (*Risk Margin*) de Solvabilité II est prescrite, tandis que l'ajustement pour risque IFRS 17 repose sur des principes, c'est-à-dire qu'il n'y a pas de méthode prescrite pour le définir
-IFRS 17 exige des ajustements de risque distincts pour le passif brut et la réassurance détenue (cédée), tandis que Solvabilité II a une seule marge de risque basée sur la position

nette de réassurance.
-Le BEL tel que défini dans IFRS 17 est similaire au BE de Solvabilité II (estimation actuelle et pondérée des flux de trésorerie résultant des contrats d'assurance émis par l'assureur). Cependant, les différences résident dans les flux pris en considération et les taux d'actualisation utilisés.

-Les risques inclus dans la *Risk Margin* sont tous les risques d'assurance, de crédit, de risque opérationnel et de risques non couvrables, alors que le périmètre d'IFRS 17 RA ne concerne que les risques d'assurance et les risques non financiers.

En utilisant l'approche du coût du capital comme dans Solvabilité II avec le même modèle d'agrégation, la formule du RA à **un niveau d'agrégation donné** devient :

$$RA = CoC_{IFRS17} \cdot \sum_{t \geq 0} \frac{CR(t)}{(1 + r_{t+1})^{t+1}}$$

Où :

-CoC_{IFRS17} : Le taux de coût du capital (pouvant être calibré) qui reflète la compensation requise

-CR : Le capital requis au niveau d'agrégation donné après t années

-r_{t+1} : Courbes de taux construites suivant les principes IFRS 17

Nous choisissons de calculer notre RA au niveau d'agrégation Regroupement de Produit (RP) en utilisant le mappage qui relie les LoBs internes SII de gestion de PartnerRe aux RP de l'IFRS 17. Ainsi :

$$RA_{entity} = \sum_{Internal\_LoB} RA_{Internal\_LoB} = \sum_{IFRS17\_RP} RA_{IFRS17\_RP}$$

Le capital requis (CR) serait ajusté pour refléter les considérations suivantes :

-Suppression des composantes du capital liées aux risques autres que les risques d'assurance et non financiers.

- Base de calcul :

Deux séries de calculs : une sur une base brute et l'autre sur une base nette. La deuxième série a pour but de nous aider à définir le montant du RA dédié à la rétrocession.

- Diversification :

Idéalement, la diversification la plus appropriée devrait être faite lorsque l'on dispose d'une matrice de corrélation pour agréger les CR entre les LoBs internes SII (ou IFRS 17 RP). Si une telle ressource n'existe pas, nous proposons que la diversification soit traitée en utilisant les mêmes matrices de corrélation SII de l'intra-vie, l'intra-santé et de vie& santé.

Le calcul de la marge pour risque SII devrait être basé sur l'hypothèse que le transfert des obligations d'assurance du portefeuille pour les activités vie et non-vie est effectué séparément, ce qui ne sera pas le cas pour le RA car IFRS 17 permet la diversification vie/non-vie dans l'ajustement pour risque [IFRS 17, B88(a)].

Le SII RM de la composante Vie & Santé a été comparé au RA de l'IFRS 17 en utilisant les deux méthodes (approche MED et CoC en fixant le taux de CoC_{IFRS17} à 3%).

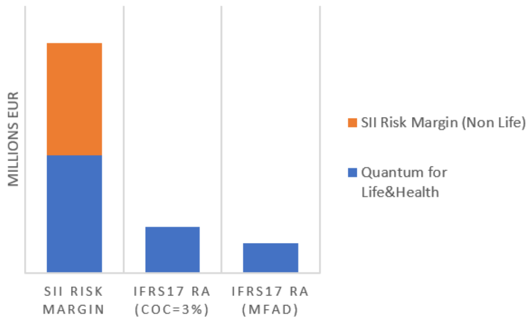

Figure 6: SII RM Vs IFRS 17 RA

Nous avons aussi essayé de calibrer le taux CoC_{IFRS17} pour chaque IFRS 17 RP. Le calibrage est réalisé de manière à avoir des montants de RA égaux entre les deux approches. La finalité de cette analyse est de former une idée sur le niveau de la compensation requise à partir du taux CoC_{IFRS17}, mais c'est aussi un moyen pour combiner les résultats des deux approches.

-*L'allocation du RA*

Le calcul effectué dans l'ensemble des différents RP de l'IFRS 17 est le résultat d'une approche descendante (*Top-Down*) pour obtenir le RA. Cependant, le RA doit être alloué à la maille la plus fine (IFRS 17 GoC) afin d'estimer les *fulfillment cash flows* du groupe de contrats lors de la comptabilisation initiale [IFRS 17, 24]. Dans ce cas, une méthode d'allocation est nécessaire. Il existe plusieurs méthodes d'allocation du capital parmi lesquelles nous avons choisi l'allocation scalaire (au prorata) en utilisant les *PV claims* comme mesure de référence.

-***Conclusions concernant la méthode***

Cette approche est très cohérente avec la définition de l'IASB[3] pour le Risk Adjustment. Elle est appropriée pour les risques complexes ou à long terme comme ceux de l'activité Vie et Santé.

La formule de l'approche du coût du capital est simple, la difficulté réside dans la détermination de ses composantes et de leurs projections. Nous avons choisi de nous inspirer de la méthodologie de Solvabilité II pour calculer le capital requis. Cependant, l'utilisation des matrices de correlation prescrites reste une limite de cette approche qui devrait être traitée.

L'utilisation d'une méthodologie basée sur Solvabilité II pour calculer les exigences de capital signifie un résultat plus prudent. Ceci est confirmé en comparant les résultats des deux méthodes, sachant que la méthode des MED traduit une compensation minimale du risque.

[3] International Accounting Standard Board

L'indicateur du niveau de confiance du RA

IFRS 17 a des exigences de publier un indicateur de quantile (niveau de confiance) qui correspond au montant du RA comme cité dans [IFRS 17,119].

Selon ce paragraphe, l'utilisation de toute méthode alternative à la technique du niveau de confiance (c'est-à-dire les techniques des quantiles, y compris la *Value at Risk* VaR ou la *Tail Value at Risk* TVaR) implique un travail supplémentaire pour déterminer le niveau de confiance. En effet, l'utilisation de marges pour écarts défavorables ou de l'approche du coût du capital pour définir le RA signifie que nous devons chercher une méthode pour exprimer le niveau de confiance. Dans ce cas, la technique du quantile peut être utilisée comme méthode secondaire.

En outre, il est raisonnable de déduire que le paragraphe 119 fait référence au RA global de l'entité, et qu'il serait à la discrétion de l'entité de divulguer le niveau de confiance du RA à un niveau de granularité autre que celui de l'entité. Nous avons donc choisi de calculer le niveau de confiance du RA au niveau de l'entité.

L'IFRS 17 ne précise pas si la divulgation du niveau de confiance doit se faire sur une base brute ou nette, mais le niveau de confiance du RA net est celui qui fournit l'information la plus significative.

Deux méthodes sont étudiées :

<u>Calibration par l'utilisation de modèles de capital</u>

L'objectif de cette méthode est d'exploiter les modèles de capital économique ou réglementaire de l'entreprise afin d'ajuster une distribution à la variation de la PV des flux de trésorerie (PVCF) de telle sorte que le RA puisse être identifié à partir de la distribution ajustée.

Pour ce faire, nous aurons besoin de définir un percentile spécifique de la distribution à partir du régime de solvabilité (nous continuons donc à utiliser la directive Solvabilité II), et des informations sur la distribution de probabilité sous-jacente de la PVCF.

À moins qu'une meilleure distribution ne soit sélectionnée, il peut être raisonnable de supposer que la variation de la PVCF a une distribution Normale, ou une distribution de probabilité convenablement asymétrique comme la lognormale.

Le fait de disposer de ces deux éléments nous permet de calibrer une distribution à partir de laquelle nous pouvons identifier le quantile correspondant au RA. Pour la distribution normale et lognormale, nous calibrons leurs paramètres de manière à ce que :

- La médiane (ou la moyenne) de la distribution soit nulle.

- Le $99,5^{eme}$ percentile de la distribution est le Capital Requis CR(0) déjà calculé.

Nous obtenons notre niveau de confiance à partir de la distribution ajustée une fois le calibrage effectué et les paramètres trouvés.

Il est important de souligner que cette méthode est sensible à la forme de la distribution. En comparant les niveaux de confiance du même RA à partir des deux distributions, nous constatons qu'ils sont différents.

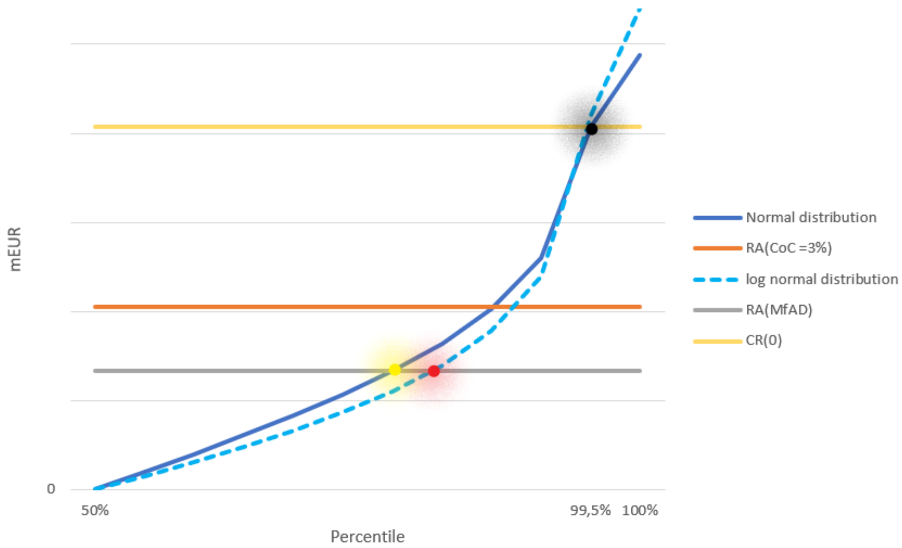

Figure 7: Mapping du Risk Adjustment pour définir le niveau de confiance équivalent (distribution normale, lognormale de la variation du PVCF IFRS 17)

Distribution stochastique pour hypothèses non financières

Dans cette méthode, la distribution de la variation des PVCF n'est pas supposée, mais elle est générée en utilisant un modèle pour les facteurs de risque non financiers sous-jacents. Cette méthode exige de générer des milliers de scénarios et de recalculer la variation des PVCF pour chacun d'entre eux. Elle est donc mieux adaptée aux entreprises qui disposent de modèles internes basés sur des scénarios, comme PartnerRe.

Les risques non financiers peuvent être modélisés de manière stochastique. Cela impliquerait la calibration des distributions des taux de mortalité, d'amélioration de la mortalité, de morbidité, de rachat et de tout autre facteur clé du risque d'assurance. Les flux de trésorerie seraient projetés pour de multiples scénarios basés sur ces paramètres d'entrée stochastiques. Cela permet d'obtenir une distribution de probabilité des risques globaux de l'entité permettant de définir le niveau de confiance RA à partir de la distribution observée.

Pour modéliser les risques d'assurance de manière stochastique, les composantes de risque suivantes sont considérées :

- Niveau de mortalité
- Tendance de mortalité
- Volatilité : Risque dû aux fluctuations aléatoires
- Catastrophe : Risque dû à des événements ponctuels de grande ampleur.

Nous tirons parti de l'utilisation de la distribution complète disponible dans le modèle interne et qui capture tous les risques clés mentionnés supra. Le principal avantage du modèle interne est qu'une distribution *full run off (FRO)* (distribution sur la durée de vie des affaires en cours) est directement calculée, avec des déviations provenant de scénarios du monde réel.

Cela nous permet d'utiliser cette distribution pour définir le niveau de confiance qui, selon la norme IFRS 17, devrait être calibré par rapport à un horizon de vie des engagements. Cependant, pour que la distribution utilisée soit correcte, quelques modifications ont été apportées afin d'omettre le risque de marché considéré dans certaines lignes de business dans le modèle interne.

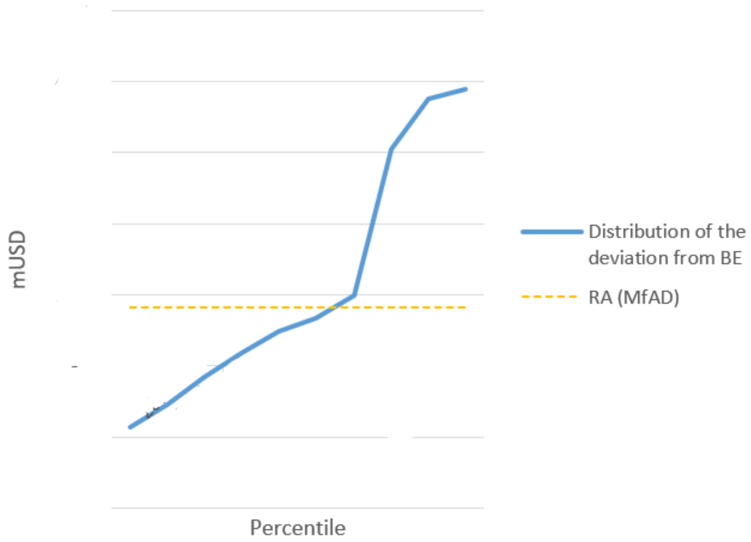

Figure 8: Distribution de la NPV deviation du BE, base net

Conclusion

L'IFRS 17 Contrats d'assurance est une norme fondée sur des principes. Elle ne précise ni les méthodes de détermination de l'ajustement pour risque ni le niveau d'agrégation à utiliser. Ceci offre une flexibilité à l'entité pour choisir les méthodes appropriées qui reflètent sa propre compensation des risques. Dans ce mémoire, nous avons proposé deux approches pour cette fin : le calibrage des hypothèses de marges et la méthode du coût du capital.

La première approche a l'avantage d'être très pratique pour couvrir tout le spectre des GoC d'IFRS 17 surtout que les marges calibrées sont directement applicables dans les modèles d'évaluation. La principale limite est l'éventuel recalibrage dans le futur en fonction de l'évolution du profil de risque de l'entité.

La deuxième approche s'appuie sur le cadre existant de Solvabilité II en l'ajustant conformément aux exigences de l'IFRS 17. Cette méthode réduit le temps de reporting et les efforts de calcul. L'entité peut également calibrer son taux de coût du capital pour refléter son aversion au risque. Le résultat de cette méthode est plus prudent étant donné la nature conservatrice des cadres réglementaires.

Par surcroît, les deux méthodes ne fournissent pas de niveau de confiance du RA, des travaux supplémentaires sont donc nécessaires pour le déterminer. Les modèles internes de capital, s'ils existent, peuvent être utilisés pour le produire, sinon, il est possible de calibrer des distributions supposées en utilisant cette fois les modèles de capital réglementaires.

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Disclaimer :

Whilst every effort has been made to ensure the coherence of the results supplied herein, all the figures, names and any other sensitive information were modified to preserve confidentiality. Unless otherwise indicated, opinions expressed herein are those of the author of the thesis and do not necessarily represent the views of Partner Re.

Introduction

As part of continuous efforts to reach an international homogenization of accounting standards for comparability purposes between listed companies, the International Accounting Standards Board (IASB) published the latest international financial reporting standard, IFRS 17, in May 2017. The standard establishes principles for the recognition, measurement, presentation and disclosures of insurance and reinsurance contracts issued and held by entities and comes to replace its provisional predecessor, IFRS 4 on accounting for insurance contracts published in 2004 and in force since 2005.

IFRS 17 revolutionizes the principles of accounting for insurance contracts. The implementation of such project required a process as long as 20 years, and it is mainly due to the nature of the insurance activity that entails the presence of long-term commitments. It is also due to the acknowledgment of the complexity of enforcing the standard itself, not only with respect to its application, but also in relation to its interpretation, as IFRS 17 implies a certain level of subjectivity underlying some of its concepts because it is a principles-based standard.

The norm was expected to be effective January 2021, however the decision to defer the effective date by two years from the original date to 2023 was motivated by the Board's desire to enable insurers around the world to implement the new standard at the same time, which is considered to be beneficial for investors, insurers and the stakeholders all together.

New concepts such as the Contractual Service Margin and the **Risk Adjustment for non-financial risks** were introduced under IFRS 17. The IFRS 17 Risk Adjustment is an influential factor in the pricing of insurance contracts and in how profit from insurance contracts is reported and emerges over time. As the standard is principles-based and not rules-based, the method for its calculation is not prescribed but must satisfy certain conditions. Hence, there are many potential methods of calculation from which the insurance company can choose the one that suits its risk aversion degree the best.

The RA represents one of the components through which the liabilities of insurance products are assessed under IFRS 17. It will be the focus of our thesis as we will try to introduce suitable estimation techniques of the RA for the Life & Health activity, with a respect of the criteria proposed by the norm.

Consequently, the first chapter intends to provide the reader with an understanding of the key principles and concepts of assessing insurance contracts liabilities under IFRS 17. The IASB provides the specific requirements regarding Risk Adjustment that will be addressed in a second chapter, where we give explanations of the rationale and considerations that underlie the IFRS requirements related to Risk Adjustment as well as the key issues related to possible interpretations of the Risk Adjustment.

As we try to produce a RA for an entity (PartnerRe Life & Health entity), a first approach considered in this thesis is the *Margin for Adverse Deviation*. It lies on the idea of calibrating a set of margins that when applied, delivers an amount that is in line with the pricing view on the compensation of risk sought by the company.

Given that the Solvency II standard has been in force since 2016, a great implementation effort was made by all European insurers who have invested a lot of time, energy and money in producing the calculations and Solvency II reports. Hence we propose through the fourth chapter a practical approach that aims at exploiting Solvency II calculations and models to produce an appropriate RA so that to avoid multiplying production work for both IFRS 17 and Solvency II.

Finally, IFRS 17 requires insurers to disclose their approaches in an auditable fashion including a disclosure of a confidence level for the RA. In the case when the approach used to derive RA does not produce a confidence level such as ours, the latter becomes a consequence of the RA determined, as opposed to methods where confidence Level is considered an input. Therefore, in the last chapter, we examine methods that enable us to translate the RA into an associated confidence level.

Part I

Regulatory context

Chapter 1

IFRS 17 : Insurance contracts

The International Financial Reporting Standards IFRS 17 Insurance Contracts is a new accounting standard that will be effective on January 1, 2023 superseding IFRS 4 Insurance contracts. IFRS 17 establishes the key principles to be applied to all aspects of accounting for insurance contracts, thereby aiming to increase the usefulness, comparability, transparency and quality of financial statements. Like all other IFRS standards, IFRS 17 is a principle-based standard, this feature gives insurers a certain freedom of interpretation and offers them the opportunity to manage their accounts published under IFRS 17. By designing it this way, the IASB offers a flexible standard that takes into account the particularities of each insurer.

Figure 1.1: Implementation of IFRS 17 standards, a timeline

Prior to the effective date of IFRS 17, insurance contract liabilities are governed by IFRS 4 phase 1. IFRS 17 will supersede IFRS 4, which is the current financial reporting standard under which insurance companies prepare their financial statements.
IFRS 4 Phase 1 has a paramount issue :

- insurance liabilities remain recognized under local standards which vary from one group to another, thus not ensuring the comparability objective that IFRS 17 intends to achieve.

Another key difference between IFRS 17 and IFRS 4 is the consistency of application of accounting treatments to areas such as revenue recognition and liability valuation. Under IFRS 4, entities were free to derive their own interpretations of revenue recognition and calculation of reserves. For instance, when it comes to the Risk Adjustment for non financial risks, subject of this thesis, it was at the discretion of the companies to include it in the liabilities under IFRS 4, whereas it is now mandatory under IFRS 17. The figure below provides key differences between IFRS 4 and IFRS 17 new requirements.

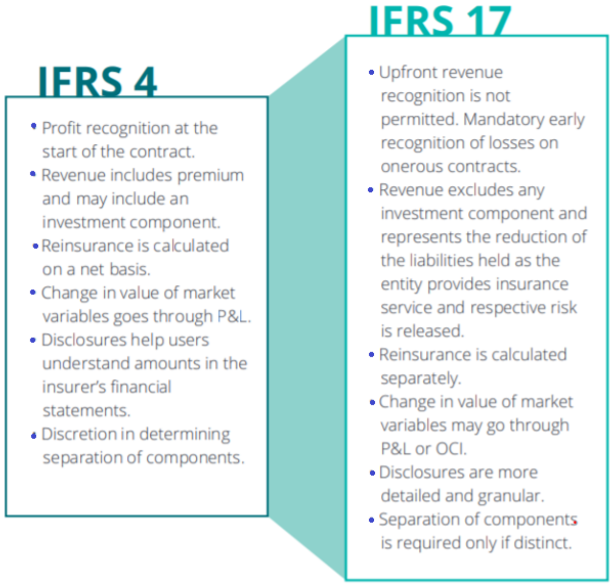


Figure 1.2: Key differences between IFRS 4 and IFRS 17 [Ma'ayeh et Abbasi, 2020]

1.1 The scope of IFRS 17

An insurance contract is the same as under IFRS4 and defined as:

A contract under which one party (the issuer) accepts significant insurance risk from another party (the policyholder) by agreeing to compensate the policyholder if a specified uncertain future event (the insured event) adversely affects the policyholder [IFRS 17, Appendix A: defined terms]

The contracts matching that definition and within the IFRS 17 scope are :

- Insurance contracts (including reinsurance contracts) an entity issues
- Reinsurance contracts an entity holds
- Investment contracts with discretionary participation features (DPF)[1] any entity issues, provided the entity also issues insurance contracts

The definition evokes an important element that is the *Insurance risk*. Under IFRS 17, insurance risk represents *risk, other than financial risk, transferred from the holder of the contract to the issuer*[IFRS 17,B18]

It is important to highlight that an insurance contract is in IFRS 17 scope if it transfers a significant amount of insurance risk to the entity and that an insurance risk is only significant

[1]share of profits distributed beyond legal minimum provided for in a contract (c.f. 1.3.2 for its definition)

when there is at least one scenario where the compensation paid by the entity is significant, regardless of the likelihood of that scenario.

However, it is possible for the entity to apply IFRS 17 or IFRS15 for some contracts which meet the definition of an insurance contract but whose service is a fixed fee service (Example of road assistance)

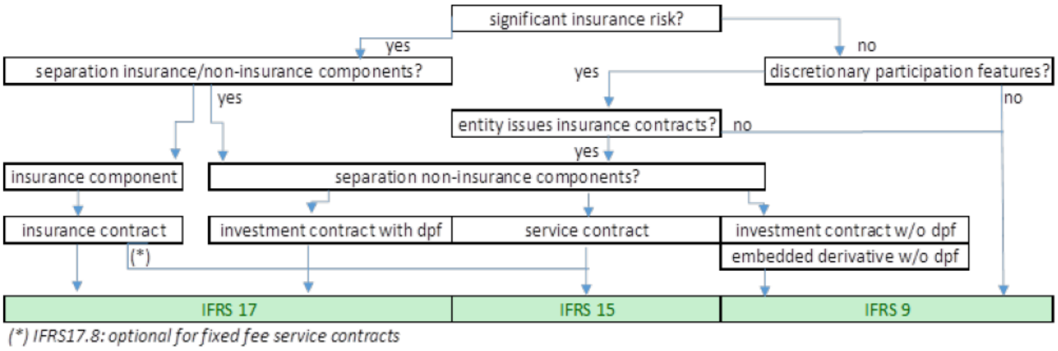


Figure 1.3: The application scope of IFRS 17 [Siddiqi, 2019]

1.2 Evaluating insurance contracts

1.2.1 Contract boundary

Paragraph 34 defines the boundary of a contract for IFRS 17 measurement purposes:

Cash flows are within the boundary of an insurance contract if they arise from substantive rights and obligations that exist during the reporting period in which the entity can compel the policyholder to pay the premiums or in which the entity has a substantive obligation to provide the policyholder with services [IFRS 17, 34]

In other words, it defines which cash flows are taken into consideration in the valuation of the insurance contract during the financial reporting period. For example, if the contract holder cannot be forced to pay the premium or if it is not obliged to renew a contract for an agreed period, the entity has no substantive right to the premiums after the agreed period and therefore cannot include these cash flows

1.2.2 Aggregated levels of insurance contracts

IFRS 17 divides insurance contracts into what we call (*Group of Contracts (GoC)*), thus separating the contracts into portfolios, cohorts (years of subscription) and into profitability groups.

We will discuss each one of these levels because understanding these concepts are important to the discussion of the level of aggregation of the RA in the next part of this thesis.

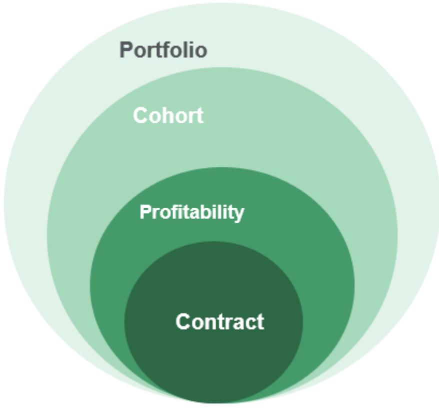


Figure 1.4: Contracts aggregation levels under IFRS 17

Portfolio level:

A *portfolio comprises contracts subject to similar risks and managed together. Contracts within a product line would be expected to have similar risks and hence would be expected to be in the same portfolio if they are managed together. Contracts in different product lines (for example single premium fixed annuities compared with regular term life assurance) would not be expected to have similar risks and hence would be expected to be in different portfolios.*[IFRS 17,14]

We should point out that there is no clear definition in IFRS 17 of what "similar risks" and "managed together" practically means. Hence the entity can aggregate its contracts following its own view, as long as the contracts are sufficiently similar, and in many cases, doing so leads to the construction of portfolios that are naturally managed together.
A practical approach to defining the portfolios for an entity can rely on the internal management reporting system. For instance, an entity's internal management system may consolidate the results into product lines. These product lines could provide a suitable aggregation of similar risks.

Cohorts level:
The contracts of each portfolio must then be grouped by cohort: that is to say that if two contracts are taken out at more than one year apart, they must belong to separate groups.

Profitability level: The contracts are then classified according to three profitability levels:

- A group of onerous contracts on the date of initial recognition. Note that this category of contract implies the recognition of losses in the PL as soon as the onerous contracts exist.
- Contracts that were not onerous at the time of initial recognition but represent a significant risk of becoming so in the future.
- The rest of the contracts, namely contracts that were not onerous at the time of initial

recognition and do not present a significant risk of becoming so in the future. Note that unlike losses, the profits of these contracts, called *non onerous*, are not immediately recognized and give place to a "CSM" which we will explain later in this chapter.

1.3 Measurement of Liabilities for insurance contracts

The choice of the valuation method for provisions under IFRS 17 is based on the particularities of the insurance products held in the portfolio by the entity (c.f. Figure 1.5).

The standard cites three independent methods: The default method or the general method, (*General Measurement Approach*) also called *Building Block Approach BBA* (c.f. 1.3.1), the *Premium Allocation Approach* and finally *the Variable Fee Approach* (c.f. 1.3.2).

The default method, BBA, applies to all non-participating contracts with a term of more than one year as well as indirect participatory contracts. Direct participatory contracts are valued by the VFA method. For non-participating contracts where the duration does not exceed 1 year, entities have the option of using the PAA method. Further details on the different approaches are summarised in the next sub-sections.

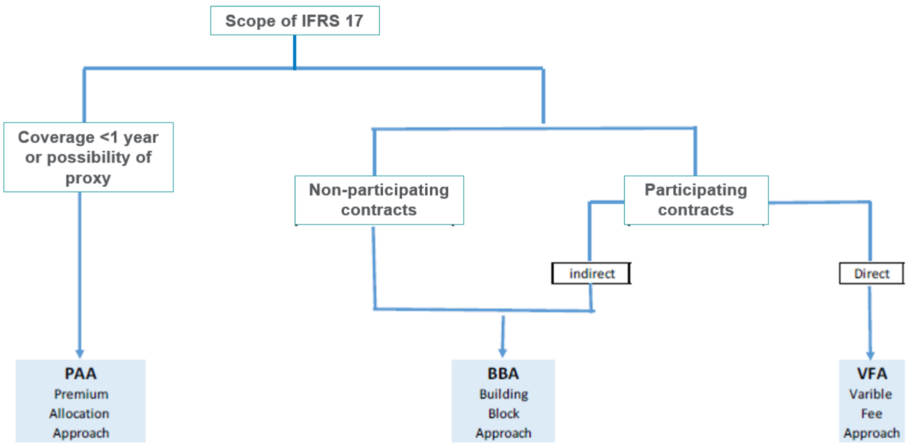


Figure 1.5: Measurement of Liabilities for insurance contracts

• Participating contract:
-Direct: the insured is entitled to a share in a portfolio of underlying assets.
the insurer expects to pay the insured a sum corresponding to a substantial part of the return obtained, a significant part of the benefits having to vary with the value of the assets (example: life insurance contract - profit sharing)

-Indirect: an insurance contract other than a direct participating contract, but where the flows of the contract vary with the underlying assets (e.g. loan insurance contract)

• Non-participating contracts: these are contracts where the flows to the policyholders do not vary with the underlying elements (e.g. property and casualty contracts)

1.3.1 The General Measurement Approach

The General Measurement Approach, also known as The Building Block Approach assesses the liabilities of insurance products through four distinct blocks (or components) :

- Best estimate of cash flows
- Discounting
- Risk Adjustment for non financial risks
- Contractual Service Margin

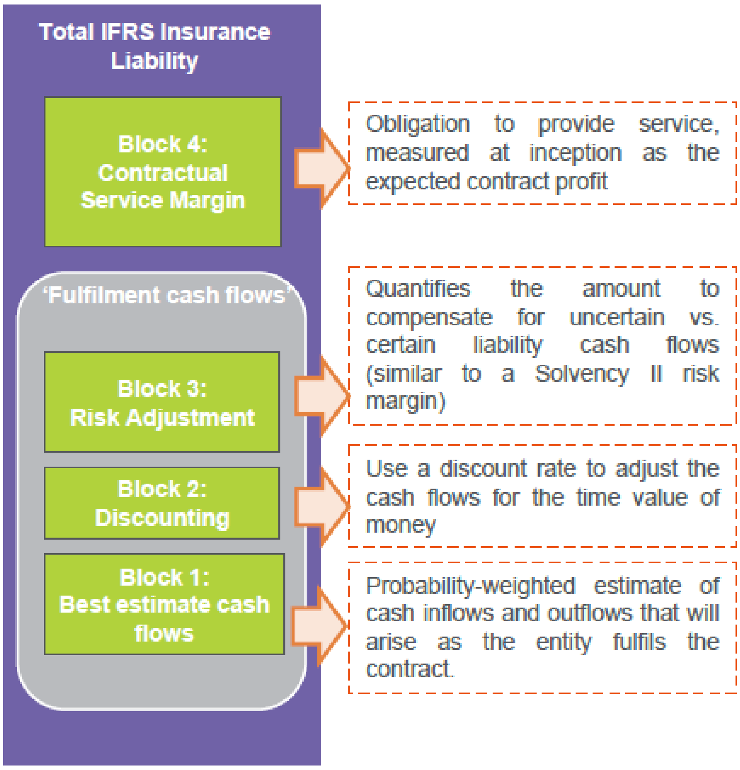


Figure 1.6: the BBA measurement blocks, *source : PartnerRe's internal IFRS 17 training*

Following a second breakdown, these liabilities should also be equal, at each closing date, to the sum of two amounts :

- Liability for Remaining Coverage (LRC)
- Liability for Incurred Claims (LIC)

-The LRC corresponds to the entity's obligation concerning insured events related to the unexpired portion of the coverage period [IFRS 17,40].

-The LIC relates to the entity's obligation to pay claims for insured events that have already occurred, which includes events that have incurred but have not been reported (IBNR) and other incurred insurance expenses.

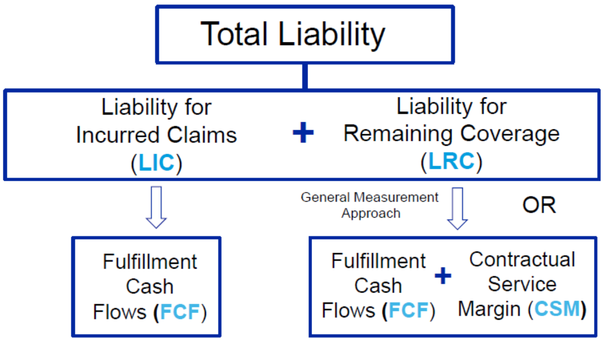


Figure 1.7: Breakdown of the liabilities under BBA by LIC/LRC

The Best Estimate of cash flows

The key characteristics of the measurement of estimates of future cash flows [IFRS 17, 33]:

1. They include all future cash flows within the contract boundary
2. Are the probability weighted mean of the full range of possible outcomes
3. Are unbiased (i.e. they do not include the Risk Adjustment for non-financial risk)
4. Reflect the perspective of the entity (except that estimates of market variables are consistent with observable market variables for those variables)
5. Are current
6. Are explicit

Discounting

The guidance around discount rates in IFRS 17 comes as follow : The rates applied to the estimates of the future cash flows should reflect time value of money and the characteristics of cash flows. They should also reflect liquidity characteristics of the insurance contracts and should be consistent with observable current market prices for financial instruments with cash flows whose characteristics are consistent.[IFRS 17,36] ,[IFRS 17,B72], [IFRS 17,B85]

-If cash flows are **not dependent** on underlying items[2] : a top-down[3] or bottom-up approach is used to determine them.

-If cash flows are **dependent** on underlying items, discount rates have to reflect the variability of the cash flows.

[2]IFRS 17 defines underlying items as some of the amounts payable to a policyholder. Underlying items can comprise any items; for example, a reference portfolio of assets, the net assets of the entity, or a specified subset of the net assets of the entity.

[3]For the Top-down approach, IFRS 17 has no specific requirements for the reference portfolio. It could be based on actual assets held by the company or on a theoretical portfolio of assets. However, the better the reference portfolio reflects the characteristics (e.g. liquidity) of the cash flows for which the discount rate is being developed, the smaller adjustments are likely to be needed in the discount rate

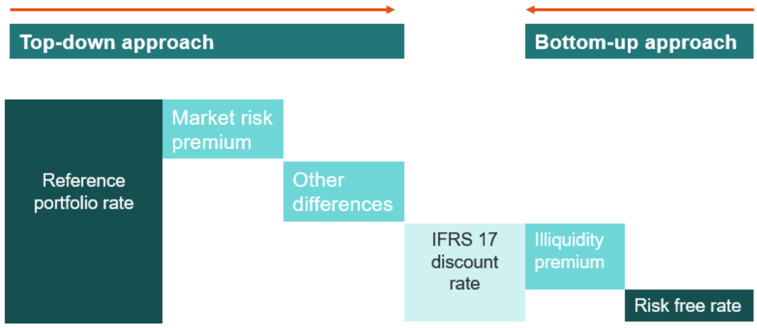


Figure 1.8: Defining IFRS 17 CF discount rates using Top-down or Bottom-up approaches

The Risk Adjustment for non-financial risk

The Risk Adjustment can be defined as *the compensation an entity requires for bearing the uncertainty about the amount and timing of the cash flows that arises from non-financial risk as the entity fulfils insurance contracts*[IFRS 17, Appendix A Defined Terms].

The *non-financial risks* announced here are the risks that might impact the expected future cash flows (and are not financial risks[4]). Hence, the risks that are expected to be incorporated in RA include mortality, disability, longevity, expense, revision, lapse, catastrophe and premium and reserve risk. Each group of contracts will of course be exposed to a subset of these risks depending on their nature. We will bring up the non financial risks in the next chapter (c.f. 2.1.1)

As IFRS 17 provides solely the principles about how the Risk Adjustment should be calculated (however, there is a requirement to disclose the implied confidence level of the method used to calculate the RA), it will be important that the quantification of such a liability value be based on methodologies that are robust and are a fair reflection of this value. Further details on the Risk Adjustment requirements and methodologies are discussed in the next fully-dedicated chapter.

Contractual service margin

The CSM is the new element introduced by the norm. Giving the fact that there is no similar concept in the current standards, it makes its calculation very challenging for insurers transitioning to IFRS 17. The Contractual Service Margin is defined as *the profit in the group of insurance contracts that has not yet been recognised* [IFRS 17,43]. It is a measure of the service the entity performs in fulfilling the contract. It won't be recognised as an immediate gain, but rather over time as the entity satisfies its obligation.
The CSM cannot be negative and have to be amortised based on coverage units[5] and over

[4]Financial risk is *the risk of a possible future change in one or more of a specified interest rate, financial instrument price, commodity price, currency exchange rate, index of prices or rates, credit rating or credit index or other variable" [IFRS17, Appendix A Defined Terms]*

[5]Coverage units reflect “the quantity of the benefits provided under a contract and its expected coverage duration [IFRS 17,B119(a)]

coverage period in proportion to the service provided in a way that :

$$\% \text{ csm released}(t) = \frac{\text{expected release of coverage units}(t)}{\text{sum of expected release of coverage units of all years}}$$

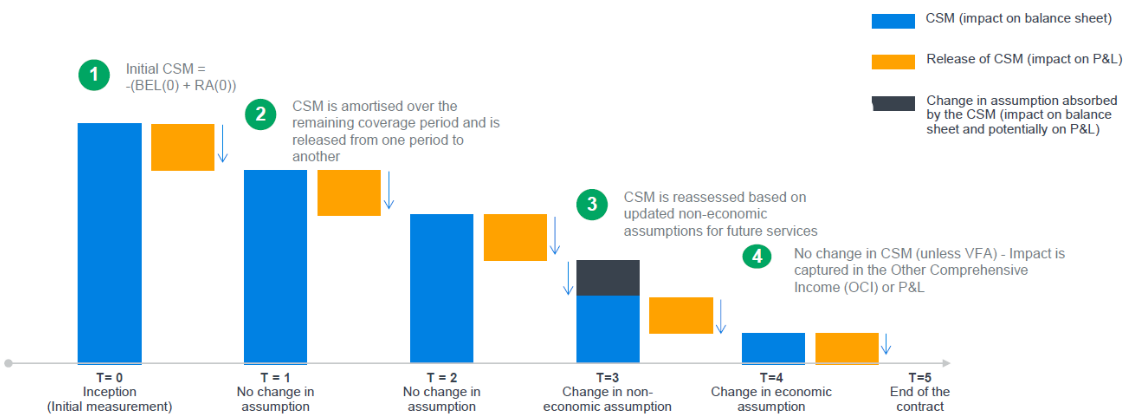


Figure 1.9: General example of the CSM amortised over the coverage period [Milliman, 2017]

At inception, a contract can be onerous. In that case the deficit is recognised as a loss. For a contract that wasn't onerous at the inception date, the CSM can decrease to zero due to unfavourable changes in cash flows. That change is recognised via CSM until it is depleted. If the contract becomes profitable again due to favourable changes, the losses previously recognised need to be earned back. Once they are, a new CSM can be created.
All components being defined, the following diagram shows a simplified case of a possible expected benefit in the form of CSM at inception date versus recognised loss.

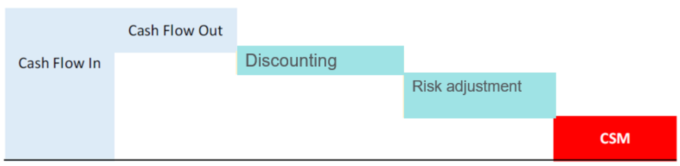


Figure 1.10: Simplified case of expected benefit CSM under BBA

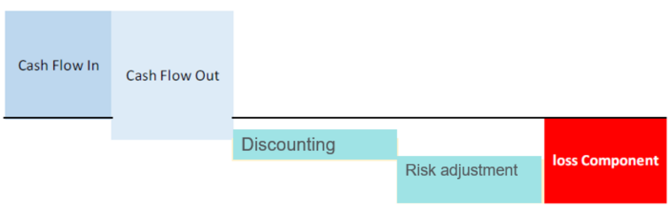


Figure 1.11: Simplified case of onerous contract where loss is recognised

1.3.2 Variations to the General Measurement Approach

The premium Allocation Approach

The premium allocation approach (PAA),is a simplification of the BBA measurement basis in IFRS 17, the norm states that this method can be used to measure the LRC part, if the entity expects the PAA would produce a measurement that wouldn't differ materially from the one produced by the BBA. Furthermore, the coverage period of these contracts should be one year or less.[IFRS 17,53]

This method is similar to current IFRS 4 reserving, particularly as it allows the firm to hold the unearned premium reserves (UPR) and acquisition costs (AC) as a simplification for the LRC [IFRS 17,55(b)], whilst the LIC is under BBA measurement.

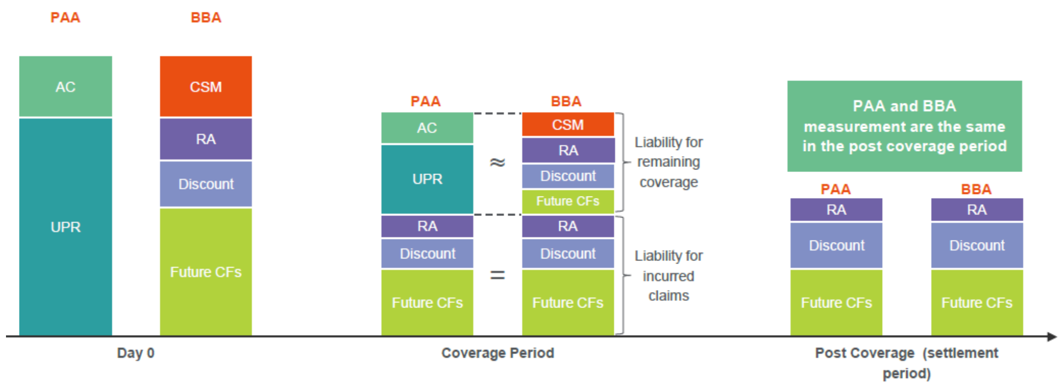


Figure 1.12: BBA Vs PAA : treatment of unexpired coverage

-*source : PartnerRe's internal IFRS 17 training*

The Variable Fee Approach

The VFA may be used for contracts with direct participation and contracts with discretionary participation features that we will define right away. Although not insurance contracts, investment contracts with discretionary participation features are in scope of IFRS 17 "provided they are issued by an entity that also issues insurance contracts" [IFRS 17,71] and [IFRS 17,B27(a)]. If so, these contracts are measured in the same way as contracts with direct participation features and therefore measured with the VFA approach

-Direct participating contracts (DPC) :

By definition, contracts with direct participation features have contractual terms that specify that the policyholder (PH) participates in a share of a clearly identified pool of underlying items. These underlying items are typically financial in nature and the contracts have cash flows that vary based on the returns on financial underlying items. The Entity expects to pay to PH a substantial share of Fair Value (FV)[6] returns on these underlying items.

[6]In IFRS 17, fair value measurement is used at initial recognition of contracts acquired in a business combination. The fair value is determined as of the date of the acquisition [IFRS 17, 11]

One example of a DPC would be the support in euros contracts.

-Investment contracts with discretionary participation features (DPF) :

A financial instrument that provides a particular investor with the contractual right to receive, as a supplement to an amount not subject to the discretion of the issuer, additional amounts :

1. That are expected to be a significant portion of the total contractual benefits
2. The timing or amount of which are contractually at the discretion of the issuer
3. That are contractually based on :
   (a) the returns on a specified pool of contracts or a specified type of contract
   (b) realised and/or unrealised investment returns on a specified pool of assets held by the issuer
   (c) the profit or loss of the entity or fund that issues the contract

One common example would be discretionary interest payments on a savings-type product, unit-linked support contracts with guaranteed minimum rate.

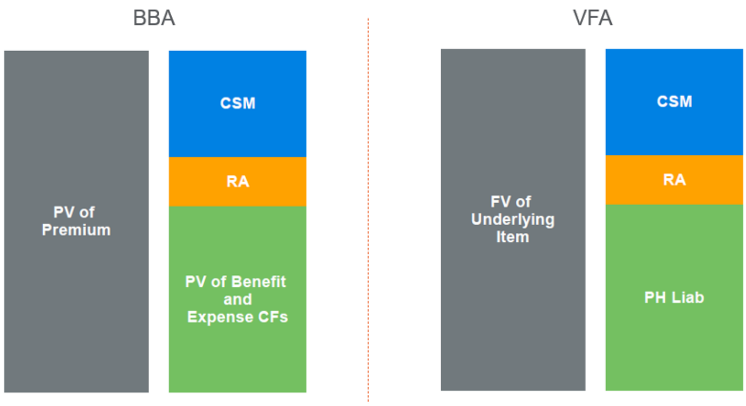


Figure 1.13: BBA Vs VFA : Differences at initial recognition [Milliman, 2017]

1.3.3 Impact of reinsurance on measurement of liabilities

Under IFRS 17, the estimates of future cash flows of a group of underlying insurance contracts would usually be the same regardless of whether there is reinsurance held with these obligations. The valuation is therefore not impacted and the insurance contracts continue to be valued on a gross basis.

This also applies to the integrity of the fulfilment cash flows, including the Risk Adjustment for non-financial risk, and the CSM. It should be noted that the use of reinsurance, among other approaches by the entity to diversify its risk exposure might impact the gross Risk Adjustment even if it is an indirect impact.

Under the definition for reinsurance held, the quantum of the Risk Adjustment for non-financial risk represents the amount of risk being transferred by the holder of a group of reinsurance contracts to the issuer of those contracts [IFRS17,64].

Therefore, we can picture the Risk Adjustment for the reinsurance as the difference in the risk position of the entity with (i.e. net position) and without (i.e. gross position) the reinsurance held. Consequently, the appropriate Risk Adjustment for the reinsurance held could be determined based on the difference between these amounts.
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 normally create an asset. On this basis, where a reinsurance contract held is reported as an asset the Risk Adjustment will have the effect of increasing the value of the asset, and will decrease the liability value where the reinsurance contract held is reported as a liability.

Chapter 2

The Risk Adjustment for non-financial risks under IFRS 17

Hereinafter , the *Risk Adjustment for non-financial risk* will be referred to as "Risk Adjustment" or RA.

2.1 Risk Adjustment requirements

As we defined earlier, the RA represents : *the compensation an entity requires for bearing the uncertainty about the amount and timing of the cash flows that arises from non-financial risk as the entity fulfils insurance contracts.* [IFRS 17, Appendix A Defined Terms]

There are two important features we learn about the Risk Adjustment from IFRS 17 principles :

1. The RA would consider only non-financial risks as insurance risk, lapse risk, and expense risk (as examples of elements possibly included) whereas operational risks, market, and credit risks are excluded [IFRS 17,B86-B92]
2. There are no prescribed estimation techniques to determine the RA, however, the approach to determine it must satisfy the overall requirements of IFRS 17 for measurement, presentation and disclosure.[IFRS 17,100–107],[IFRS 17,119]

We hence dedicate the next subsections to exploring these features thoroughly :

2.1.1 The non-financial risks

Insurance liabilities are different by nature between life and non-life insurance. These differences can be noticed in the different risks that are likely to impact the FCF and therefore Risk Adjustment.

Focusing on the Life & Health activity in this thesis, we give below a list[1] of selected risks

[1] This list is an illustration of key risks and sources of uncertainty in Life & Health insurance, it is not exhaustive

that are considered in RA Life & Health :

-life insurance and annuity liabilities:

1. **Mortality (Longevity) risk:** the future mortality represents a key assumption, it measures expected decrements from an insured population. The risk arises from assuming mortality rates that can be different from the best estimate calculation assumption

2. **Policyholder behaviour risks including lapse Risks[2]:** related to PH's propensity to exercise options provided in contracts (for contracts that have embedded options) , the risks arise from assumptions that will be different from the baseline assumptions and will adversely impact the value of guarantees. Such risks increase the uncertainty about future insurance liability cash flows

3. **Long duration trend risks:** The valuation of life insurance and annuity liabilities often require projections of 30-50 years depending on the insurance product. Such risk is a result of exogenous variables that disturb (with most of the time a residual effect) the evolution trend of the mortality table over time. This results in a source of uncertainty that disturbs the average value of the reference table used in the best estimate calculation.

-Health insurance :

1. **Morbidity risk** the risk that actuarial predictions of claim frequency and severity will be significantly different than past experience

2.1.2 Measurement requirements

Even though IFRS 17 only gave guidelines regarding the RA, a number of characteristics were however stated in [IFRS 17,B91]. We display them below. (c.f. Figure 2.1):

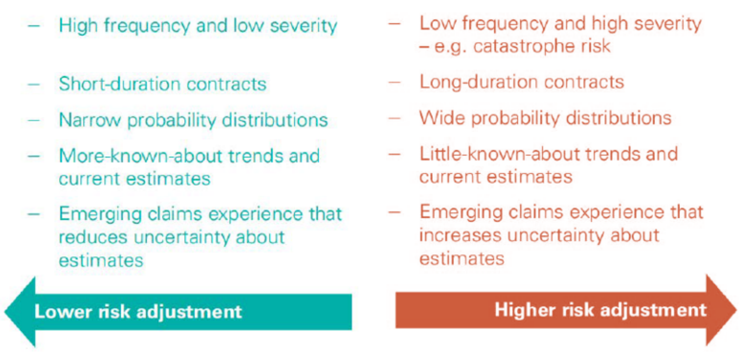


Figure 2.1: Risk Adjustments reasoned characteristics cited in *[IFRS 17,B91]*

[2]Lapse risk is the risk associated with the variability in liability cash flows due to the incidence of policyholder lapses. Policyholder lapsation includes options to fully or partially terminate an insurance contract, or decrease or suspend/resume insurance coverage
Source :https://www.osfi-bsif.gc.ca/Eng/fi-if/rg-ro/gdn-ort/pp-do/Pages/qis7$_ir.aspx$7

The measurement requirements are based on the IFRS 17 GoC (i.e. RA determined for a single contract or group of contracts), whereas presentation and disclosure requirements tend to be at lower levels of granularity (RA for the aggregation of portfolios of contracts, or entity-level RA). However, [IFRS 17,24] allows the fulfilment cash flows FCF (of which the RA is part) to be determined at a lower level of aggregation and then allocating it up to the IFRS 17 GoC level.

2.1.3 Disclosure requirements

While the measurement requirements of IFRS 17 require a RA for each GoC, most of the presentation and disclosure requirements of IFRS 17 will be met at a more aggregate level such as reporting segment or reporting entity level [IFRS 17,97–109].

It was specifically required in [IFRS 17,117(c)(ii)] for the approach used to determine the RA to be disclosed, and [IFRS 17,119] requires disclosure of the confidence level corresponding to the reported RA. The full text of the latter paragraph is the following :

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.[IFRS 17,119]

The paragraph implicitly refers to the entity's aggregate Risk Adjustment, and it would be at the discretion of the entity to disclose the confidence level of Risk Adjustments at anything less than an entity-level.

The compensation the entity requires under IFRS 17 for its RA is a subjective assessment of an entity's own risk appetite. There are many ways an entity can put a price on that risk, although their ultimate usage depends on the extent to which they meet the criteria we mentioned above.

2.1.4 Diversification and aggregation of RA

Diversification

In order to illustrate the concept of diversification, we give the example of life insurance and a payout annuity products. These products contain risks that are naturally offsetting. Mortality risk for life insurance products may be at least partially offset by mortality risk for payout annuity products. In that case, all else equal, higher mortality experience would typically:

- Increase the insurer's cash outflow for life insurance products
- Decrease the insurer's cash outflows for annuity products in the payout phase

The appropriate Risk Adjustment for the two IFRS 17 contract groups should therefore be smaller than the sum of the Risk Adjustments for each contract group, reflecting diversification of risk between the mortality risk contract groups and longevity risk contract groups.

IFRS 17 allows this kind of diversification in the Risk Adjustment :
the Risk Adjustment for non-financial risk also reflects: The degree of diversification benefit

the entity includes when determining the compensation it requires for bearing the risk [IFRS 17, B88]

The diversification happens because of the interaction:

- Between risks
- Between collections of contracts, for example between contracts, contract groups, portfolios, entities and so on

Aggregation

- *The Bottom-Up approach :*

A Bottom-Up approach is where the Risk Adjustment calculations are carried out at IFRS 17 contract group level directly. This approach has the advantage of outputting the Risk Adjustment at contract group level. However there, aggregating the Risk Adjustment across contract groups, the diversification between contract groups might be included when this aggregation approach is used otherwise the Risk Adjustment might potentially be overestimated. Meaning that the RA can be :

-A simple sum of RAs for each contract group
-Aggregated through the use of correlation matrices
-Aggregated through the use of copulas

-The Top-Down approach :

A Top-Down approach is used when the Risk Adjustment calculation is performed in aggregate across different IFRS 17 contract groups. This method will implicitly include an allowance for the diversification between the contracts. Therefore, in order to identify the IFRS 17 Risk Adjustment for each GoC an allocation method is required.

2.2 Risk Adjustment techniques

2.2.1 The Cost of Capital

In a Cost of Capital approach, the RA is based on the compensation that the entity requires to meet a target return on capital. Three elements are necessary for this calculation :

- *Projected capital amounts:* to determine the level of non-financial risk during the duration of the contract
- *Cost of Capital rate(s):* represents the relative compensation required by the entity for holding this capital
- *Discount rates:* to obtain the present value of future required compensation

This approach is conceptually close to the definition of the RA, and allows allocation of the RA at a more granular level. It might also be a little bit complex, as the projection of capital requirements is an input to the liability calculation.

The general formula for the RA based on a Cost of Capital approach is :

$$\sum_{t\geq 0} \frac{r_t.C_t}{(1+d_t)^t}$$

Where,
- C_t is the capital amount for t
-r_t is the selected Cost of Capital rate for t
-$C_t.r_t$ the compensation required by the entity for t
-d_t the selected interest rate, reflecting the appropriate yield curve

Consideration for defining :

C_t : practically, entities would use the capital model used for pricing purposes to derive the capital requirements, internal capital model or even the regulatory capital model for which few changes were made by the entity, under the condition to justify the appropriateness of any approach as it is required in the IFRS 17 disclosures.

r_t : The Cost of Capital rate is traditionally the weighted average Cost of Capital (WACC) for an entity that considers all sources of capital, minus the rate that could be earned on surplus. this rate is certainly the most complex to define. Theoretical Cost of Capital rates might be determined by the entity depending on their risk aversion. A practical approach would be to use target rates of return on capital and their respective weights that are consistent with management's view.

2.2.2 Quantile techniques

Quantile techniques including Value at Risk (VaR), Tail Value at Risk (TVaR) (also called Conditional Tail Expectation (CTE)) can be used to assess the probability of the adequacy of the fulfilment cash flows and thus help quantifying the desired magnitude of the RA. The primary advantage is that it will directly satisfy the IFRS 17 disclosure requirements regarding confidence level corresponding to the RA.

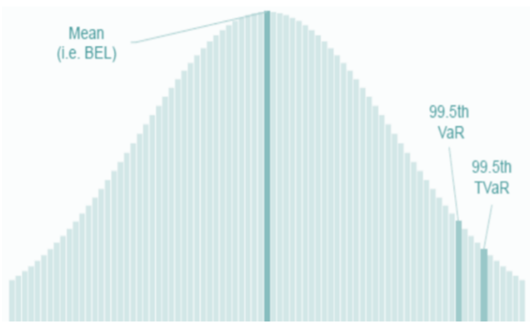


Figure 2.2: Deriving the VaR or TVaR from a Cash flows distribution (Illustration)

To generate a distribution of the future cash flows, two known approaches can be considered:

• Fit future cash flows for non-financial risks into a probability distribution (frequently a Normal distribution, or a suitably skewed probability distribution)

• Monte Carlo Simulation (modelling the non-financial risks stochastically)

Once the distribution is generated, both risk measures VaR and CTE can be observed and used to calculate RA :

$$RA = m(\sum_{s>t} \gamma_s.CF_s(Y_s^{NF})) - \mathbb{E}(\sum_{s>t} \gamma_s.CF_s(Y_s^{NF})|\mathfrak{G}_\infty)$$

where :

m(X) : a risk measure (whether VaR or CTE)
γ_s : Discounting factor
$\mathfrak{G}_\infty$: Non financial risks filtration[3]
Y_s^{NF} : Non financial risks scenario

The Value at Risk (VaR)

The value-at-Risk at a confidence level (α) for a random variable X defined on a time horizon T is :

$$VaR_\alpha^T(X) = inf\{x \in \mathbb{R} \,|\, \mathbb{P}\; [X \leq x] \geq \alpha\}$$

Hence using the VaR for deriving the RA can be described as follow:

1. Entity determines the target confidence level at which it determines its compensation required : α^{th} percentile
2. VaR is determined such that the probability of actual fulfilment cash flows being less than VaR is $\alpha\%$
3. Risk Adjustment is then determined as the VaR at α^{th} percentile less the mean of present value of probability-weighted cash flows

The Conditional Tail Expectation (CTE)

The Conditional Tail Expectation at a confidence level (α) for a random variable X defined on a time horizon T is :

$$CTE_\alpha^T(X) = E(X|\, X > VaR_\alpha^T(X))$$

The steps to using this approach for deriving RA are :

[3]In the theory of stochastic processes, filtrations are totally ordered collections of subsets that are used to model the information that is available at a given point and therefore play an important role in the formalization of random processes

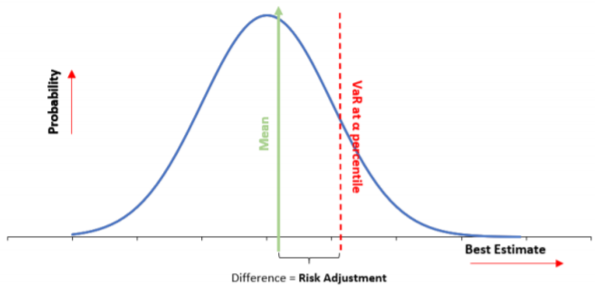


Figure 2.3: Deriving the Risk Adjustment using the VaR at the α^{th} percentile

1. Entity determines the target confidence level at which it determines its compensation required : α^{th} percentile
2. From the probability distribution, an entity can determine :
   - (A) Conditional mean of the fulfilment cash flows beyond the target percentile
   - (B) Mean of present value of probability-weighted cash flows
3. Risk Adjustment is then determined as the difference between (A) and (B)

We should note that the Confidence Level Value at Risk measure is not a statistical coherent measure since The VaR measure does not pass the sub-additivity test which may discourage diversification when aggregating risks. [Deloitte, 2015] whereas the CTE is a coherent measure. A statistical coherent risk measure f(X) satisfies the four mathematical properties :

1. Monotonicity: $if\ X \leq Y \quad \text{then} \quad f(X) \leq f(Y)$
2. Sub-additivity: $f(X+Y) \leq f(X) + f(Y)$
3. Homogeneity: $f(aX) \leq a \times f(X) \quad \text{if} \quad a > 0$
4. Translation invariance: $f(X+a) = f(X) + a \quad \text{for } a \text{ constant}$

2.2.3 Margins for adverse deviations (MfAD)

The two techniques we have seen so far (quantile and Cost of Capital approaches) are ideally used when we target an aggregate RA. The margin approach we are about to explain would primarily be used for *unit-of-account* RA, meaning the IFRS17 group contract level. The method is acceptable as long as the RA satisfies the five characteristics defined in IFRS 17.B91[4]

The Margin for Adverse Deviations is the difference between the assumption for a calculation and the corresponding best estimate assumption.
The purpose of a margin approach is to adjust the fulfilment cash flows by shocking the non-financial assumptions to create an incremental provision for non-financial risk. The incremental provision would then be the Risk Adjustment and it is seen as a provision for adverse deviation (PAD) which is the difference between the actual result of a calculation and the corresponding result using best estimate assumptions:

[4] c.f. Figure 2.1

$$RA_{Risk_i} = BEL_{Risk_i} - BEL_{central}$$

Hence the PAD reflects error of estimation, deterioration or improvement of the expected experience as a result of influences which the actuary does not anticipate, commensurate with the degree of uncertainty of the expected experience scenario assumptions. Therefore, MfADs approach would be explicitly representing the compensation the entity requires for bearing uncertainty for a given group of contracts. The *compensation the entity requires* would be quantified through the margin-setting process.

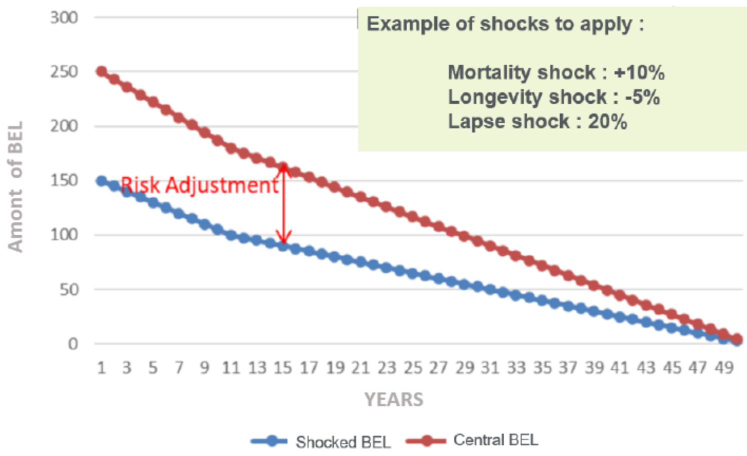


Figure 2.4: Deriving the RA by adjusting the central BE using shocks (Illustration) [COUSIN et FAYE, 2019]

This uncertainty results from the risk of misestimation of and deterioration from the best estimate assumption. The potential for misestimation is greater when the past experience has been more volatile and hence would justify a greater margin. However, the MfAD would be based on a forward-looking assessment of the expected experience and would not act as a mechanism to absorb changes in observed experience, such as changes caused by statistical fluctuations.[Faulds, 2006]

Part II

Measuring the Risk Adjustment for a Life & Health entity

Chapter 3

Calibrating margins for the Risk Adjustment

As per IFRS 17 guidance, the RA should reflect PartnerRe's risk appetite [IFRS17.B87] i.e. be aligned to how the entity manages risk within the business and be reflective of the compensation required by the risk-bearing entity for such risks. As we are in pre-IFRS 17 times, companies are trying to find the most convenient ways to be in line with the guidance upon RA. Therefore, common "industry-view" for RA detail items are starting to take shape and being assessed on whether they are acceptable or not. This represents a driver to explore certain options, like the one we are investigating here in this chapter : Calibrating a set of margins for non financial risks as a way to derive the RA at the IFRS 17 GoC level.

As we will implement this method for the L&H activity of PartnerRe, it is paramount to understand the structure of its L&H business and IFRS 17 structure. The first section of this chapter serves this purpose before discussing the calibration method.

3.1 PartnerRe's L&H IFRS 17 structure

3.1.1 Organisation of the L&H business

PartnerRe L&H entities provide reinsurance coverage to employer sponsored pension schemes and primary life insurers who provide pensions or issue annuity contracts offering long-term retirement benefits to consumers, who, in turn, seek protection against outliving their financial resources. Mortality and morbidity business is written primarily on a proportional basis through treaty agreements and is subdivided into death and disability covers (with various riders), term assurance and critical illness (TCI) and Guaranteed Minimum Death Benefit GMDB.

The Company also writes certain treaties on a non-proportional basis. Longevity business is written on a long-term, proportional basis. The Company's longevity portfolio is subdivided into standard and non-standard annuities(NSA). The non-standard annuities are sold by insurance companies to consumers with aggravated health conditions and are usually medically underwritten on an individual basis

The long-term business

The Table provides a summary of long-term life products. It displays the risks which are in scope for RA for each line of business :

Line of Business	Description	Non-Financial Risks
Term and Critical Illness (TCI)	Long Term (LT) individual business that cover death and critical illness benefits. Also includes features such as an option to convert to a whole life, and an option to renew. Term renewals can pose an anti-selection risk to the insurer.	Mortality, Morbidity, Expense, Lapse, Mortality / Longevity Trend, Morbidity Trend
Non-Standard Annuities (NSA)	LT individually underwritten, impaired life annuity contracts that are in run-off (closed block of business).	Longevity, Longevity Trend, Expense
Mortality Long Term (Mort LT)	LT Yearly Renewable Term (YRT) business covering death and disability and proportional business covering death, disability, critical illness and long term care. Also includes some business financed through a reduction in commissions charged where potentially a risk financing is not repaid.	Mortality, Morbidity, Expense, Lapse, Mortality Trend, Morbidity Trend
Standard Longevity (SL)	LT annuities underwritten on a group basis. Consists primarily of mortality swap treaties.	Longevity, Longevity Trend, Expense
Guaranteed Maturity Death Benefit (GMDB)	LT quota share GMDB rider with death benefit pay out. Provides guarantee of a minimum death benefit regardless of a policyholder's underlying account value. Lapse risk (one of the main risks) can be affected by economic conditions.	Mortality, Mortality Trend, Lapse, Expense

Table 3.1: summary of long-term life products and their non-financial risks

-*Source : PartnerRe Internal Paper on Long Term and Short Term business*

The short-term business

PartnerRe's Short-Term (ST) Life business is managed as two sub-portfolios, split between short tail and long tail risks:

- Short Term Short Tail (STST) risk consisting of both death/mortality and disability/health business.
- Short Term Long Tail (STLT) risk consisting of only disability/health business.

3.1.2 PartnerRe's IFRS 17 aggregation levels

Portfolios and groups of contracts are established on initial recognition and are not reassessed [IFRS 17,24]. Therefore, it was necessary for PartnerRe to appropriately define its Portfolios and Groupings in order to meet the requirements of IFRS 17 at adoption of the standard.[1]

[1] c.f. 1.2.2 for the definitions of an IFRS 17 portfolio and levels of aggregation.

IFRS 17 does not provide any further guidance on defining "manged together" as we have seen earlier. PartnerRe therefore has deemed appropriate to leverage the existing product groupings used for internal management reporting. The following levels outline the levels of aggregation proposed by PartnerRe in order to meet the requirements of IFRS 17 :

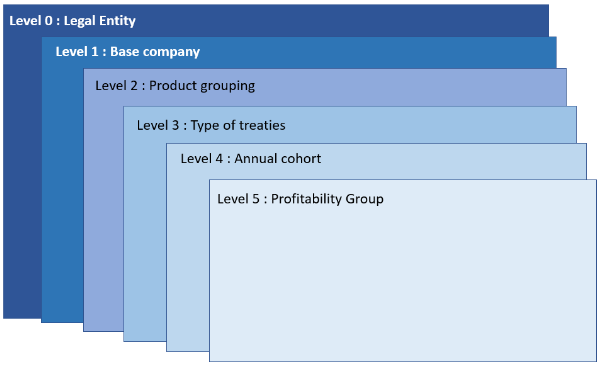


Figure 3.1: PartnerRe's IFRS 17 levels of aggregation

Aggregation Level 0 : Legal Entity Split :

PartnerRe will treat business written within one legal entity separate to business written in another legal entity for the purposes of CSM calculations under IFRS 17.

The entities holding PartnerRe's EMELA/APAC business (including L&H activities). are the following legal entities :

- PartnerRe Europe SE (PRESE)
- PartnerRe Asia
- PartnerRe Reinsurance Company Ltd.
- PartnerRe Company of Bermuda Ltd

In this thesis , We mainly focus on the European Legal Entity (LE) PRESE.

Aggregation Level 1 : Split by base company

PartnerRe will further separate business written within one legal entity into the base reinsurance companies (branches) that belong to that legal entity for the purposes of CSM calculations under IFRS 17. We display the branches of PRESE as it is the focus of our calculation.

If PartnerRe did not use this base company split, it would result in a separate process to extract assumed cash flows, and determining a method for allocation to each base company to feed the retrocession calculations.

As we put our focus on the PRESE LE, we note that its related base companies are in France, Switzerland, Ireland and Hong-Kong.

Aggregation Level 2 : Split by grouping product for assumed business PartnerRe will further separate its life health business written within each base company into four product groupings for IFRS 17 with the aim of being as consistent as possible with current management product groupings, and the level of granularity required by Statutory Reporting requirements.

The groupings identified are deemed to be products which have "similar risks, and are managed together" as required by IFRS 17.

<table>
<tr><th colspan="2">Product groupings</th></tr>
<tr><th>Internal management grouping</th><th>IFRS17</th></tr>
<tr><td>GMDB</td><td>GMDB</td></tr>
<tr><td>Longevity standard</td><td rowspan="2">Longevity
a) Longevity Swaps (1 treaty = 1 group)
b) Standard Longevity (1 treaty = 1 group)
c) NSA (1 treaty = 1 Group)</td></tr>
<tr><td>Longevity non-standard</td></tr>
<tr><td>Term & Critical Illness</td><td rowspan="3">Long-term protection
• includes term, critical illness, whole of life etc.
• includes with and without financing</td></tr>
<tr><td>Long-term protection</td></tr>
<tr><td>Financing with risk transfer</td></tr>
<tr><td>Short-term protection</td><td rowspan="2">Short-term protection</td></tr>
<tr><td>Non-proportional</td></tr>
</table>

Table 3.2: Breakdown of IFRS 17 grouping product

-*Source : PartnerRe Internal IFRS 17 process paper*

Aggregation Level 3 : Type of treaty To facilitate the identification of inwards vs outwards business and also internal vs external business.

Aggregation Level 4 : Annual cohorts

[IFRS 17,22] prohibits contracts issued more than one year apart to be included in the same cohort. For instance, contracts issued on 1 Jan 2019 and 1 Jan 2020 should not be in the same cohort. For PartnerRe, annual cohorts, aligned to the financial reporting period would be the most appropriate. This is due to the following evaluation principles:

- Annual cohorts will create less groups and reduce the burden on data and system requirements.
- Annual cohorts align to PartnerRe's current view of business (e.g. underwriting years).

Aggregation Level 5 : Profitability groupings

PartnerRe will separate its insurance cohorts into three separate profitability groups:

- Onerous
- No significant chance of becoming onerous
- Other profitable

We note that the portfolio requirements defined in IFRS 17 set the maximum level of aggregation in IFRS 17, however, insurance contracts can be aggregated into more granular portfolios where the company deems it necessary. For the case of PartnerRe, more granular levels beyond the profitability groups were defined, but we will focus only on the previously stated levels as they are of interest for our calculations of Risk Adjustment.

3.2 The calibration process

3.2.1 Motivations and considerations

Calculating the RA via the Margin for Adverse Deviation approach[2] entails applying margins to non-financial assumptions. The RA would be calculated by determining the difference in the value of liabilities under the best-estimate assumptions (BEL), and Best Estimate assumptions plus RA margins (hereinafter, we will call them *Padded* BEL). Therefore, the RA is similar to the Provisions for Adverse Deviations (PADs). We remind that the Provision for Adverse Deviations is the difference between the actual result of a calculation and the corresponding result using best estimate assumptions.

An entity's (or a group of entities such as PartnerRe) pricing is a very practical reference point for measuring the entity's risk aversion and/or compensation requirements. Therefore, we propose to calibrate the RA to reflect the entity's pricing of risks. It is practical because the compensation will reflect any pricing concessions due to competitive market pressure and/or price discounting in pursuit of market positioning. Another view would be that the entity could accept less than its theoretical compensation requirements, and that the RA would reflect the latter. Hence pricing framework will be our starting point for trying to derive the RA.

The pricing metric that reflects the best required compensation for non-financial risk is the present value Cost of Capital (PV CoC). It reflects the price of holding risk capital, and aiming for the RA to align with the PV CoC would reflects a view on a minimal compensation of the risk if this method is adopted. The PV CoC is a reinsurance treaty-level metric that we can obtain using pricing tools.

The idea of calibration is an interesting exercise to effectively solve for margins that , when applied, will produce a Risk Adjustment level that would be in alignment with the expected pricing PV CoC in such a way that :

$$Valuation\,(BE + RA\ Margins) - Valuation\,(BE)\ \simeq PV\ CoC$$

There is a degree of segmentation of the RA margins to be considered when performing margin calibration. The IFRS 17 standard does not specify a required level of segmentation for the application of RA margins. Therefore the spectrum of possible segmentation for the calibration is :

Level	Segmentation
Highest	Treaty Level
	Entity and LoB Level
	Duration and LoB Level
	LoB Level
Lowest	Group Level

Table 3.3: Possible segmentations for the calibration

There is however some important issues to highlight :

[2] c.f. 2.2.3 for introduction of the method

-at the valuation period 2020 Q4, we count 1000+ treaties overall for the Life&Health EMELA/APAC business across PartnerRe entities

- For the same valuation period, considering PRESE entity and the 2020 cohort only, we count 100+ IFRS 17 groups up to the profitability level.

It is operationally difficult to obtain the complete universe of treaty-level PV CoC under the current pricing framework, which makes the most granular level of segmentation unfeasible (Ideally, a calibration process should be carried for each IFRS 17 group). On the opposite side, going for a group level calibration might ease the global implementation, but the difficulty lies in the potential RA subsidization across entities, bearing in mind the Internal reporting/management for each entity. Hence, choosing representative reinsurance treaties at a medium level, the product group level (LoB , or LoB and duration) sounds a reasonable choice with results applied to remaining in-force business.
Thus, the following outlines the calibration steps :

A. Split In-force business into segments with similar risk characteristics
B. Select deals for calibration
C. Perform the calibration exercise
D. Validation of calibration results

3.2.2 Calibration metric target : The present value Cost of Capital

The present value Cost of Capital (PV CoC) is a metric which is used in pricing activities. This value has been determined to appropriately reflect the compensation PartnerRe requires for the variation in cash flows due to non-financial risks. It reflects the price of holding risk capital which makes it the perfect target for deriving the appropriate margins to apply on the cash flow model in order to have incremental provision for each of the underlying non-financial risks of the treaties.

The calculation of PV CoC (monthly projection basis):

$$PVCoC = \sum_{t} \frac{\Delta(RM(t) + EC(t)) + Interest_{RM(t)+EC(t)} - Tax_{interest}(t)}{(1 + r_t)^t}$$

Where :

$EC(t)$=Diversified Economic capital[3] for non-financial risks at time t

$RM(t) = CoC_t . \sum_{i=t} \frac{EC(i)}{(1+CoC_i)^t}$[4]

CoC_t = The monthly Cost of Capital rate

$\Delta(RM(t) + EC(t)) = (RM(t + 1) + EC(t + 1)) - (RM(t) + EC(t))$

r_t = Appropriate discounting rate

[3]The Economic Capital should be calculated by considering the change in the BEL.
Please refer to Appendix to see the capital factors to be used for a proportional business like TCI

[4]Life Pricing uses its own implementation of an Economic Balance Sheet as fundament for deriving long term economic cash flows and calculating IRR and VNB

From its definition, PV CoC catches the variations in time ($\Delta(RM(t) + EC(t))$) in the economic capital (due to non financial-risks), and perceived as the price of holding such risk capitals throughout the lifetime of contract(multiplies by a Cost of Capital rate). It accurately expresses the *uncertainty about the amount and timing of the cash flows that arises from non-financial risk* hence matching to an extent the definition of RA under IFRS 17. We can also consider using the RM at time 0 as a target metric since it also matches the purpose of RA, especially that it is calculated with a "Cost of Capital " approach. the PV CoC is however a better measure as its calculation is more comprehensive.

3.2.3 Applying Risk Adjustment margins by risk

Next step would be identifying the main risk drivers that would be material in any LoB. That's why we have selected the following non-financial assumptions for which we will develop the margins[5] :

Mortaliy Level Risk

Multiplier applied to the base mortality/incidence table. Therefore a margin of x% will be applied by multiplying all base mortality rates by (1+x%)

Mortality Trend Risk

Margin is stated in terms of basis points. The mortality improvement margin is applied cumulatively to the existing mortality improvement rates.

There are two common types of mortality table for longevity, showing attained age either :
- per calendar year
- year of birth

The calendar year is the most common approach which is also used by the CMI[6]

	2016	2017	2018
65	2.10%	2.05%	1.93%
66	2.02%	2.00%	1.95%
67	1.93%	1.92%	1.90%

Table 3.4: Mortality improvement table for males, example

In the improvements table, each diagonal follows a cohort of policyholders. The cohort reaching 65 years old in 2016 is expected to have an improvement of 2.10% compared to the mortality observed on the cohort that reached 65 in 2015 – i.e. the mortality is 2.10% less

So for the portfolio projection, the adjusted qx for improvements is calculated as following:

$$q(x,t) = q(x,t-1) * [1 - MI(x,t)]$$

Where x is the age and t is the year, and MI(65, 2016) = 2.10% for the example above

Therefore, if the trend margin is +y basis points, the mortality improvement factor would be : $(1 - MI(x,t) \ - y \ bps)$

[5]c.f.2.1.1 for general definitions

[6]CMI : Continuous Mortality Investigation carries out research into mortality and morbidity experience and produces tables used by actuaries especially in UK life assurance

Lapse Risk

Lapse margins are applied in absolute terms, depending on the sensitivity of the business to lapses (lapse sensitive vs. lapse supported)

The lapse margin of x% will be applied by multiplying the best-estimate lapse assumption by (1-x%) for lapse supported business[7], and by (1+x%) for lapse-sensitive business[8]

Expense Risk

For EMELA/APAC regions (which business is respectively under the European/Asian entity), the expense contribution to PV CoC is sufficiently small that it can be absorbed into other margins without any concern of substantial misalignment of risks. Therefore, expenses will be stressed by the same % used to derive expense PADs.

3.3 Application : Calibrating the RA for the long term life business

The methodology therein is implemented in an internal pricing tool [9] used for Long Term EMELA/APAC business.

As we mentioned earlier, the objective of the calibration process is to determine LoB-level RA margins that can be inferred from treaty-level calibrations. Ideally, we should use recently closed (won) deals where the recent updated pricing tool is readily available and consistent with the current view of risk because it exhibits full duration and full risk. Therefore the proposed scope for calibration is 2020+ treaties.

To summarise, the principles for treaty selection are:

- Use treaties priced under current pricing framework
- Use closed deals (which were won)
- A selection of representative treaties are required for each LoB
- Select treaties which cover the range of factors which may affect the relationship between PV CoC and RA margins (such as duration and region)

Thereby, we illustrate the calibration process on particular LoBs belonging to two IFRS 17 group product : the long term protection and longevity IFRS 17 group products. For the former, the application will be done on two LoBs from different business regions : TCI LoB in EMELA region and LT-CI LoB in APAC region.

3.3.1 The long term protection

The long term critical illness

Term and Critical Illness Insurance (TCI) individual life business to provide life and critical illness cover with a lump sum payment in case of either death or diagnose of a critical illness. No maturity or surrender benefits are provided. The contract terms of the insurance policy contain specific rules that define when a diagnosis of a critical illness is considered valid.

[7] lapse supported life insurance policies have their future cash values closely correlated with a high lapse ratio of the insurance company's book of business

[8] Lapse supported and lapse sensitive products are assumed to be negatively correlated

[9] PartnerRe pricing tool for long term life business

The long term CI (LT-CI), has, for most of them, only the critical illness cover with a lump sum payment in case of diagnosis.

Long term Critical Illness LoB is mostly sold in APAC, while the TCI is rather sold in EMELA. We selected treaties that were relatively the largest available in these regions responding to the previous criteria of selection and covering a range of benefits and durations.

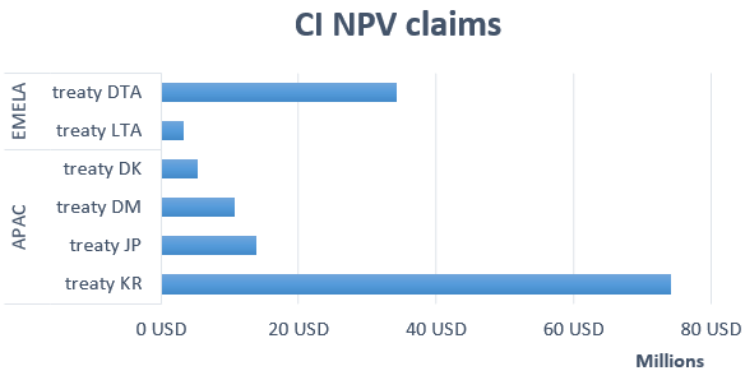


Figure 3.2: Representative treaties for critical illness, split by region

The PV CoC as a % of PV claims generally increases with the duration of the treaty. The claims-weighted duration is defined as :

$$\sum_{t \geq 0} t.\frac{PV\ (Claims\ Paid\ in\ year\ t)}{PV\ (all\ Claims\ Paid)}$$

The dependency between the PV CoC and duration is related to the duration-dependence of the trend shock but may have further drivers. Furthermore, the CI LoB has a duration dependency that is also related to the region[10]. Below the average weight duration of our representative treaties :

Region	*Average duration of the representative treaties*
EMELA	*8 years*
APAC	*21 years*

Table 3.5: Average claims-weighted duration by region

[10]We will expose that region dependency further in the calibration results

We will use the selected european treaty as a detailed illustration of the calibration process for the EMELA region. It has multiple sub-treaties (Level Term Assurance(LTA)[11] treaty and Decreasing Term Assurance(DTA)[12] treaty). They both have two underlying benefits : CI and Death benefits.

The risks covered in this treaty is death and CI. CI represents 80% of the PV claims. Mortality represents 20% of the PV claims.

Variable	
NPV Premiums	41 355 525
NPV Claims	37 599 807
PVFP	2 269 192
Claims-weighted duration in years	8,4
Loss Ratio	91%
Guarantee Period	Fully Guaranteed

Table 3.6: Pricing variables of the representative LT-CI treaty (sums in GBP)

- Testing the margins

The cash flow model will be used to stress assumptions (the RA margins) such that the RA for the treaty is aligned with the treaty's PV CoC. To explain our choice of the PV CoC over the RM, the figures in the table below shows how the PV CoC is deemed more conservative than the RM and therefore a better metric to target rather than RM. Profit commissions have been removed from the PV CoC calculation as these commissions buffer the risk and reduce the PV CoC.

Calibration target metrics (GBP)	
PV CoC	2 542 404
RM at t=0	2 043 115
PV CoC / RM	124%
PV CoC/NPV claims	6,76%

Table 3.7: Treaty's calibration metrics target

Once we apply the additional level, trend and lapse set of shocks, the impact is captured in the change of the PVFP(Present Value of Future Profit) or the BEL(0) . We choose to use the PFVP to derive the margins through iterative process, and the difference between the base PVFP and shocked PFVP is what should be the quantum of the Risk Adjustment.

$$Valuation\,(shocked\ PVFP\ ) - Valuation\,(PFVP)\ \simeq PV\ CoC$$

We choose the NPV claims as a driver to ease the interpretation and data visualisation :

$$\frac{Valuation\,(shocked\ PVFP\ ) - Valuation\,(PFVP)}{NPV claims} \simeq \frac{PV\ CoC}{NPV claims}$$

[11]LTA is an insurance policy that provides a set sum assured (the amount of money your beneficiaries will receive upon your death) if you die within a defined period (the term). The word level is used because the sum assured remains the same

[12]DTA provides a sum assured that decreases over time if you die within a set term. The term part is identical to LTA, but the decreasing part means that the later into the term the claim is made, the less the policy will pay out

-For this treaty, the target is $\frac{PV\ CoC}{NPV claims} = 6.76\%$ (c.f. Table 3.8)

We note that the expense risk will be ruled out from this calibration as its impact isn't paramount as we can deduce from the pricing economic capital metrics of the treaty.

Standalone capital (GBP)	
Biometric capital	27 268 653
Expense capital	242 714
Expense Vs Biometric	**0,89%**

Table 3.8: Biometric risk (level,trend,Lapse) Vs expense risk

We most mention that there is no unique solution to this problem, as it has multiple degrees of freedom (the level qx margin, the improvement mortality (Trend) margin, lapse margin,...) to match a single number. To find an acceptable solution, we aimed for approximately mirroring the balance of standalone risks in the economic capital. The iterative process tests various combinations of RA margins until the resulting comparison of RA and PV CoC is within acceptable thresholds. Further, the per-risk comparison of RA and PV CoC should be within acceptable thresholds.

First, it was important to include testing single-risks to get a sense of the sensitivity of the PVFP and BEL to each assumption, and then we can choose an appropriate set of margins :

Level	***Trend***	***Lapse***	***Impact on PVFP (GBP)***
1%	-	-	(354 712,91)
5%	-	-	(1 771 737,10)
-	-10 bps	-	(308 409,83)
-	-40 bps	-	(1 255 592,90)
-	-	-5%	93 248,27
-	-	+10%	(170 233,90)

Table 3.9: Single-risk impact on the base PVFP

Analysing the table, we deduce for instance that applying a +1% margin to the mortality base table , reduces the PVFP by 354 712,91 GBP. And as the treaty is lapse-sensitive, applying a -5% shock to the lapse leads to a increase of PVFP by 93 248,27 GBP. The single-risk analysis helps us to determine the right direction of the shocks, especially for the lapse shocks. We also caught the per-risk variable impacts on the projected BEL (40 years projection period, c.f. Figure 3.3) :

We have sequentially added shocks/stresses to the cash flow model to catch the impact of the combined (level,trend,lapse) shocks. Since the process is iterative (not automatic, as the tests should be run one by one), we run the pricing tool using a chosen set of combined margins that we deemed convenient based on the previous per-risk tests.

The combined effect of 3 sets of possible margins come specifically close, we favour the set :

$$(level, trend, lapse) = (1.04, -40bps, +6\%)$$

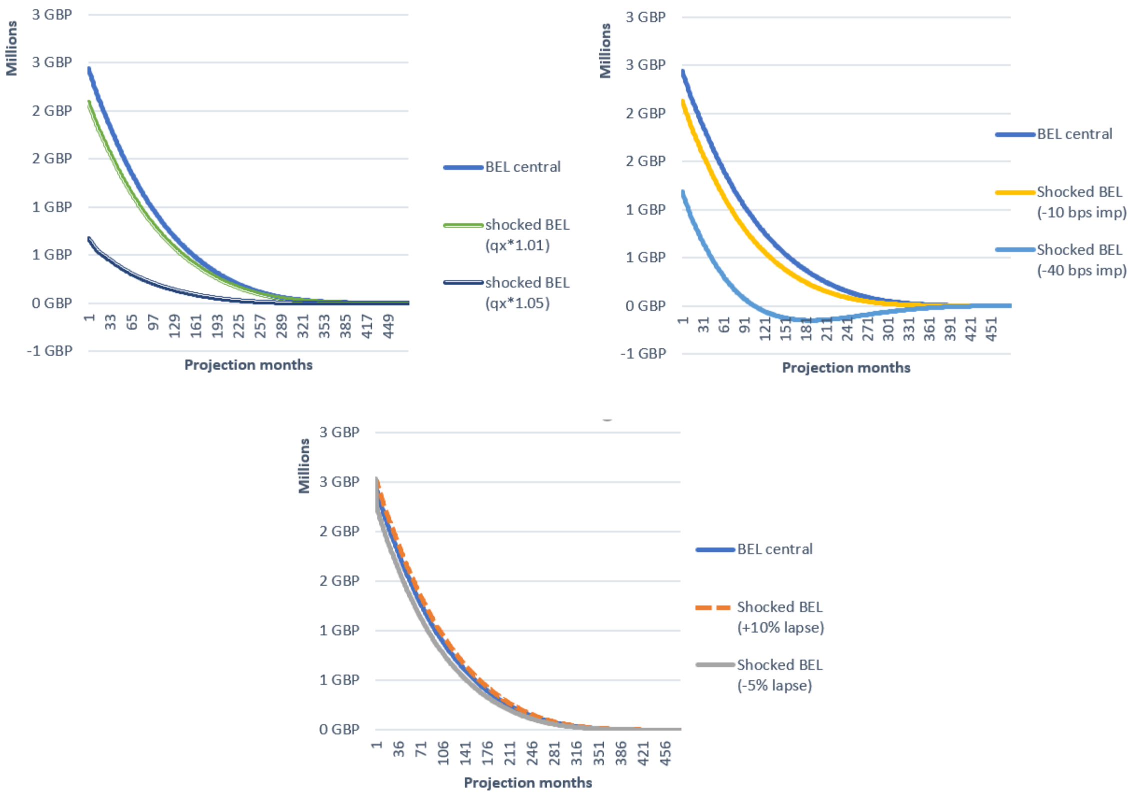


Figure 3.3: Single-risk impact on the monthly projection of the BEL

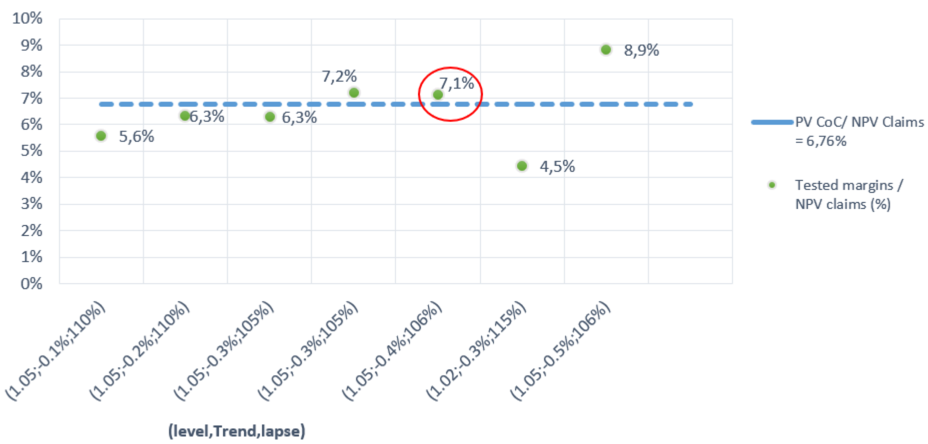


Figure 3.4: Calibration results : choosing the appropriate margins

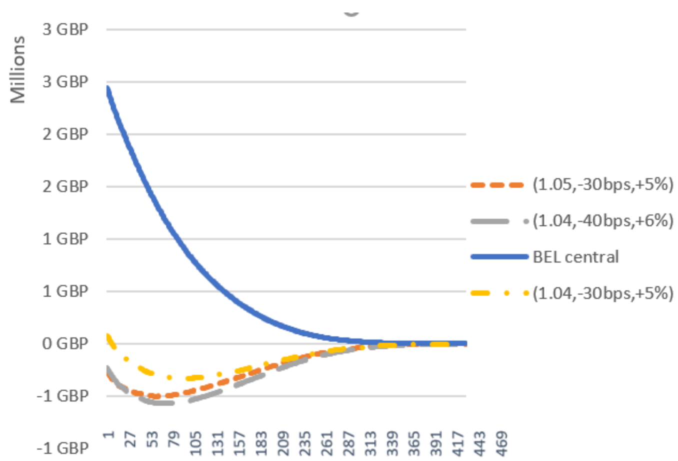


Figure 3.5: Calibration results, impact on the BEL

as it reflects the narrowest difference to the PV CoC. We display below the impact of the 3 best-fit margins on the BEL:

The same calibration process is replicated for the APAC region using the four representative treaties we mentioned earlier. With the same steps, we choose a set of margins that fits best the PV CoC of each treaty.

	Level	*Trend*	*Lapse*	*calibrated margins Vs PV CoC*	*% of PV claims*
treaty JP	8%	-100bps	-	101%	18,3%
treaty KR	5%	-70bps	+3%	102%	11,4%
treaty DK	8%	-100bps	+5%	102%	18,0%
treaty DM	8%	-100bps	+5%	99%	17,5%

Table 3.10: Calibration results : APAC region

The claims duration are different between EMELA and APAC region. This classification is based on the implicit understanding that duration differences are due to differences in product types covered in different regions.

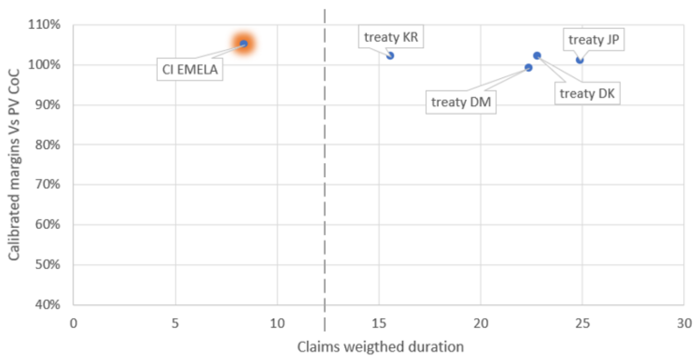


Figure 3.6: Calibration results in function of duration, comparing EMELA and APAC

Seeing a reasonable degree of consistency for trend and level margins, we can go for a parametric solution as a function of duration in order to derive the in-force block set of appropriate shocks as a relationship between margin (dependent variable) and duration (independent variable) is established from the treaty calibration results.

For each of the margins (level,trend,lapse) for the in-force block, each one is interpolated from the calibrated treaties margins. The interpolation is done relative to duration. Then, the in-force block margins are determined by fitting the in-force block's duration to the linear relationship. Since we have four calibrated treaties, we can also use a minimum-least-squares linear regression.

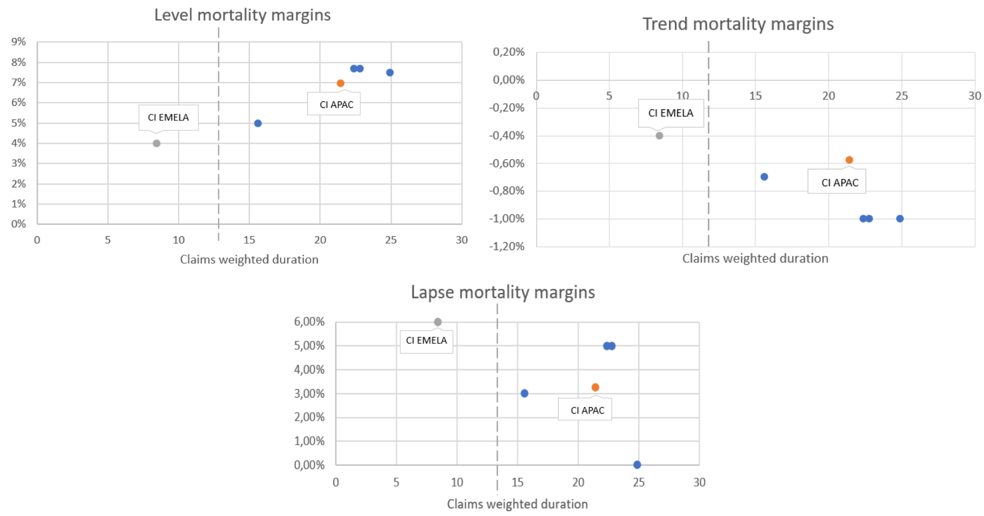


Figure 3.7: Finding the appropriate set of margins for the in-force LoB block

3.3.2 Longevity

Longevity products are insurance contracts that protect an individual from exhausting his/her savings by living longer than expected. Typically a fund is built up from an individual's premiums or contributions and then, upon annuitization, pays out an income to the individual at a later point in time. Longevity products are designed to secure a steady cash-flow for an individual during their retirement years – in its simplest form, this can be achieved using an annuity[13]

Annuities are payable until death, and it is not possible to surrender the policy.

There are currently treaties covering approximately thousands of policies in payment. The oldest treaty was underwritten in 2002 and the others were underwritten between 2010 and 2020. A new treaty 'Calypso' was written in 2020 and another won, 'Sparrow' is almost a closed deal. Longevity deals are predominantly in the UK.

For this type of products, since a fund is built up from an individual's premiums or contributions, no lapse risk will be taken into consideration. The risk margins in the calibration are only level and trend risks.

The same calibration methodology is followed to derive the appropriate shocks. As the process is clear at this point, analysis and calibration steps for longevity will be the same.

Two treaties were used for this calibration, namely Calypso and Sparrow. Both respond to criteria and both are longevity Standard Annuity Swaps[14], which is the only type of Longevity business that has been written in the past 5+ years. These margins can also be used for other longevity business given that they have been in-force for many years and the otherwise material additional risk is substantially reduced.

Calypso (GBP)	
Variable	
NPV Claims	956 054 469
Claims-weighted duration in years	14,7
Loss Ratio	91%
Guarantee Period	Fully Guaranteed
Calibration target metrics (GBP)	
PV CoC	11 562 246
RM at t=0	13 517 320
PV CoC / RM	86%
PV CoC/NPV claims	1,21%

Sparrow (GBP)	
Variable	
NPV Claims	524 196 362
Claims-weighted duration in years	13,9
Loss Ratio	91%
Guarantee Period	Fully Guaranteed
Calibration target metrics (GBP)	
PV CoC	6 907 364
RM at t=0	8 175 461
PV CoC / RM	84%
PV CoC/NPV claims	1,32%

Table 3.11: Longevity treaties calibration metrics target

For both treaties, The PV CoC represents about 1% of the PV claims that we want to target in both calibrations. And as the risk margins in the calibration are level and trend risks, we try a set of margins that we will want to apply on the whole longevity business regardless of their region/duration distinction previously done in the critical illness calibration as the longevity portfolio is predominantly written in UK.

[13]In Europe, annuity is a decumulation product and strictly refers to the fixed income stream secured via a single premium at the point of retirement

[14]Longevity swaps involve the ceding scheme paying a fixed schedule of "expected" pension payments in exchange for the actual scheme's pension payments. This converts its net outgo to fixed payments, thereby hedging the longevity risk

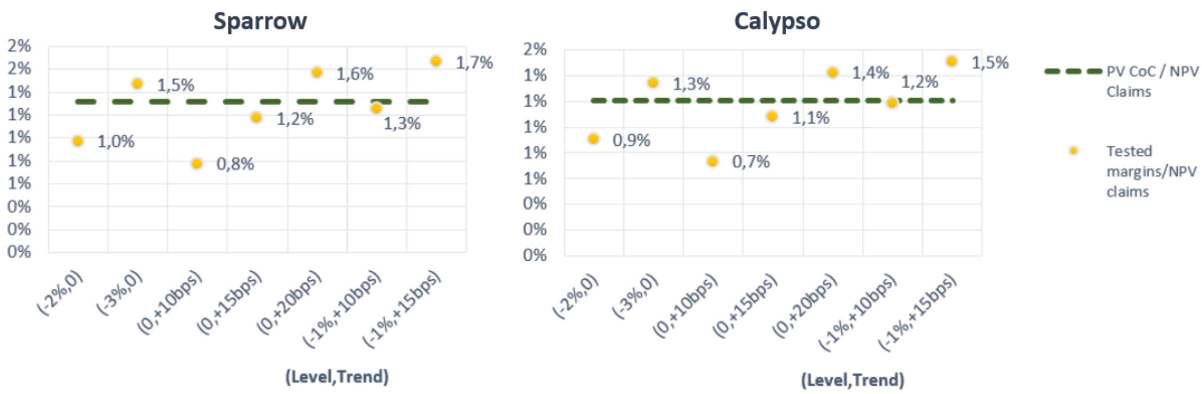


Figure 3.8: Longevity calibration results, choosing appropriate margins

The most appropriate margins to apply resulting from the longevity calibration are :

$$(Level, Trend) = (-1\%, +10bps)$$

To analyse the impact of duration , we apply the same margins on two olders deals (Davy and Barbossa) that were priced with the current assumptions of the pricing tool. We can see a dependence of the match on duration, but the view is that the line of business is homogeneous enough to justify the use of a single set of margins for the in-force block.

Figure 3.9: Longevity calibration results in function of duration

3.3.3 Calibration results and validation

For each of the calibrated long term product lines, we display the margins that will serve as an input in the valuation models under IFRS 17. The margins, added to the assumptions of the BEL , will produce a *Padded BEL*. The difference between the *Padded BEL* and the original BEL is set to represent the RA for each IFRS 17 group of contract. Thereby we have (c.f. Figure 3.10) :

As the expense shocks were ruled out from the calibration, the expense margin will be equal to +3%.

	Mortality/Incidence (Level)	Mortality improvement (Trend)	Lapse	Expense
EMELA TCI	4%	-40bps	+6%	+3%
APAC LT-CI	7%	-57bps	+3,25%	+3%
Longevity	-1%	+10 bps	-	+3%

Figure 3.10: Results : Applied margins for the non-financial risks for the designated LoBs

Validation

The calibrated margins are expected to result in a RA which broadly reflects the present value of the cost of holding risk capital from a pricing perspective (pricing PV CoC). Valuation models are still being developed as part of the IFRS 17 project in PartnerRe, only few treaties are fully run under IFRS 17 projection models, meaning that a comprehensive validation of the margins is not possible. However, the validation of RA can be done for designated treaties that were run under IFRS 17 valuation model.

We were able to test the RA margins on a subset of large in-force treaties, the RA was normalized by PV Claims to get a "RA Intensity" (ratio of RA to PV Claims), and compared to the RA intensity from the calibration exercises. The results show that the tested RA margins resulted in a RA intensity which was similar to the calibration view.

			IFRS 17 valuation model run			Expectations from calibration	
Treaty ID	LoB	Region	RA (Millions USD)	PV claims (Million USD)	RA intensity	Lower bound	Upper bound
Treaty 1	LT-CI	APAC	15,6	128,3	12,1%	7,0%	18,0%
Treaty 2	LT-CI	APAC	30,0	259,0	11,6%		
Treaty 3	LT-CI	APAC	20,5	171,0	12,0%		
CI-APAC Total			***66,1***	***558,3***	***11,8%***		
Treaty 4	TCI	EMELA	11,3	158,9	7,1%	4,0%	7,0%
Treaty 5	TCI	EMELA	10,7	157,6	6,8%		
Treaty 6	TCI	EMELA	16,6	358,0	4,6%		
Treaty 7	TCI	EMELA	9,7	178,7	5,4%		
Treaty 8	TCI	EMELA	19,1	299,4	6,4%		
TCI Total			***67,4***	***1 152,6***	***5,8%***		
Treaty 9	Longevity	EMELA	2,0	163,1	1,2%	1,1%	1,6%
Longevity Total			***2,0***	***163,1***	***1,2%***		

Figure 3.11: Validation of RA margins

Another way to assess RA numbers is the *Value In-Force Economic Capital* (VIF EC) that shares the same concept of holding risk capital as the PV CoC.

The VIF is a concept used within (re)insurance that essentially refers to the future profits expected to emerge from a particular life portfolio. There is a "cost of non-hedgeable risks" included in the VIF calculation which is the cost of holding capital against non-hedgeable risks. Its calculation is based on pricing economic capital model where the PV CoC is calculated as discounted Cost of EC.

The VIF EC numbers are expected to reasonably reflect the pricing PV CoC and can also be used as a benchmark for validating RA margins by LoB. Thus the resulting RA intensities from calibration can be compared to VIF EC numbers as well.

Management Reporting Segment	***PV claims due***	***PV CoC (VIF EC)***	***Intensity***
LT_CI	1 075	66	**6,2%**
Longevity-NSA	308	3	**0,9%**
Longevity Standard_Annuities	6 932	74	**1,06%**

Source: VIF EC Work (mUSD)

Table 3.12: Intensities from VIF EC work 2020 Q4

The VIF EC intensities are consistent with calibration intensities. The Non standard annuities segment is however slightly inferior to the expected 1% for longevity LoB. it is basically due to the decision of applying margin calibrated for specific longevity deal to all longevity business.

Considerations for the short term business

For short term business, it is very common and practical to use simple methods. For instance a factor approach can be adopted to determine the RA required for the liabilities : Such factor can be defined relative to expected claims or relative to premiums.

Such methodology would treat premiums or claims as the risk driver. As we focused on long term, the calibration of the factors for short term is beyond our application scope.

Conclusion

The RA is an entity-specific measurement, and the indifference requirement under [IFRS17,B87] establishes a direct link between the RA and preferences and appetite of the entity to bear non-financial risk arising from the insurance contracts. For that reason, an entity can choose to use any method that suits its view on risk. In this chapter, we explored the option to use margins for adverse deviation that were calibrated against a CoC framework that defines the minimal compensation for risk.

These margins were defined through a calibration process targeting the pricing PV CoC. The calibration aimed to reflect the PV CoC in assumption margins in a way that can also be applied to the broader in-force business. Therefore, only material risks needed to have margins applied.

The margins calibrated were for mortality-level, mortality-trend and lapse, whereas the expense risk was ruled out from calibration as it is not material compared to biometric risks. Besides, not all LoBs demonstrated in this chapter used all margins (the example of Longevity LoB where the lapse risk was not included).

We stress the point that under [IFRS 17,B91] , for similar risks, contracts with a longer duration will result in higher Risk Adjustment for non-financial risk than contracts with a shorter duration. a statement we were able to validate when comparing the respective RA intensities (% of PV claims).

This method has the advantage of being simple, transparent and most importantly easy to implement. However, it might lead to an estimation error giving the LoB-level of calibration. Actual impact in valuation models is difficult to quantify until the valuations models are all run. Another issue is that in order to maintain the appropriate linkage between PV CoC and the RA margins developed through calibration, a re-calibration may be necessary in the future if PartnerRe's view of risk fundamentally changes due to evolving business circumstances (i.e. changes in discount rate, changes in diversification factors, or even change in pricing philosophy) or that the characteristics of the future in-force block is no longer consistent with the current one.

Chapter 4

Exploiting Solvency II framework for the IFRS 17 Risk Adjustment

In this chapter, we explore the possibility of adopting SII calculations of risk allowance, notably The SII Risk Margin (referred to as RM hereafter), to derive an appropriate aggregated IFRS 17 RA.

For contracts within the scope of IFRS 17, the liabilities under Solvency II and IFRS 17 regimes are based on a probability-weighted estimate of the future cash flows, discounted at an appropriate interest rate plus an allowance for the risk. There is therefore significant opportunity to leverage Solvency II framework by using the same cash flow models for both Solvency II and IFRS 17, potentially with some changes.

There are key considerations before adopting Solvency II framework [PWC, 2017] :

1. Cash flows : Insurers are faced with the choice of building flexibility into existing models, so that they can cope with both metrics, or taking copies of the Solvency II models and adjusting them to create parallel models which meet the requirements of IFRS 17
2. Discount rate : This is largely prescribed under Solvency II, while IFRS 17 is more principles-based and offers more scope for management choice. There may be certain blocks of business for which the same discount rate can be used for both metrics.
3. Granularity of information : Solvency II does not require IFRS 17 level of granularity and therefore additional model development are required.

4.1 Comparing IFRS 17 and Solvency II

Solvency II came into force on 1 January 2016. Many insurers completed their first annual reporting cycle when the latest insurance accounting standard, IFRS 17, was published in May 2017.

As a prudential regulatory regime, the focus of Solvency II reporting is on the financial strength (capital resources) of the insurer as opposed to its performance during the year. As such, the Solvency II balance sheet is intended to reflect an "economic" valuation of assets and liabilities at the balance sheet date. As a financial reporting regime, IFRS is focused on reporting not only the financial position at the balance sheet date but also the performance in the period. We summarise the main differences between reporting under Solvency II and IFRS 17 in the table 4.1.

4.2 The SII Risk Margin

4.2.1 Important definitions

The Solvency Capital Requirement SCR

The SCR is a Value at Risk measure based on a 99.5% confidence interval of the variation over one year of the amount of basic own funds (assets minus technical provisions). The SCR is calculated using standard prescribed stress tests or factors, which are then aggregated using prescribed correlation matrices. This is the well known standard formula.

The diagram illustrates the structure of the SCR calculation under the standard formula.

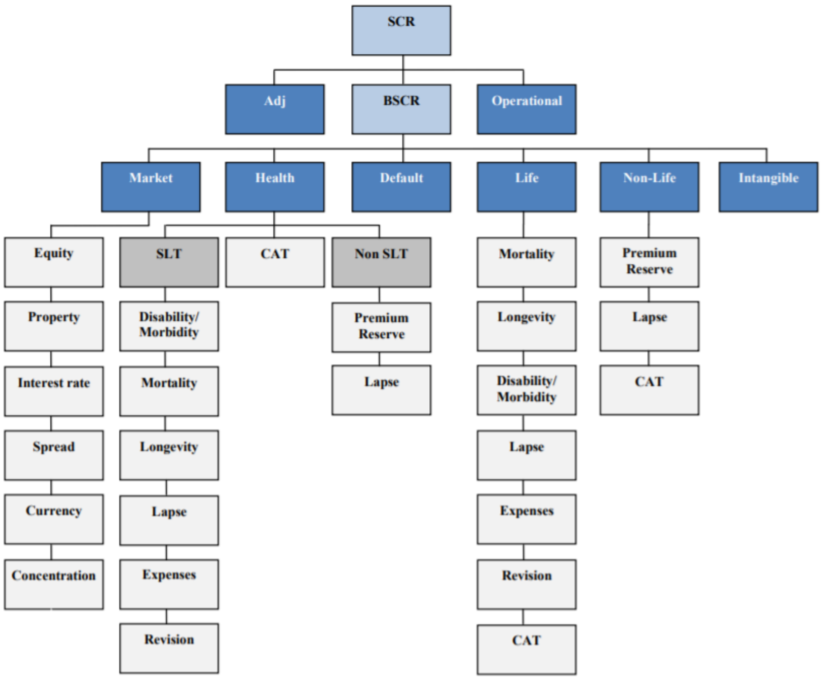


Figure 4.1: Structure of the SCR calculation under the SII standard formula

The SCR is first calculated for each module, each individual stress is performed separately according to detailed rules. The calibration and application of each stress is specified within the standard formula, e.g. 15% increase in mortality rates. The SCR for each individual risk is then determined as the difference between the net asset value (for practical purposes this can be taken as assets less best estimate liabilities) in the unstressed balance sheet and the net asset value in the stressed balance sheet.
These individual risk capital amounts are then combined across the risks within the module, using a specified correlation matrix and matrix multiplication.

Topic	IFRS 17	Solvency II
Scope	Insurance (and participating investment, for companies that also issue insurance contracts).	All contracts regulated as insurance.
Separating components	Separation of distinct investment components, certain goods, and non-insurance services and certain embedded derivatives.	No separation of components
Recognition	Date coverage begins or date first payment due for a 'group' of contracts	Date coverage begins or date party to contract
Granularity	Portfolio x cohort x profitability	Line of business
Cash flows	Cash flows related directly to the fulfilment of the contracts	All cash in-and out-flows required to settle the obligations over the lifetime
Acquisition costs	Attributable at portfolio level and included in measurement of liability	Expensed as incurred
Discount rate	'Top-down' or 'bottom-up' reflecting the characteristics of the liability Both current and inception rates required	Prescribed based on swaps less credit risk (plus matching or volatility adjustment in certain circumstances). Current rates only
Allowance for risk	No prescribed method. Company's own view of the compensation required for uncertainty arising for non-financial risks (only). Gross of reinsurance.	Prescribed 6% cost of capital method, with defined risks, level of diversification benefit and other components. Net of reinsurance.
Profit recognition	CSM eliminates day-one gain and defers profit over the coverage period. Day-one losses are recognized immediately. CSM is subsequently updated for certain changes.	Day-one gains, or losses are recognized for all contracts, including reinsurance.
Contracts with a participation feature	'Market consistent' measurement principle. Cash flows from the participation feature are included in the liability, including where these relate to future policyholders	'Market consistent' measurement principle. Cash flows from the participation feature are included in the liability except for 'approved surplus funds'.
Reinsurance contracts	All components presented gross of reinsurance; separate reinsurance asset. Specific requirements apply to reinsurance contract held.	Presented gross of reinsurance with a separate reinsurance asset (except for the risk margin).

Table 4.1: Summary comparison of the main differences between IFRS 17 and Solvency II contract liabilities [PWC, 2017]

Having obtained the SCR for each module, a further specified correlation matrix is used to combine them to give the Basic SCR (BSCR). Aggregation is therefore performed at different levels.

To obtain the overall SCR, two adjustments are made to the BSCR: an allowance for operational risk and an allowance for the loss absorbing capacity of technical provisions and deferred taxes.

The SII Risk Margin formula

The Risk Margin *shall be such as to ensure that the value of the technical provisions is equivalent to the amount that insurance and reinsurance undertakings would be expected to require in order to take over and meet the insurance and reinsurance obligations*[1]

This definition implies that the insurer will have to set aside funds for the duration of the commitments. The principle of the Risk Margin is then to assess the cost of immobilizing this capital. The Risk Margin is necessary because insurance risks are "non hedgeable" meaning that they cannot be neutralized by a hedging strategy. Hence the margin serves as a buffer against possible losses during run-off of the insurance liabilities.

The Risk Margin is determined using the “Cost of Capital” method. The risks included are all insurance risk, reinsurance credit risk, operational risk and residual market risk (non-hedgeable risks). The Risk Margin for the whole portfolio of insurance and reinsurance obligations shall be calculated using the following formula[2] :

$$RM = CoC. \sum_{t\geq 0} \frac{SCR(t)}{(1+r_{t+1})^{t+1}}$$

Where :

-CoC : the Cost of Capital rate, fixed rate of 6% per annum [3]

-the sum covers all integers including zero

-SCR(t) : the Solvency Capital Requirement after t years

-r(t + 1) : the basic risk-free interest rate for the maturity of t + 1 years.

The basic risk-free interest rate r(t + 1) shall be chosen in accordance with the currency used for the financial statements of the insurance and reinsurance undertaking.

Projection approach of SCRs

The computation of the Risk Margin requires calculating SCR over the entire projection period. Since the projection of the SCR is potentially complex, various simplified approaches can be used. EIOPA offered different methods[4] to calculate SCRs over the projection horizon, from the most difficult to implement to the simplest. In particular :

[1]Directive 2009/138/EC, article 77

[2]supplementing Directive 2009/138/EC, article 37

[3]This rate represents the cost of raising incremental capital in excess of the risk free rate, or alternatively it represents the frictional cost to the company of locking in this capital to earn a risk-free rate rather than being able to invest it freely for higher reward, SII fixes it to 6%

[4]comments on the simplified approaches can be found in *CEIOPS Consultation paper No.76 of 02/11/2009*

1. The exact calculation of future SCRs
2. The approximation of all or part of the risk modules or elementary sub-modules
3. The approximation of the overall SCR for each future year using a proportional approach
4. The estimation of future SCRs in "one time" using an approximation by an approach of duration
5. Approximate the Risk Margin by a percentage of the best estimate.

We will focus on defining the proportional approach (or the *driver* approach) as it is declared as a default method for RM[5], and will be used next for our RA calculation. A description of the simpler methods (4 and 5) are in the appendix

-The proportional approach

This method involve selecting a driver (reserves, Sum at risk, PV claims, premiums) which has an approximately linear relationship with the required capital or its components. The initial capital requirement can be expressed as a percentage of that driver, and the projected capital is then approximated as the same percentage of the projected values of the driver.

Hence we can define projected SCRs as follow :

$$SCR(t) = \frac{SCR(0)}{Driver(0)}.Driver(t)$$

Where :

$SCR(0) = BEL_{central}(0) - BEL_{stressed}(0)$ under the Solvency II standard formula.

This implies that the ratio : $\frac{SCR(0)}{Driver(0)}$ is a constant and that the share of the SCR in the driver remains the same throughout the projection. This method requires compliance with several assumptions of constancy of the insurer's profile overtime[6]

4.2.2 SII Risk Margin Vs IFRS 17 RA

When comparing the risk allowances in both SII and IFRS 17, the key differences are that the Solvency II Risk Margin is prescribed, while the IFRS Risk Adjustment is principles-based. In IFRS 17 there is no prescribed method and the calibration must conform to the principle we remind again : *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.*

Another key difference is that IFRS 17 requires separate Risk Adjustments for the gross liability (or asset) and reinsurance held (ceded), while Solvency II has a single Risk Margin based on the net of reinsurance position. We summarise the remaining differences in the table 4.2.

[5] comment n°8, *CEIOPS Consultation paper No.76 of 02/11/2009*

[6] Conditions of compliance are enumerated in Appendix, c.f. *Simplified approaches for capital requirement projection*

Topic	IFRS 17	Solvency II
Approach	Compensation for bearing the uncertainty about the amount and timing of the cash flows that arises from non-financial risk	Transfer value, prescribed (e.g. cost of capital at 6%, 99.5% risk allowance etc.)
Scope of risks	Narrower than Solvency II.	Prescribed set of risks
Calibration of risks	Not prescribed (principle-based)	Standard formula or internal model (where approved)
Diversification	Not prescribed (principle-based)	Entity level
Impact of reinsurance	Separate risk allowance for insurance and reinsurance held	Single net of reinsurance risk margin
Unit of account	Group of contracts (for CSM purposes notably)	Line of business
Disclosure of confidence level	Yes	No

Table 4.2: Summary of the differences between the Solvency II and IFRS 17 allowances for risk [PWC, 2017]

4.3 Calculation of IFRS 17 RA using SII framework

Using the Cost of Capital approach as in Solvency II, the formula for the RA at a given level of aggregation is:

$$RA = CoC_{IFRS17} \cdot \sum_{t \geq 0} \frac{CR(t)}{(1 + r_{t+1})^{t+1}}$$

Where :

-CoC_{IFRS17} : The calibrated Cost of Capital rate
-CR : The Capital requirement at the appropriate aggregation level

-r_t : The future Capital requirements are discounted using the discount rate euro yield curve for the corresponding year 2020.

After calculating the CR at the module level, and as we have the Capital Requirements of each module/sub-module for the relevant internal LoBs managed under Solvency II, then, by using the IFRS 17 mapping at the group product (GP) granularity, we can reallocate the RA in a way that :

$$RA_{entity} = \sum_{Internal\_LoB} RA_{Internal\_LoB} = \sum_{IFRS17\_GP} RA_{IFRS17\_GP}$$

We only illustrate the mapping[7] of IFRS 17 Grouping Product against SII internal LoBs. The SII internal LoBs are strictly confidential. :

[7] Refer also to table 3.3 for high level descriptions

IFRS GP	***SII Internal LoB***
LT	Internal LoB 1
	Internal LoB 2
	Internal LoB 3
ST	Internal LoB 4
	Internal LoB 5
	Internal LoB 6
	Internal LoB 7
	Internal LoB 8
Longevity	Internal LoB 9
	Internal LoB 10
	Internal LoB 11
GMDB	Internal LoB 12

Table 4.3: IFRS 17 group product mapping against the SII internal LoBs (confidential)

We will explain in detail the methodology hereafter.

4.3.1 The cash flows

We remind that[8] the Best Estimate of Liabilities (BEL) corresponds to the explicit, current and probability-weighted estimate of the difference between the PV of future cash outflows and the PV of future cash inflows resulting from insurance contracts issued by the insurer.

The BEL as defined in IFRS 17 is similar to the BE of the Solvency II. However, differences lie within the flows taken into consideration and the discount rates used. For the sake of this study, we start with the assumption $BEL_{SII} = BEL_{IFRS17}$ with re-treatments applied to the SII cash flows[9], as the official IFRS 17 cash flows are not yet available for us on an aggregate level to properly use it[10]

	Treatment	
Item	**IFRS17**	**SII**
ENIDs	Excluded	Included
Discounting	IFRS17 discount rates	SII discount rates
Expenses	IFRS17 expenses ~ x% of VIF expenses	SII Expenses
Contract boundary/Recognition	Excludes BBNI	Includes BBNI

Table 4.4: Treatments of SII Cash flows VS IFRS 17 Cash flows

BBNI

BBNI New Business refers to new treaties that have been written or renewed on new pricing terms but have not yet been incepted, these will be recognised if they are determined to be onerous[IFRS17,25(c)].

For BBNI treaties, we will be required to capture whether a treaty is onerous so it can be

[8] c.f. 1.3.1
[9] The 2020 Q4 SII cash flows are used
[10] using SII cash flows doesn't affect the calculation methodology pursued.

recognised prior to inception if it is onerous, for the sake of our study, we will consider all the BBNI treaties as non-onerous and therefore not included in our cash flows.

ENIDs

ENIDs (“Events Not In Data”, sometimes called “binary events”) are events that have not occurred in the historical claims experience but should be allowed for in a best estimate that allows for all possible future outcomes. They are are essentially a Solvency II concept to address the requirement that the BEL is required to ‘take account of all uncertainties in the cash flows’ not just reasonably foreseeable outcomes

ENIDs are less common for life business but can be used to reflect extreme risks that do not feature in historical data such as pandemic risks.

Under IFRS 17, it is required to incorporate the full range of possible outcomes in the best estimate liability [IFRS17,33]. However, in determining the full range of possible outcomes, *the objective is to incorporate all reasonable and supportable information available without* ***undue cost or effort*** *rather than identify every possible scenario*[IFRS17,B39]. Given the complexity of reinsurance business, if a reinsurer does not have a complete stochastic model of all possible risks which dynamically models the interactions between all risks, the cost of calculating ENIDs are naturally important. Therefore, we put the assumption of excluding ENIDs from the cashflows.

Expenses

Under the IFRS 17 Standard, it is necessary to determine whether expenses are attributable [IFRS17,B65] or non-attributable[11] [IFRS17,B66]. Under [IFRS17,34], for expenses to be considered attributable, they must be directly linked to the lifespan of the contracts, i.e. they should arise from substantive rights and obligations that exist during the reporting period in which the entity can compel the policyholder to pay the premiums or in which the entity has a substantive obligation to provide the policyholder with services.(contract boundary)

Based on [IFRS 17,B66 (iii)], expenses relating to future new business cannot be attributable to existing business. Rather, such expenses are considered to be attributable to future new business

4.3.2 The Capital requirement

The Capital requirement represents margins/deviations for the accounted risks. It is calculated for the same SII modules/sub-modules before being apportioned across the internal Solvency II LoBs then the corresponding IFRS 17 group product.

The SII modules are :
- Life
- Health SLT[12]

[11] Given the BEL is a key driver of the CSM established at initial recognition, higher levels of assumed attributable expenses will result in a lower CSM and therefore, lower future profits

[12] SLT : Similar to Life Techniques, as Non-SLT segment will not be taken into consideration in the calculations

• Health CAT

And their sub-modules will be similar to the Solvency II as depicted below :

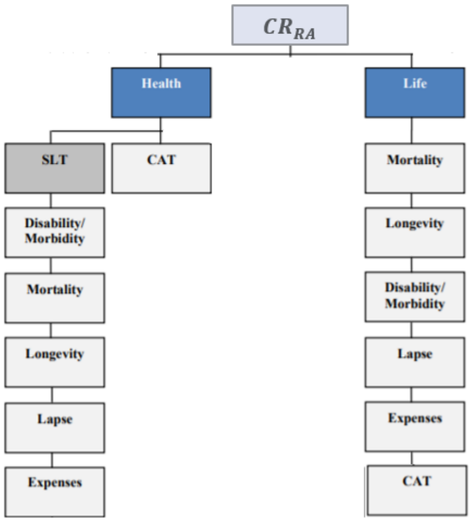


Figure 4.2: Cartography of risks involved in IFRS 17 RA

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

• Removal of the capital components related to risks other than the non-financial risks in scope of the RA. (i.e. the reallocation of market, credit default and operational risks)

• Basis calculation :

While Solvency II has a single Risk Margin based on the net of reinsurance position, the RA separates the gross liability from reinsurance held, therefore, two sets of calculations will be done : on a gross basis and on a net basis. The purpose of the second set is helping us define the quantum of RA dedicated to the retrocession. Therefore the appropriate Risk Adjustment for the retrocession [13] could be determined based on the difference between the gross position and the net position[14]

• Diversification[15] :

The RA can be reduced to take into account diversification up to legal entity level. As it is possible to sell or re-insure a portfolio of contracts, it may be judged unreasonable to take credit for diversification between portfolios in the entity because in the event of a sale, the diversification allocated to the portfolio would not be part of the sale, that is to say that the diversification benefits would not be realized by the purchaser, and this is taken into account in the SII Risk Margin . Since it is not a requirement under IFRS 17 Risk Adjustment, the

[13] c.f. 1.3.3

[14] The internal program of retrocession between the other LE (Legal Entities) of PartnerRe was used. The weight of the external program is way lower than the internal one.

[15] IFRS 17 permits diversification in the Risk Adjustment, see [IFRS 17, B88(a)]

group(Life/Non-life) diversification hence can be taken into consideration[16]. We remind that the intra-life and life & health diversification will be addressed using the same SII correlation matrices.

As we remind that the RA at the entity level is the sum :

$$RA = \sum_{Internal\_LoB} RA_{Internal\_LoB}$$

And also should be equal to:

$$RA = \sum_{IFRS17\_GP} RA_{IFRS17\_GP}$$

Therefore, for each SII internal Lob the corresponding RA will be :

$$RA_{Internal\_LoB} = CoC_{IFRS17\_GP} . \sum_{t \geq 0} \frac{CR_{Internal\_LoB}(t)}{(1 + r_{t+1})^{t+1}}$$

Where :

$$CR_{Internal\_LoB}(t) = \frac{CR_{Internal\_LoB}(0)}{Driver_{Internal\_LoB}(0)} .Driver_{Internal\_LoB}(t)$$

And using the IFRS17/SII internal LoB mapping we obtain with a simple reallocation :

$$RA_{IFRS17\_GP} = \sum_{Internal\_LoB \subseteq IFRS17\_GP} RA_{Internal\_LoB}$$

As mentioned earlier[17], the proportional approach is the selected method for projecting the CRs. Specific drivers were chosen to reflect the best how each internal LoB runs off throughout time. The two main drivers are basically the PV claims and PV premiums. The latter is used only for two internal lines of business : the GMDB and Catastrophe Excess of Loss (CAT_XL). Due to the nature of GMDB business, mortality claims are not the only component that shapes GMDB claims, there is also unit-linked economical assumptions that makes the run off of the claims very volatile. The PV premiums are deemed more stable throughout time which makes it a good driver to use.

To define the $CR_{Internal\_LoB}(0)$ we have :

$$CR^{module}_{Internal\_LoB}(0) = \sqrt{R_1(0)^t \Sigma_1 R_1(0)}$$

And then through the Life & Health aggregation :

$$CR_{Internal\_LoB}(0) = \sqrt{R_2(0)^t \Sigma_2 R_2(0)}$$

[16]. In relation to undertakings referred to in Article 73(2) and (5) of Directive 2009/138/EC, the computation of the Risk Margin should be based on the assumption that the transfer of the portfolio insurance obligations for life and non-life activities is carried out separately, which won't be the case for IFRS 17 RA

[17]Projection approaches of SCRs c.f. 4.2.1

Where :

-$R_1(0)$: vector of marginal capital requirements $CR^{sub-module}_{Internal\_LoB}$
-Σ_1 : the correlation matrice between sub-modules.

-$R_2(0)$: vector of marginal capital requirements $CR^{module}_{Internal\_LoB}$
-Σ_2 : the correlation matrice between modules.

Important: The correlation matrices defined in the Solvency II standard formula are defined to diversify (sub-) modular SCRs, and therefore regulatory capital obtained after application of a shock defined at 1 year and for a confidence level of 99.5%. The use of the Solvency II correlation matrix for the correlation of IFRS shocks 17 is a choice that should be perceived as a limit but more importantly an operational solution.

Finally, the $CR^{sub-module}_{Internal\_LoB}$ results from shocking the BEL(0) with the non-financial risks assumptions.

$$CR^{sub-module}_{Internal\_LoB}(0) = BEL_{central}(0) - BEL_{stressed}(0)$$

The stresses

To define the stresses to be applied for our CRs, we use the standard formula approach as set out by the Solvency II Directive and Delegated Regulations to calculate the SCR. The entity PRESE of PartnerRe uses the standard formula as well.

	Stress applied	***IFRS 17 GP Stressed***
Mortality	15% increase in mortality rates	GMDB, Long term,Short term
Longevity	20% decrease in mortality rates	NSA-Longevity,MSWAP-longevity
Disability/morbidity	first 12 months : 35% increase Next 12 months : 25% increase Thereafter : 20% decrease	Long term , Short term
Lapse	Lapse up : 50% increase in lapse rates Lapse down : 50% decrease in lapse rates Mass Lapse : 40% lapse at time 0	GMDB, Long term
Expense	10% increase , 1% increase in expense inflation rate	All
Catastrophe	1.5/mille increase in claims over the next year	GMDB, Long term, Short term

Table 4.5: Per risk stresses applied to derive capital requirements

This involves application of the stresses defined in the Solvency II Regulations to the relevant cash flows using the actuarial models (2020 Q4 period) Life Underwriting stresses are applied to Base BEL by each LOB in their respective actuarial models. We run these inputs into the *Aggregator* model[18] to get the stressed BELs. Overall, 8 runs are executed in the *Aggregator* plus the base BEL run.

[18]The aggregation model in PartnerRe was built using MoSes (actuarial software). One of the main purposes of the model is to combine the reinsurance cash flow projections at treaty level from each LoB model into a standardised format to facilitate upload into the SII reporting platforms

We display the resulting CR(0), their respective drivers for the CR(t) projection, on both gross and net basis. We note that a correct calculation of CRs implies that the whole Life business should be involved to catch the full specter of intra-life diversification. Therefore, CRs(0) were calculated including EMELA, APAC and NA life business. Once it is done, we can reduce the scope to only focus on the business within PRESE entity (EMELA and part of APAC business).

SII Internal LoB	*IFRS17 GP*	*Driver(0)*	*CR(0) Pre Life/Non Life diversification*	*CR(0)/Driver(0) %*
Int_LoB1	GMDB	423,7	76,7	18%
Int_LoB2	Long Term	1 388,0	222,0	16%
Int_LoB3	Long Term	911,0	112,0	12%
Int_LoB4	Long Term	1 867,5	230,8	12%
Int_LoB5	Longevity - NSA	274,5	21,4	8%
Int_LoB6	Longevity - STA-SWAP	5 835,7	452,1	8%
Int_LoB7	Longevity - Variable Annuity	98,9	7,7	8%
Int_LoB8	Short Term	0,4	0,3	84%
Int_LoB9	Short Term	18,7	0,7	4%
Int_LoB10	Short Term	685,8	81,7	12%
Int_LoB11	Short Term	66,8	11,5	17%
Int_LoB12	Short Term	42,7	38,5	90%
	Total (mEUR)		***1 255***	

Table 4.6: Results : Gross Capital Requirements, Drivers at time 0 per internal LoB/IFRS 17 GP

SII Internal LoB	*IFRS17 GP*	*Driver(0)*	*CR(0)*	*CR(0)/Driver(0) %*
Int_LoB1	GMDB	201,6	37,9	19%
Int_LoB2	Long Term	677,5	145,1	21%
Int_LoB3	Long Term	283,6	79,9	28%
Int_LoB4	Long Term	1 096,9	147,0	13%
Int_LoB5	Longevity - NSA	136,3	11,0	8%
Int_LoB6	Longevity - STA-SWAP	3 174,7	253,4	8%
Int_LoB7	Longevity - Variable Annuity	121,5	9,8	8%
Int_LoB8	Short Term	0,2	0,2	80%
Int_LoB9	Short Term	8,9	0,4	4%
Int_LoB10	Short Term	302,1	54,5	18%
Int_LoB11	Short Term	30,1	11,8	39%
Int_LoB12	Short Term	17,8	15,6	88%
	Total (Million EUR)		***766***	

Table 4.7: Results : Net Capital Requirements, Drivers at time 0 per internal LoB/IFRS 17 GP

The diversification

For the group diversification (Life/non Life diversification), as mentioned earlier, can be taken into consideration under IFRS 17 RA. For PRESE LE, we put the assumption that the Life/non Life diversification at time 0 is 50% of the CR (diversification benefit is hence 50% of CR). However, for the RA, we expect diversification benefit to decrease overtime as Non Life runs off faster than Life business, and as we go further in the projection, there won't be nothing left to diversify the life segment with.

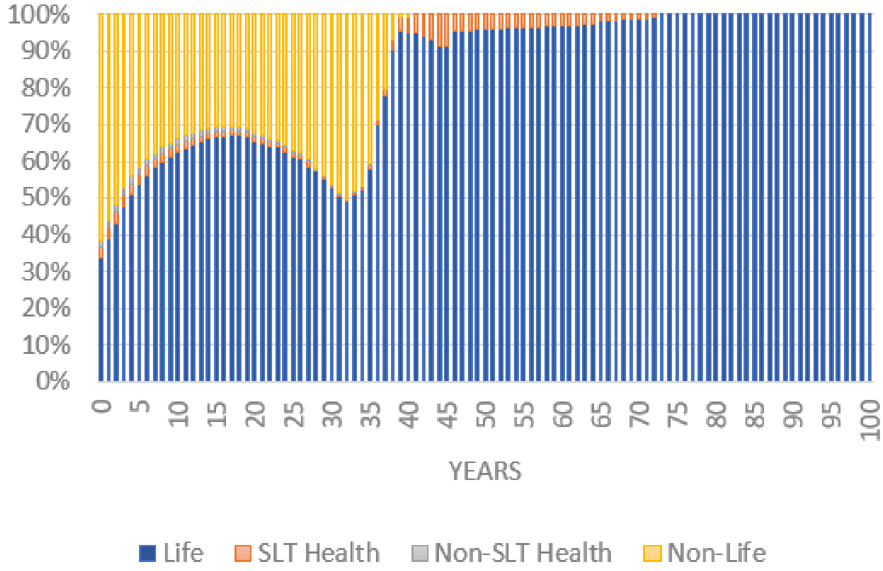


Figure 4.3: Example of a Split of SII segments during run off

To catch this decreasing aspect in our calculation, we define a split between SII, similar to the *Allocation Key SCR* before operational risk used in SII Risk Margin calculations, as they run off (c.f. Figure 4.3). At time 0, 61% of the total SII SCR is non-life,it was reduced to 37% after 8 years. It then re-increases before falling back to neighbor the 0% by 40 years span. We would expect the diversification to decrease because of that particular pattern. After 40 years, only life&Health segments remain, prompting the diversification benefit to be 0%.

To reflect the decreasing pattern in the diversification (50% at time 0), we mimic the decreasing pattern of Non-Life segment using a weight factor: $\frac{ratio\ of\ Non\!-\!Life\ to\ Life(t)}{ratio\ of\ Non\!-\!Life\ to\ Life(0)}$. For instance, at time 0, non life represents a ratio of 160% to the life&Health segments. We then use them to derive diversification factors $= 1 - weight(t).(1 - diversification)$ to apply instead of the constant 50%. The diversification factors are depicted below (c.f. Figure 4.4).

We remind that during the projection of CRs, we should also be allowing for the change in the diversification between life risks overtime (i.e. project the CRs of the intra-life risks and apply the appropriate correlation matrices at each time period of the projection to allow diversification). We however put the assumption that intra-life diversification remains constant for the whole projection as a simplification.

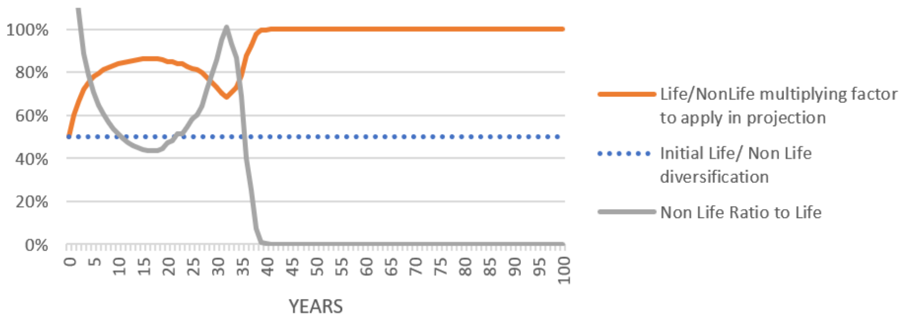


Figure 4.4: Diversification factors throughout the projection of Capital Requirements

The diversification started with the 50% at time 0 and ended with 100% by the end of the projection. We can see how the decreasing pattern mirrors the Non Life ratio to Life segment while it run off.

4.3.3 The Risk Adjustment

To align with IFRS 17 requirements we must bear in mind the interlocking of IFRS 17 portfolios (i.e. the granularity)[19]. Legal entity and Base company are anterior to the IFRS 17 GP, therefore, and as we cited earlier, we only focus on the PRESE LE.

Once we include the diversification, the next step is deducing the RA for each internal LoB under PRESE scope. We remind that :

$$RA_{Internal\_LoB} = CoC_{IFRS17\_GP} \cdot \sum_{t \geq 0} \frac{CR^{Post\ L/NL\ div}_{Internal\_LoB}(t)}{(1 + r_{t+1})^{t+1}}$$

And

$$RA_{IFRS17\_GP} = \sum_{Internal\_LoB \subseteq IFRS17\_GP} RA_{Internal\_LoB}$$

For this set of calculations, we use the *Aggregator* model output of 2020 Q4 cash flows, where the drivers for the CRs projection can be found.

One LoB is entirely out of PRESE scope : Variable annuities (NA business). It will therefore not appear in the results.

We display here the Risk Adjustment on a gross and Net basis calculation. The latter represents Risk Adjustments for the liability of PRESE, whilst the difference between the gross and net position represents the Risk Adjustments for the retrocession held by PRESE (ceded)[20]

We further compare outcomes of the Cost of Capital approach with the MfAD approach of the previous chapter. To do so, we use RA intensities (Ratio of RA to PV claims) used for validation from the previous chapter as an approximation of the RA. The scope widens to include also the LoBs belonging to the other IFRS 17 GP not explicitly calibrated in the

[19] c.f. Figure 3.2

[20] As we explained in 4.3.3, internal PartnerRe relies mainly on internal retrocessions between its legal entities for risk transfers. PRESE has Quota- Share cessions with other entities.

previous chapter namely GMDB, Financing and the Short term. As the SII internal LoBs are confidential, their RA intensities aren't displayed either.

IFRS GP	*SII Internal LoB*	*RA intensities (% PV due claims)*
LT	Internal LoB 1	x%
	Internal LoB 2	x%
	Internal LoB 3	x%
ST	Internal LoB 4	x%
	Internal LoB 5	x%
	Internal LoB 6	x%
	Internal LoB 7	x%
	Internal LoB 8	x%
Longevity	Internal LoB 9	x%
	Internal LoB 10	x%
	Internal LoB 11	x%
GMDB	Internal LoB 12	x%

Table 4.8: RA intensities, numbers from the VIF EC

Therefore, results include a calculated RA with the SII 6% CoC rate[21] so we have a ground for comparison with the SII RM. As nothing in IFRS 17 dictates the CoC rate to use, an elected rate of 3% is used. The third result represent an approximated RA from the MfAD approach.

IFRS17 GP	*CR(0) post Life/Non Life diversification*	*RA (CoC=6%)*	*RA(CoC=3%)*	*RA(MfAD)*
GMDB	38,3	35,6	17,8	20,4
Long Term	170,3	149,0	74,5	79,7
Longevity - NSA	10,7	8,6	4,3	2,5
Longevity - STA-SWAP	226,1	249,7	124,9	51,6
Short Term	62,0	31,3	15,7	2,9
Total (Million EUR)	***507,4***	***474,3***	***237,2***	***157,1***

Table 4.9: Results : Gross RA, breakdown at the IFRS17 GP granularity

The resulting RA for PRESE using SII framework with a Cost of Capital approach is higher than RA calculated based on MfAD. unlike the margin approach which reflects a view of minimal compensation of risk by PartnerRe, SII is deemed more prudent and more conservative explaining hence such differences. With a Cost of Capital of 3% the quantum of RA is still 50% higher than a MfAD RA, without Longevity, it is only 6% higher. Longevity group product is mainly what drives this difference as we can deduce from comparing both results. Indeed, from the previous calibration results, RA intensity represented only about 1% of due PV claims (c.f. Figure 3.12), whereas, and if compared to CR(0) for longevity, it represents 8% due PV claims. It reflects the philosophy of minimal compensation of risk by PartnerRe regarding the RA.

Under the same standard formula, and having in mind that the scope of SII RM encompasses not only non-financial risks (subscription risks) as in the IFRS17 RA but also credit default and operational risks, we can compare and quantify the difference between SII RM and

[21] The Cost of Capital rate referred to in Article 77(5) of Directive 2009/138/EC shall be assumed to be equal to 6%

IFRS17 GP	*CR(0) post Life/Non Life diversification*	*RA (CoC=6%)*	*RA(CoC=3%)*	*RA(MfAD)*
GMDB	15,4	14,4	7,2	8,0
Long Term	77,9	72,4	36,2	34,0
Longevity - NSA	4,1	3,4	1,7	1,0
Longevity - STA-SWAP	101,4	112,2	56,1	22,9
Short Term	4,6	2,4	1,2	1,0
Total (Million EUR)	***203,5***	***204,9***	***102,4***	***66,8***

Table 4.10: Results : RA for the liability of PRESE, breakdown at IFRS17 GP granularity

FRS17 RA calculated at entity level. The SII RM displayed is the RM for the entity at 2020 Q4. Under the same approach of Cost of Capital, and with the current calculation, the RM related to Life&Health is 61% higher than IFRS17 RA woth $CoC_{IFRS17} = 3\%$. As for the Margin approach, the RM is 74% higher.

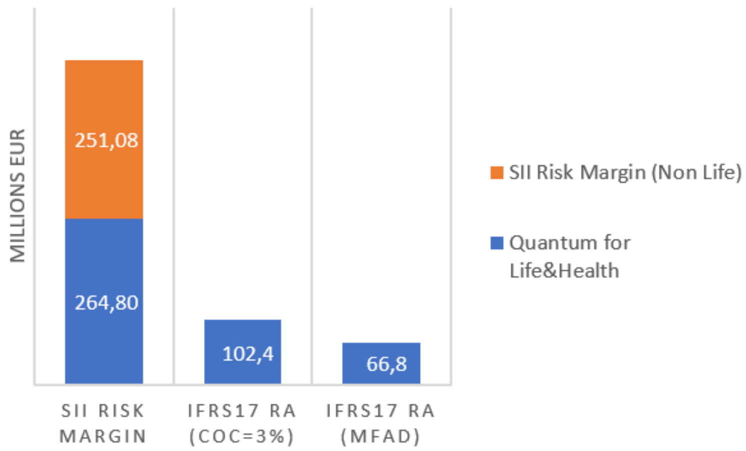


Figure 4.5: Comparing the SII RM with IFRS17 RA

For the retrocession held by PartnerRe, by subtracting the gross position of RA from the net position, we obtain the appropriate amount of RA dedicated to the retrocession activity.

IFRS17 GP	*RA (CoC=6%)*	*RA(CoC=3%)*	*RA(MfAD)*
GMDB	21,3	10,6	12,4
Long Term	76,6	38,3	45,8
Longevity - NSA	5,2	2,6	1,5
Longevity - STA-SWAP	137,6	68,8	28,7
Short Term	28,9	14,4	1,9
Total (Million EUR)	***269,5***	***134,7***	***90,3***

Table 4.11: Results : RA for the retrocession held by PRESE, breakdown at IFRS17 GP granularity

4.3.4 The Cost of Capital rate

The Cost of Capital rate is traditionally designed as the weighted average Cost of Capital (WACC) for an entity that considers all sources of capital, minus the rate that could be earned on surplus. In this section, the Cost of Capital rate will be calibrated to reach the same quantum of RA under the MfAD approach. The purpose is to assess how much it deviates from to the mandatory SII 6%. The rate is definitely decreasing seeing the level of MfAD RA.

To do so, as we maintained the same SII standard formula stresses, it reduces the degrees of freedom to target only the CoC rate. Therefore the level of compensation would be reflected in the Cost of Capital rate rather than the amount of capital requirement. The calibration here is a simple excel 0 goal target applied to the difference between the RAs at the IFRS 17 GP level by varying the CoC rate.

Thereby, we varied the CoC rate by group product. Even if these rates are calibrated in a simple way, they may still represent the compensation required by the entity for each IFRS 17 group product level.

IFRS17 GP	***RA (Million EUR)***	***Corresp. CoC rate***
GMDB	7,97	2,7%
Long Term	33,95	2,3%
Longevity - NSA	1,02	1,4%
Longevity - STA-SWAP	22,86	1,0%
Short Term	1,01	2,0%
	66,8	

Table 4.12: Results : CoC rates calibration for IFRS17 Group Product

4.3.5 The allocation of RA

The calculation performed in aggregate across different IFRS 17 GPs is an output of a Top-down approach to derive RA. The metric covered the collection of IFRS 17 GPs and lower, which means a RA at entity level. This will implicitly include an allowance for the diversification between the contracts, but the second important thing to do is to identify the IFRS 17 Risk Adjustment at the higher levels of granularity left. In that case, an allocation method is required.

Indeed, the RA needs to be allocated to the IFRS 17 group level per the requirements of [IFRS 17, 24], and perhaps to the contract level for purposes of initial grouping of contracts as per [IFRS 17, 16] and [IFRS 17, 47]. Again, IFRS 17 does not prescribe any allocation methodologies, hence possible solutions range from simple proportional allocation techniques to more sophisticated weightings based upon an analysis of the component risks.

An allocation method will allow us to allocate the capital requirement (initially determined by considering the diversification at an aggregate level) to the most granular level. At a minimum, the entity would simply allocate the RA at the granularity levels to meet IFRS 17 requirements. However, for internal needs, an entity might want to allocate the capital requirement by contract and by risk (within a contract). Literature includes a few capital allocation methods such as the pro-rata (scalar allocation), continuous/discrete marginal, or the Shapley method[22].

Scalar allocation

A scalar or pro-rata allocation is one of the most practical methods of allocation. The idea behind it is to use a reference measure, and allocate the aggregate RA to the next level of aggregation in proportion to that reference measure, therefore that measure needs to be available at the targeted level. Of course Any suitable reference measure can be used as long as it is available, relevant and appropriate, as it has to reflect to an extent the cash flow uncertainty. For example guaranteed benefits or present value of future cash flows can be used, in our case, we choose to use the present value of claims.

Currently, we cannot go further than the cohort level, as profitability groups demands a calculation of both CSM and RA to assess the contract profitability at recognition and create the groups, we therefore allocated the RA of PRESE entity at a cohort level. The same mechanism is set to be used to allocate at the IFRS 17 group of profitability once it is possible to do so.

To illustrate this, we give the example of the allocation of RA using pv claims as a reference measure, for cohorts from 2000 to 2020 under PRESE, French base company FR070. We can see for instance how the RA allocated to 2003 (about 30%) cohort downsized (to 20%) when the scalar allocation was used whilst the allocation increased for 2017 cohort.

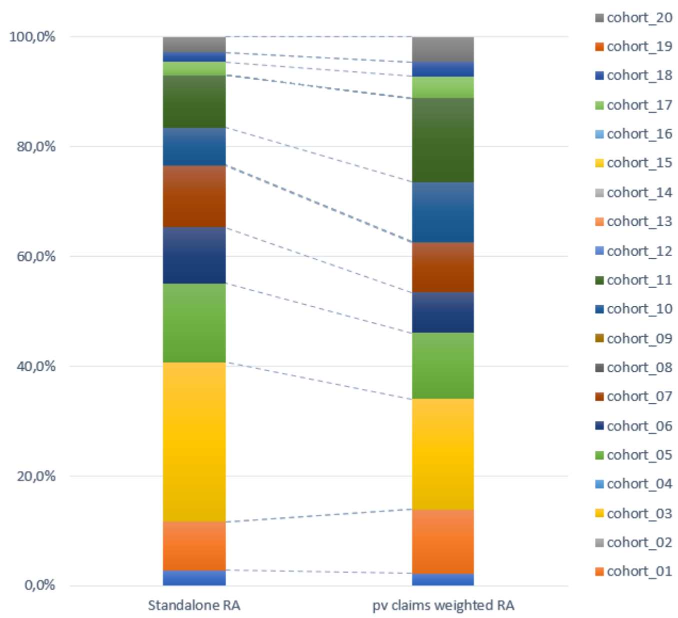


Figure 4.6: Allocation of RA, simple allocation Vs scalar allocation, illustration for the IFRS 17 cohort level : PRESE x FR070 x IFR17 GP Long Term x Cohorts

[22]The reader can refer to *Shapley Allocation — The Effect of Services on Diversification* by Peter Mitic, Bertrand K. Hassani to know more about this allocation method

Conclusion

In this chapter, we applied the Cost of Capital approach to derive an aggregate RA. The idea was to calculate a RA which is based on the compensation that the entity requires to meet a target return on capital, just like in SII RM. This approach has the advantage of being conceptually close to the definition of the RA, and allows allocation of the RA at a more granular level like we did, as we targeted a RA at the group product level.

Whereas the formula for this approach is simple, there are a variety of ways to determine its components, therefore using Solvency II as a reference for calculation methodology of the capital requirements was the most practical way to do it as we were able to exploit the regulatory capital model.

The Cost of Capital method is appropriate for complex or long duration risks [Deloitte, 2015], but is likely to have challenges in meeting other criteria, such as simplicity, because it might be operationally complex, as the projection of capital requirements is considered an input to the liability calculation.

However, with this method, as well as for the MfAD, RA needs to be translated to confidence level, as the CL disclosure is mandatory under IFRS 17. There might be no link between the confidence level corresponding to the RA required for disclosure and the confidence level of the SII capital model used. SCRs stresses are calibrated to cover risks at the 99.5^{th} percentile over a one-year horizon, which is conceptually very different than a Risk Adjustment that covers a lifetime horizon. Thus, the quantification of the confidence level of the RA can be different and would be determined using another approach. We must stress that an entity could, 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.

Chapter 5

Confidence level disclosure

The disclosure requirements for the confidence level are cited in [IFRS 17,119]. The full text of that paragraph is the following:

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.

The confidence level technique, also called the quantile technique including Value at Risk (VaR) and Conditional Tail Expectation (CTE) enables the entity to derive simply the confidence level as the technique itself assesses the probability of the adequacy of the fulfilment cash flow and help to quantify the desired magnitude of the RA. The main pros of a quantile technique is that it will directly satisfy the IFRS 17 disclosure requirements regarding confidence level corresponding to the RA.

However, we understand from the paragraph that using any alternative method implies an additional work for disclosing the confidence level which is our case. The use of margins for adverse deviations or the Cost of Capital approach as a way to define the RA means we have to look for a method to disclose the confidence level which is the purpose of this final chapter. In that case, quantile technique can be used as a secondary method.

Furthermore, it is reasonable to infer that paragraph 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 anything less than an entity-level.

We will expose possible approaches to converting the overall RA into a confidence level for disclosure. Potential techniques range from full stochastic modelling to a relatively simple assumption about the shape of the underlying probability distribution of liabilities cash flow.

Therefore, we will discuss the following methods :

1. Calibration through the use of capital models.
2. Stochastic distribution of non-financial assumptions

5.1 Assumed distribution of the cash flows

The premise that a company has an internal model in which full run off horizon distributions can be available is not always accurate. The goal of this method is to leverage the company's economic or regulatory capital models in order to fit an overall distribution to change in the PV of cash flows (PVFC) of such that the RA can be identified along a fitted distribution. The idea behind this method discussed by Moody's [Hannibal, 2019b] and the CIA [Easson, 2019] is that it is simple and less burdensome as efforts were already poured to derive a RA with a method other than the quantile technique, especially that the confidence-level calculation will need to be calculated every financial reporting period (i.e. annually).

To do so, at least the information about the underlying probability distribution of the present value of future cash flows is required. Unless a better fit to the distribution is found, it might be reasonable to assume that the change in PVCF follows a Normal distribution.

5.1.1 Methodology

We will illustrate how the quantile technique could be applied based on an underlying Normal probability distribution assumption for the future cash flows.

A Normal distribution is defined by its mean and its standard deviation. Any point on the distribution can be identified if these two variables are known

The method to derive the standard deviation of the assumed distribution of future cash flows lies on defining a second point on the distribution, then a simple mathematical technique to calculate the standard deviation. So, the key to this approach is being able to identify the future cash flows associated with another point on the Normal distribution.

A reasonable approach is that a specific percentile of the distribution can be derived from the local Solvency regime by using the entity's own economic capital model and re-calibrating it beyond the typical one year risk horizon of most economic capital models for quantification of the confidence level of the RA.[1]

PRESE calculates economic capital based on a Solvency II standard formula as we have seen in the previous chapter. We saw that under the Cost of Capital approach, the capital requirement for non-financial risk at the 99.5% percentile was projected for the lifetime of the business. The present value of these capital requirements were calculated using the appropriate discount rates and a Cost of Capital is applied. The resulting IFRS 17 Risk Adjustment for PRESE liability is 102.4 mEUR for a CoC = 3% , and the RA under the MfAD was 66.8 mEUR wich approximates a CoC rate $\approx$ 2%. We take a view of the distribution of the change in PVCFs over a one-year horizon.

The distribution is described by two parameters, we choose these parameters so that :

- The median (or the mean) of the distribution is Zero

- The 99.5^{th} percentile of the distribution is the Solvency II Capital requirement CR(0) readily calculated, which is 203,4 mEUR.

[1] It is much simpler if an internal model provides us with full run off time horizon distribution, which is the case for PartnerRe

Once that second point on the assumed Normal distribution is identified, the implied standard deviation of the entity's future cash flows distribution can be calculated.

Given that :

X : The random variable of PV future cash flows (assumed to follow a Normal distribution)
BEL : the best estimate of PV future cash flows ($BEL = \mathbb{E}(X)$)
$CR_{y\%}$: the best required capital at the y percentile
σ : the implied standard deviation we are looking for

We have :

$$P\left(X \leq \ BEL + CR_{y\%}\right) = y\%$$
$$P\left(X - BEL \leq \ CR_{y\%}\right) = y\%$$
$$P\left((X - BEL)/\sigma \leq \ CR_{y\%}/\sigma\right) = y\%$$
$$P\left(Z \leq \ CR_{y\%}/\sigma\right) = y\%$$

Where

Z : the standard Normal variable (mean =0, standard deviation =1)

As a result :

$$\left(CR_{y\%}/\sigma\right) = \Phi^{-1}(y\%)$$

where

Φ^{-1} : the inverse-CDF function of the standard Normal variable

As we chose the percentile $y\%$ to be = 99.5% , then $\Phi^{-1}(y\%)$ = 2.57 looked up in the standard Normal table.

$$\sigma = CR_{y\%}/\Phi^{-1}(y\%)$$
$$\sigma = 79.0 \text{ mUSD}$$

Once the standard deviation of the entity's future cash flows is calculated, the standard Normal formula can be used to solve for the implied confidence level corresponding to the RA.

This method is sensitive to the shape of the chosen distribution. A Normal distribution is used for its bell-shape with no skewness. However, if skewness is observed, suitable distributions exist like the lognormal because of its tailed-distribution.

The lognormal is also a two-paramaters distribution that we need to find.

We remind that if X $\sim LogNorm(\mu, \sigma^2)$ then $ln(X) \sim \mathcal{N}(\mu, \sigma^2)$

Hence given :

X : the distribution of PV future cash flows (assumed to be lognormal distribution)

We have :

$$P\left(X \leq \ BEL + CR_{y\%}\right) = y\%$$

The mean of a lognormal is : $\mathbb{E}(X) = e^{\ \mu + \frac{\sigma^2}{2}}$

In that case : $BEL = \mathbb{E}(X)$

Then

$$\mu = ln(BEL) - \frac{\sigma^2}{2}$$

Therefore :

$$P\left(ln(X) \leq \ ln(BEL + CR_{y\%})\right) = y\%$$

$$P\left(\frac{ln(X)-\mu}{\sigma} \leq \ \frac{ln(BEL+CR_{y\%})-\mu}{\sigma}\right) = y\%$$

$$\frac{1}{\sigma}.(ln(\frac{BEL+CR_{y\%}}{BEL}) + \frac{\sigma^2}{2}) = \Phi^{-1}(y\%)$$

$$\frac{\sigma^2}{2} - \Phi^{-1}(y\%).\sigma + ln(1 + \frac{CR_{y\%}}{BEL}) = 0$$

We obtain a 2^{nd} degree equation to solve for σ which gives us :

$$\sigma = \Phi^{-1}(y\%) \pm \sqrt{\Phi^{-1}(y\%)^2 - 4.\frac{1}{2}.ln(1 + \frac{CR_{y\%}}{BEL})}$$

The solution set with positive σ and μ is selected. We note that negative sigma is beyond the range of feasible solutions, however negative μ is technically feasible.

With both parameters (μ, σ) of the lognormal distribution being calibrated, we center the distribution to have (mean = 0) to obtain the distribution of the change in PVFC against which we check the CL of the RA.

5.1.2 Interpretation of results

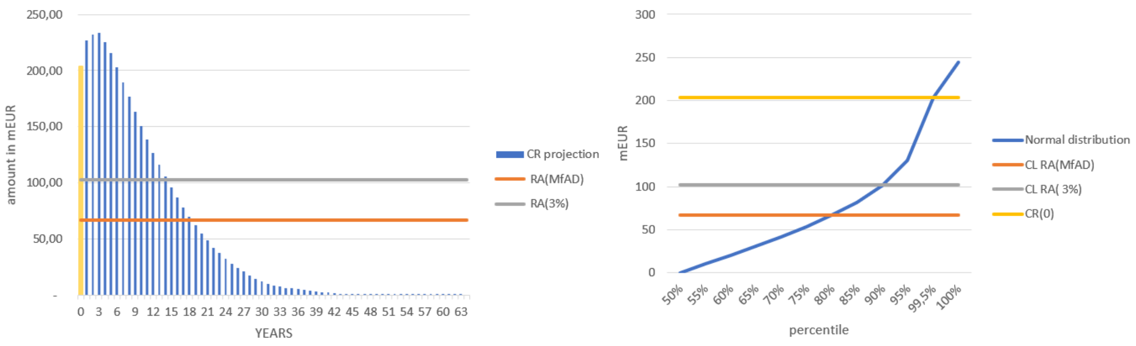


Figure 5.1: Projected CRs (left), percentiles of normal distribution calibrated (right)

The bar chart on the left shows the projected CRs, with the yellow bar highlighting CR(t=0) the resultant Risk Adjustments, calculated by both methods (CoC and MfAD)

The chart on the right shows the percentiles of a Normal distribution calibrated so that it matches the assumed median (mean) = 0 and 99.5^{th} percentile.

The equivalent confidence levels are disclosed as 90.3% (assuming 3% Cost of Capital) and 80.1% (MfAD).

As shown by the difference in result when lognormal distribution was used instead of the normal distribution, we can conclude about the sensitivity of the shape of the chosen distribution to the definiton of the confidence level.

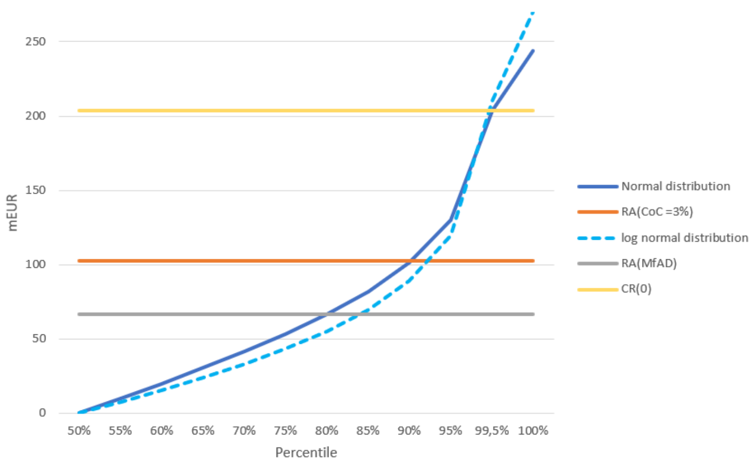


Figure 5.2: Mapping of Risk Adjustment to equivalent confidence level (Normal, lognormal for change in PVCF)

We remind that the distributions were calibrated to match the same median and 99.5th percentile. We display the resulting equivalent confidence levels :

Assumed distribution for PVCFs	***RA equivalent confidence level***
Normal	80%
LogNormal	86%

Figure 5.3: Risk Adjustment (MfAD) equivalent confidence level

The result can be interpreted as the net of reinsurance risk-adjusted liability (BEL plus RA(MfAD)) would be greater than the true unknown value of the net fulfilment cash flows 80.1% of the time if the underlying distribution was assumed Normal.

Under the Cost of Capital technique, despite the Risk Adjustment being calculated using projected capital requirements at a 99.5% confidence level, it does not mean that the equivalent confidence levels for the Risk Adjustment will be equal to 99.5%. However, the Risk Adjustment is calculated by projecting 99.5% capital requirements over the entire coverage period, discounting, summing, and multiplying by the designated Cost of Capital. The resulting Risk Adjustments in this case are lower than the SCR for non-financial risk, and so the equivalent confidence levels are lower than 99.5%.

Comments regarding the method

The advantage of such method is that assuming a distribution does not demand any stochastic models or complex calculations. It is efficient and simple to calculate so it is unlikely to delay a reporting process as long as the corresponding Solvency II inputs are available.

However, this method makes some general assumptions. Particularly, it assumes the distribution of the best estimate liabilities (BEL) is an appropriate proxy for the distribution of the IFRS 17 PVCFs. Whether this assumption is appropriate depends mainly on the consistency between the IFRS 17 cash flows and those assumed for Solvency II used for the calibration. Elements to take into consideration include exclusion of financial risks, contract boundaries and application of stresses.

5.2 Stochastic distribution of non-financial assumptions

Under this method, the distribution of the change in PVCFs is not assumed, instead, it is generated using a model for the underlying non financial risk factors. This method demands generating thousand scenarios and recalculating the change in PVCFs under each one and so is better suited to companies that have scenario-based internal models.

Non-financial risks can be modelled stochastically. This would involve calibration of distributions of rates of mortality, mortality improvement, morbidity, lapse, and any other key drivers of insurance risk. Cash flows would be projected for multiple scenarios based on these stochastic input parameters. This enables the obtaining of a probability distribution of the entity's aggregate risks making it possible to define the RA confidence level from the observed distribution.

To model insurance risks stochastically, the following risk components are considered:

- Level mortality
- Trend mortality:
- Volatility: Risk due to random fluctuations
- Catastrophe: Risk due to one-time large-scale events

The Group Capital Model (GCM)

PartnerRe has a Group Capital Model (GCM) which is an internal capital model that can be leveraged across the entire organization. The purpose of the GCM is to assess risks (including insurance risks) through *risk pillars*, with the outcomes of these individual assessments being consolidated into the Group Capital Model. These risks are assessed on both a standalone as well as a collective basis. Besides, the GCM produces results both gross and net of retrocession.

We use as input to the GCM the reserving data (*Aggregator* consolidated output 2020 Q4). The central best estimate claims projection for the risk pillars for all future years at the valuation period (2020 Q4) are depicted here (c.f. Figure 5.4)

The major advantage of the GCM is that a full run off (FRO) distribution is directly calculated as an over-the-life time run of the in-force business, with deviations coming from real-world scenarios. Hence we can leverage its outcomes to define confidence level that should be calibrated against a lifetime horizon.

Calculating distributions of the Best Estimate means there is a need to make claims stochastic using relevant risk factors to be diffused.

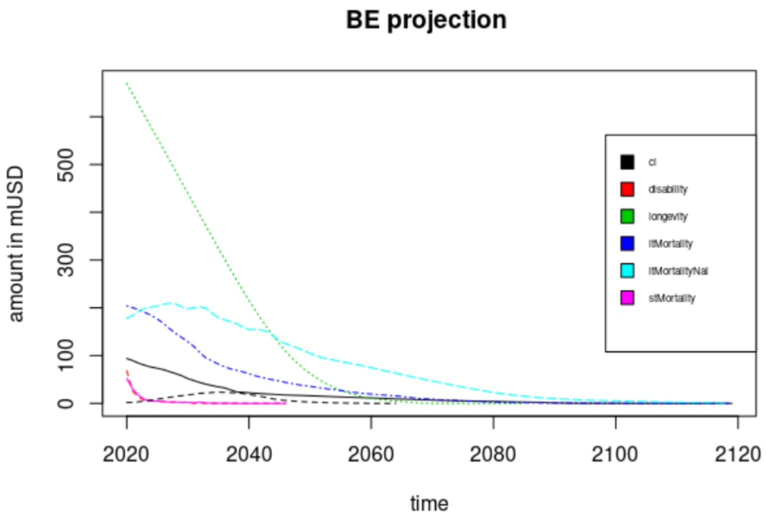


Figure 5.4: Central BE of claims, full run off, by risk segment

5.2.1 The risk factors

To make liabilities (claims notably) stochastic, we explain here how to apply stochastic factors to the claims.
As we mentioned earlier, modeling insurance risks considers main risk components such as, trend, volatility and pandemic to be applied for the main risk categories.

Mortality trend risk

The purpose is to model and quantify mortality trend risk for long-term protection and longevity as a way to derive relative risk factors for this component.

Multiple models aimed at stochastically projecting mortality rates exist. Most of these models have two components: In a first step, a stochastic parametric mortality model is fitted to historic data, which yields time, age and cohort-related parameter vectors. In a second step, the time-related parameter vectors (plus the cohort-parameters, if available) are projected into the future. This is a time series problem, and typically ARIMA[2] models are used in this context.
Common models include the well-known Lee-Carter model or the Cairns-Blake-Dowd (CBD) model which is the designated model for trend risk.[3]

In the CBD model, we have :

$$logit(q_{x,t}) = k_t^{(1)} + k_t^{(2)}.(x - \overline{x})$$

Where :

$k_t^{(1)}$: The overall level of mortality rates (The intercept)
$k_t^{(2)}$: Slope of logit-mortality with age x
$\overline{x}$: The mean age

[2] Autoregressive Integrated Moving Average
[3] The calibration of the CBD model is beyond the scope of this thesis as well as other risk components parameters assumptions, as the purpose is to leverage the existent framework to produce a life distribution

$k_t^{(1)}$ and $k_t^{(2)}$ are the two factors estimated. The evolution of the two factors through time is modelled by : $\begin{pmatrix} k_t^{(1)} \\ k_t^{(2)} \end{pmatrix} = \begin{pmatrix} \pi_{11} & \pi_{12} \\ \pi_{21} & \pi_{22} \end{pmatrix} . \begin{pmatrix} k_{t-1}^{(1)} \\ k_{t-1}^{(2)} \end{pmatrix} + \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} + \begin{pmatrix} \delta_1 \\ \delta_2 \end{pmatrix} .t + \begin{pmatrix} \epsilon_t^1 \\ \epsilon_t^2 \end{pmatrix}$

Where : $\begin{pmatrix} \epsilon_t^1 \\ \epsilon_t^2 \end{pmatrix} \sim \mathcal{N} \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix} \quad \begin{pmatrix} v_{11} & v_{12} \\ v_{21} & v_{22} \end{pmatrix} \right)$

As the target is to use the model for capital and risk calculations, in order to make the model's simulations applicable for risk/capital considerations in a wide range of contexts with differing underlying best estimate models, a simplification to the stochastic qx outputs is made :
Divide the stochastic qx by the mean of the qx. With this, we get risk factors with mean 1 that can be applied in any context, not altering the best estimate from pricing or valuation.

Volatility risk

For the Short Term Mortality, The simulation of risk factors used are based on a Normal distribution $\sim \mathcal{N}(\sigma_1, \mu_1)$. This distribution represents a type of "volatility risk" of the ST.

Short Term Disability risk

ST disability risk is split into two parts:

• Incidence risk : reflecting the fact that there may be more claims than expected. It is modelled as a random walk model with volatility parameter is set to σ_2

• Termination risk : representing the risk that income protection claims may be open for a longer time than expected. We use a standard lognormal distribution with σ_3

These factors are generated for 1 year and then kept constant for the rest of the years.

Pandemic risk

The pandemic model is a simple frequency-severity model where :

-Frequency $\sim \mathcal{B}(p\%)$ a standard Bernoulli model with an annual probability of p%

-Severity is an exponential distribution.

Lapse risk

Lapse risk is not stochastically modelled in the GCM, but should be taken into account. As a simplification, a fixed percentage of pv claims is used for lapse risk independently of the 1 year or FRO view. Lapse gets added to the existing deviations using a correlation assumption of $p_1\%$.

consideration for GMDB segment risks

The risks covered in the GMDB distribution are predominantly market risk (with equity as dominating component), plus biometric risks (trend + pandemic) and some allowance for lapse risk. Therefore the market risks will not considered in the risk factors as the scope is non-financial risks.

Outcome

As a result, for each of the components mentioned above, a set of matrices exists

We therefore have matrices $S_{i,j}$ for scenario i and year j to stress the BE claims (multiplicative stress factors, e.g. 110% claims for scenario 10 in year 20). Scenarios range from 1 to 5000 and a time horizon of 100 years.

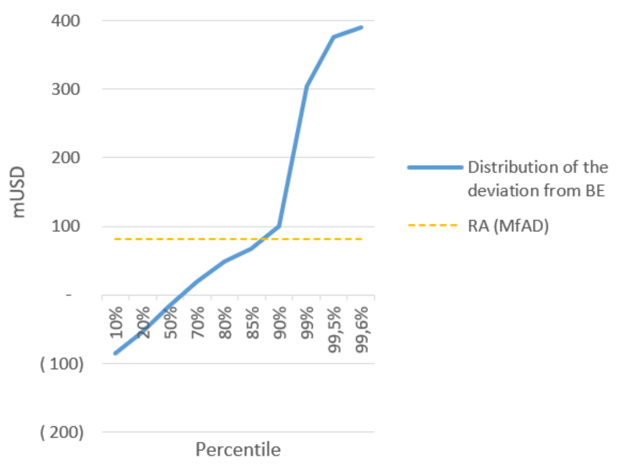
For each such risk, a matrix of stochastic claims, on which we calculate the deviations to the BE claims. The different claims deviations for a single segment (e.g. LT Mortality Trend, LT Mortality Pandemic) are added up (this step introduces intra-LoB diversification), which gives us, for each risk segment, a matrix of claims deviations $C_{i,j}$

Most correlation assumptions are already built-in through scenario-consistent calculation of the deviations. For instance, the ordering of the scenarios in the trend matrices in the GCM already implements the desired correlation structure.

5.2.2 Distribution of the Best Estimate

The claim matrices obtained have to be discounted with currency-specific risk-free rates (quarterly L&H economic yield curves) to arrive at a distribution of NPV deviations from BE for each risk segment.

These are then centered around the mean (i.e. the resulting distributions have mean 0). The density of the deviation from the BE distribution is depicted below.



Percentile	Distribution of the deviation from BE
10th percentile	(89)
20th percentile	(52)
50th percentile	(10)
70th percentile	19
80th percentile	48
85th percentile	68
90th percentile	100
99th percentile	305
99,5th percentile	375
99,6th percentile	390

Figure 5.5: Distribution of NPV deviation from BE, net basis, PRESE Legal entity

As we specifically focus on PRESE deviation from BE distribution, the granularity of the calculation enables us to actually derive splits of the in-force business by legal entity, on both gross and net of retrocession basis.

IFRS 17 does not specify whether the confidence level disclosure has to be on a gross or net basis, but the confidence level of the net RA is the one providing the most meaningful information.

The implied confidence level of the gross and ceded RA might or might not be relevant on their own, but could be calculated using the same approach. While the confidence level of the ceded RA could theoretically be calculated, it does not have a clear conceptual meaning. That is why we will only focus on disclosing the confidence level for RA net of retrocession and therefore deriving the PRESE life distribution of BE on a net basis.

We note that the split by legal entity can also be used to allocate the risk segments into the legal entity, the NPV deviations are aggregated to have single distributions by risk segment (e.g. a single distribution for Longevity)

The calibrated RA for the liability of PRESE considered is the 66.8 mEUR (82 mUSD) derived from using the pricing framework (MfAD approach), the confidence level can be derived directly from the FRO life distribution we obtained for PRESE. Hence :

$$Confidence\ Level_{PRESE}(RA) = 82,7\%$$

Conclusion

In this chapter, we used two practical industry-known methods to meet IFRS 17 disclosure requirement of the confidence level. The first method of assuming a distribution has the advantage of being simple to explain compared to some other methods. Consequently it is pertinent for disclosures and will not delay a reporting process as long as the corresponding economic capital inputs, such us of Solvency II we used for instance, are available. Conversely, the method makes broad assumptions which need to be checked for their consistency before using it to translate the RA into a confidence level.

The second method uses stochastic modeling to derive the non financial risk factors and the distribution from which the confidence level of the Risk Adjustment can be defined. This method is however more difficult to implement if an entity doesn't have an internal capital model.

Using these two methods shows us that after calculating a single value for the IFRS 17 Risk Adjustment, several equivalent percentiles can be derived depending on the translation methodology used. Thus defining an appropriate methodology for the translation is as important as choosing the methodology for the IFRS 17 Risk Adjustment calculation itself.

General Conclusion

Under the principle-based standard, IFRS 17 Insurance Contracts specifies neither the methods for determining the Risk Adjustment for non financial risks nor the level of aggregation to be used. Even though this could be challenging, it offers a flexibility to the entity to select appropriate methods and levels of aggregation that reflect the entity's compensation for bearing the risks in the fulfillment cash flows at the reporting date. We proposed through this thesis two industry-known methods to derive an appropriate Risk Adjustment for the Life & Health activity of the European entity of PartnerRe (PRESE) as part of its current efforts poured into implementing IFRS 17 for its financial reporting.

The first method discussed in the thesis defines a way to compute Risk Adjustment directly at *the GoC* level when running IFRS 17 valuation models. It relies on limiting the quantification of the Risk Adjustment primarily to the mis-estimation risk of the non financial (i.e. insurance) assumptions and the variability of cash flows that could arise from the "unmeasurable" aspects during the pricing process. This method is conceptually close to the definition of provisions for adverse deviations as well as for its implementation.

Defining such margins has the advantage of being highly practical to cover the whole spectrum of IFRS 17 GoC. However, even with the use of margins, aiming a computation at the IFRS 17 GoC level of granularity proved to be complex, especially that PartnerRe L&H is a multi-lines reinsurer. A calibration exercise was hence proposed to derive these margins by aligning the Risk Adjustment to the inherent pricing Cost of Capital for different lines of business rather than IFRS 17 GoC. The results will be used as inputs in the valuation models for the relevant IFRS 17 groups.

The second method proposed the use of Cost of Capital approach. This approach is the most consistent with IASB's definition for the Risk Adjustment and is also the methodology used for estimating the Risk Margin in the technical provisions for Solvency II. Solvency II takes account of diversification effects when using economic capital as the definition of required capital. We built this method around defining the requirement capital based on a new risk mapping. Perhaps keeping the same correlation matrices was one of the limits that yet needs to be improved in this thesis. Leveraging the Solvency II methodology while trying to adapt it to IFRS 17 specific features related to the Risk Adjustment remains a practical solution that will reduce reporting time, costs and calculating efforts for entities who would like to recycle as much as they can from existing regulatory calculations.

Besides being consistent, the CoC method provides stability of calculations across reporting cycles, which might not be the case for the first method as it relies on how the pricing view can change overtime. Also, the CoC method does not suffer from over-reliance on historical data, although the capital assessment is typically based on the VaR method.

Another advantage of the method is that it is easier to communicate than other methods as it aligns more closely with the commercial realities of the business model. While the first method translates a view of a minimal compensation for risk sought by the entity, the use of a Solvency II-based methodology to derive capital requirements means a more conservative and prudent outcome. This was confirmed when we compared the results of the two methods.

Unlike the margins for adverse deviations, we applied the CoC approach in a Top-Down fashion, meaning that the Risk Adjustment was determined at entity level and IFRS 17 grouping product. Therefore it needed to be allocated up to the GoC level. We chose to allocate the Risk Adjustment using a scalar or pro-rata allocation approach as the RA represents an important component as it forms, along with the present value of future cash flows and the contractual service margin, the liability for remaining coverage, hence the need to have it at the same granularity level.

None of the two methods proposed in this thesis provided a confidence level to which the total Risk Adjustment liability corresponds. IFRS 17 Insurance Contracts requires that kind of disclosure because it intends to provide the users of financial statements with some means of comparison and indications of the level of risk corresponding to the amount of the Risk Adjustment.

To disclose the confidence level, Two methods were discussed. Through the use of the resulting capital requirement for non financial risk computed in our CoC approach, we proposed a calibration of an assumed Normal distribution of the PV cash flows and then looked up the relevant confidence level of the RA. Another way was exploiting PartnerRe's internal capital model by using the stochastic distribution for non financial risks generated for the whole L&H European entity to define the appropriate confidence level.

For the same risk adjustment, results of confidence Level differed hence highlighting the importance of choosing the appropriate translation methodology. Such decision depends on many factors encompassing accuracy, complexity and ease of communication, as it would be inappropriate for the translation methodology to be more complex than the underlying IFRS 17 Risk Adjustment methodology. The disclosed confidence level will not necessarily be consistent over time either when the CoC method or the Margins for Adverse Deviations are used. They can vary from period to period due to changes in underlying assumptions (e.g. the Life/non Life diversification patterns, change in the pricing policy etc.)

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List of Acronyms

BEL Best Estimate of Liabilities.

CL Confidence Level.

CR Capital requirement.

EC Economic Capital.

FCF Future Cash Flow.

FRO Full Run Off.

GCM Group Capital Model.

GMDB Garanteed Minimum Death Benefit.

GoC Group of Contract.

IFRS International Financial Reporting Standard.

IRR Internal Rate Return.

LoB Line of Business.

MfAD Margin for Adverse Deviation.

NPV Net Present Value.

NSA Non Standard Annuity.

PAD Provision for Adverse Deviation.

PVCF Present Value of Cash Flows.

PVCoC Present Value Cost of Capital.

PVFP Present Value Future Profit.

RFR Risk Free Rate.

SCR Solvency Capital requirement.

SII Solvency II.

STA Standard Annuity.

TCI Criticall Illness.

VNB Value New Business.

Appendix A: Presentation of RA in the statement income

We display here changes brought upon by IFRS 17 to the Statement of Comprehensive Income (SCI) and the subsequent measurement done each reporting period.

We remind that the Statement Income, also known as the profit and loss statement or the statement of revenue and expense, primarily focuses on the company's revenues and expenses during a particular period.

The new SCI under IFRS 17 is depicted below :

Statement of comprehensive income
Insurance contract revenue
Insurance service expenses
Incurred claims and insurance contract expenses
Insurance contract acquisition costs
Gain (or loss) from reinsurance
Insurance service result
Investment income
Investment expenses
Insurance finance income
Insurance finance expense
Net financial result
Other operating income
Other operating expenses
Total expenses
Profit before tax
Income tax expense
Profit for the year
Effect of changes in discount rates (*OCI solution optional)*
Total comprehensive (expense)/income for the year

Figure 6: The IFRS 17 new SCI

According to a release pattern defined by the entity, The RA will be released in the SCI as the risk in the group of contracts decreases, which is expected to happen gradually as the contract covered risks expire. Therefore, the company shall recognise as *insurance revenue* (in the *insurance service result* section) the movement in risk adjustment relating to expired coverage during the coverage period as well as the amortisation of CSM

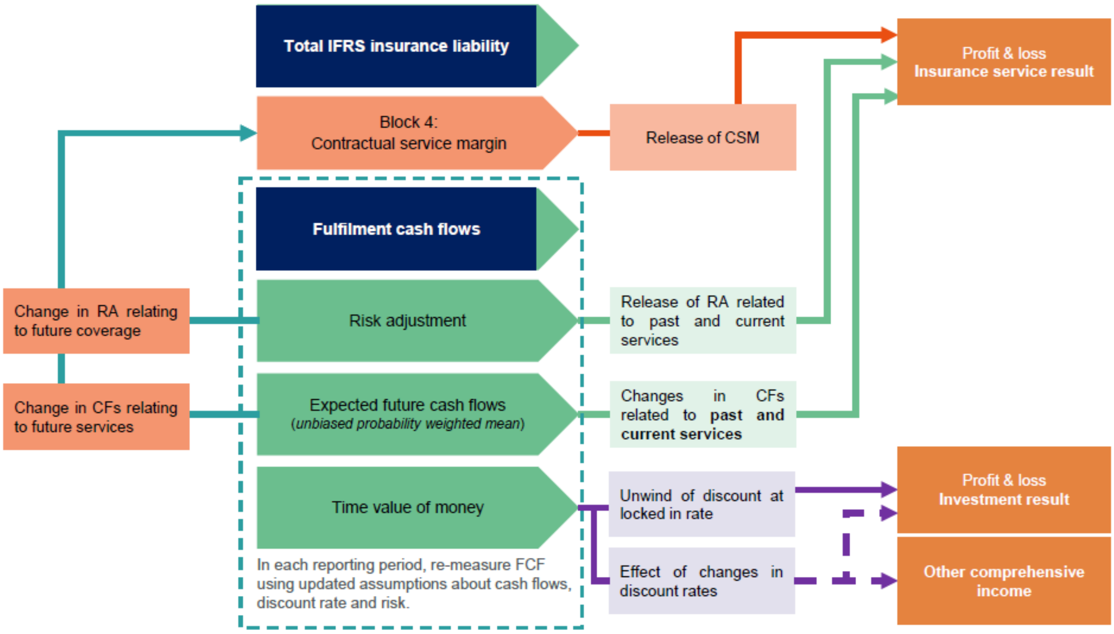

Figure 7: Subsequent measurement in the IFRS 17 SCI for future periods

Appendix B: The pricing Economic Capital for proportional business

This appendix highlights the pricing capital framework and capital factors to be used for different lines of business for proportional deals in PartnerRe. Life Pricing uses its own implementation of an Economic Balance Sheet (EBS) as fundament for deriving long term economic cash flows and calculating IRR (Internal Rate Return) and VNB(Value of New Business).

The Economic Capital should be calculated by considering the change in the BEL. However, where this is not practical, the metrics overlay applies shocks to a different set of drivers and has adjustments to approximate the capital as if the change in the BEL was ran.

The Pricing Economic Capital at time t is defined as :

$Economic\_Capital(t) =$

= *Post Intra Risk Diversified Capital (t). (1 – Intra Life Diversification). (1-Intra Group Diversification)*

+ *Post diversified credit capital (t)*

+ *Other capital (t)*

Where :

For intra risk diversification the entries of the matrix are defined as linear correlation coefficients in line with SII methodology. Overall this suggests :

$$Capital_{post\ Intra\ risk\ div} = \sqrt{\sqrt{\sum_{i,j} Corr_{i,j}.Undiv\ Cap_i.Undiv\ Cap_j}}$$

	Biometric	Lapse	Expense
Biometric	1	0.25	0.25
Lapse	0.25	1	0.25
Expense	0.25	0.25	1

As an illustration, Stand-Alone capital factors drivers are provided here for Critical illness and long term mortality as they were subject to the calibration exercice displayed (c.f. 3.3)

	Trend Risk				One off event risk	Termination risk
Stand Alone Capital Drivers	**Factor to apply to trend**	**Factor to apply for Full run-off to 1 year view**	**% of base table**	**Absolute % trend improvement** as at time t	**Per Mille impact % of Sum at risk at time t**	**Reduction in terminations at time t**
CRITICAL ILLNESS ONLY:	5 x	60%	114%	-1.3%	n/a	n/a
Long Term DEATH ONLY: without Critical Illness or Disability benefit	1 x	100%	110%*	See chart below	See pandemic below	n/a

The pandemic capital will be a factor of the PartnerRe share of the current death Sum at Risk from ground up on mortality business. The factors are based on the region where the exposured risk is situated. The classification is the following trisection:
-Developed : 0.625 per mille excess mortality
-Emerging/frontier : 1.0 per mille excess mortality
-Least developed : 1.5 per mille excess mortality

Appendix C: Simplified approaches for Capital Requirement projection

The methods displayed here are possible alternatives to the proportional approach for risk allowances calculations using CoC approach which are deemed more simple than the proportional approach.
We remind that EIOPA offered different methods to calculate SCRs over the projection horizon, from the most difficult to implement to the simplest.

-Duration approach

Before defining the approach, let's define the notion of duration. The duration measures average life of cash flows weighted by the present value of these flows. The duration of commitments is defined as follows :

$$Duration = \frac{\sum_{t\geq 0} \frac{t.CF_t}{(1+r_t)^t}}{\sum_{t\geq 0} \frac{CF_t}{(1+r_t)^t}}$$

Where :

— CF_t : Cash flows included in BE calculation
— r_t : Risk Free rate at maturity = t.

The approximation relies on estimating the discounted sum of future SCRs by considering the modified duration of liabilities over the projection horizon. We define the latter as follows :

$$Duration_{Modified} = \frac{1}{1+r}.Duration$$

Where :

r= the actuarial return rate solution of the equation :

$$\sum_{t\geq 0} \frac{t.CF_t}{(1+r_t)^t} = \sum_{t\geq 0} \frac{t.CF_t}{(1+r)^t}$$

We get the following approximation :

$$RM \approx CoC. \sum_{t\geq 0} \frac{SCR_t}{(1+r_t)^{t+1}} \approx CoC. \frac{1}{1+r_1}.Duration_{Modified}.SCR_0$$

Where :

— $Duration_{Modified}$: modified duration of liabilities
— SCR_0 : initial SCR at t=0 ; — r_1 : risk free rate of the first year of projection

this method requires compliance with the constancy assumptions of the insurer's profile over time which are :

1. The composition of the elementary subscription risk modules remain the same over time.
2. For counterparty risk, the credit quality of reinsurers and transfer vehicles risk remains the same over time.
3. The best estimate market risk is constant over time.
4. The modified durations of liabilities, net and gross of reinsurance, remain constant over time.
5. The loss absorption capacity by technical provisions remains constant over time.

-Proportion of the BE

This approach considers the proportionality of the risk allowance with the net BE evaluated at t = 0 for each line of business (LoB) .
We have :

$$CR_{lob} = \alpha_{lob}.BE_{net}(0)$$

Where :

-BE_{net} : Best estimate at t=0 net of reinsurance
-α_{lob} the % of BE(0) for the corresponding LoB

The EIOPA specifies that this approach, which is the simplest, is to be applied only if none of the other more sophisticated approximations can be implemented.

Appendix D: CoC approach relevant elements

L&H Correlation matrices

Life	mortality_up	longevity_up	disability_up	expense_up	revision_up	lapse	cat_up
mortality_up	1	-0,25	0,25	0,25	0	0	0,25
longevity_up	-0,25	1	0	0,25	0,25	0,25	0
disability_up	0,25	0	1	0,5	0	0	0,25
expense_up	0,25	0,25	0,5	1	0,5	0,5	0,25
revision_up	0	0,25	0	0,5	1	0	0
lapse	0	0,25	0	0,5	0	1	0,25
cat_up	0,25	0	0,25	0,25	0	0,25	1

Health (non-Cat)	mortality_up	longevity_up	disability_up	expense_up	revision_up	lapse
mortality_up	1	-0,25	0,25	0,25	0	0
longevity_up	-0,25	1	0	0,25	0,25	0,25
disability_up	0,25	0	1	0,5	0	0
expense_up	0,25	0,25	0,5	1	0,5	0,5
revision_up	0	0,25	0	0,5	1	0
lapse	0	0,25	0	0,5	0	1

Health (agg)	SLT Health	Health CAT
SLT Health	1	0,25
Health CAT	0,25	1

Total	Life	Health
Life	1	0,25
Health	0,25	1

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