MASTER
ACTUARIAL SCIENCE

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INTERNSHIP REPORT

WORKERS' COMPENSATION INSURANCE AND IFRS17 NON-SIMILAR TO LIFE TECHNIQUES WITH FOCUS ON RISK ADJUSTMENT

OLAMILEKAN DIYAOLU

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ABBREVIATIONS

ASF	Autoridade de Supervisão de Seguros e Fundos de Pensões
CoC	Cost-of-Capital
CLM	Chain Ladder Method
CSM	Contractual Service Margin
EIOPA	European Insurance and Occupational Pensions Authority
FCF	Fulfilment Cash Flows
GMM	General Measurement Model
GoC	Group of Contracts
IASB	International Accounting Standards Board
IBNR	Incurred But Not Reported
IFRS	International Financial Reporting Standard
LIC	Liability for Incurred Claims
LoB	Line of Business
LRC	Liability for Remaining Coverage
NSLT	Non-Similar to Life Techniques
PAA	Premium Allocation Approach
PV	Present Value
RA	Risk Adjustment
RM	Risk Margin
SCR	Solvency Capital Requirement
SII	Solvency II
SLT	Similar to Life Techniques
TVaR	Tail Value at risk
VaR	Value at Risk
VFA	Variable Fee Approach
WC	Workers Compensation

ABSTRACT

The need for global comparability, recognition, measurement, presentation, and disclosure of insurance contracts gave birth to IFRS17. IFRS17 marks a new era for insurance contract accounting. This work brings forward the impact of IFRS17 on the Workers Compensation line of business (WC LoB).

Liabilities in the WC LoB can be of a very different nature, namely workers compensation insurance using non-similar to life techniques and annuities originating from non-life insurance contracts and relating to health insurance obligations that use similar to life techniques (SLT).

The main focus of this paper will be on the non-similar life technique as this is the very specificity of the Portuguese insurance market. The report will present the basic measurement approaches with more focus on the Premium Allocation Approach (PAA) under the standard.

The structure of the report resumes the analysis of the impact of IFRS17 on Workers Compensation by considering the disaggregation into non-similar and similar to life techniques i.e., claims arising from the WC LoB are divided into two types. The Addactis IBNRS software will be used in the analysis of this report. This is dedicated software for the non-life type of claims reserving.

Keywords: IFRS17, Workers' Compensation, Premium Allocation Approach, General Measurement Model, Risk Adjustment, NSLT, SLT

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1. INTRODUCTION

After several years of development, the IFRS17 final standard was released in May 2017 with application to all insurance and reinsurance contracts. The standard is the biggest shake-up in global insurance reporting with such impact on all insurers reporting under IFRS.

This work results from my internship with ADDACTIS IBERICA, Lisbon area. I joined the actuarial consulting team; this allowed me to put into practical use all I learned in my masters' degree. I was integrated into several projects teams to work alongside actuaries that are well cultured in the actuarial field.

At first, I started to understudy three basic actuarial software packages required for IFRS17 implementation. However, I have followed up with the standard's progress but with limited knowledge on its applicability with insurance contracts. As of the time of writing this internship report, IASB is reviewing the implementation of the standard to ensure adequacy and effectiveness.

The internship report has been structured as follows:

i. Presents an overview of the IFRS17 standard; this part of the internship report will involve the review of the IFRS17 standard and the components. It is also the aim of this part of the report to make an adequate comparison between the IFRS17 standard and the Solvency II regime.

ii. Overview of the Workers' Compensation; presents the conceptual framework of WC LoB, its diversified and complex risk exposures as well as its composition of life and non-life type of liabilities. Practical analysis of the Workers' Compensation Best Estimate under Solvency II will be presented. Note that the focus will be on the Portuguese insurance market.

iii. The concluding chapter would present the Workers' Compensation NSLT type of claims analysis under the IFRS17 standard and its indicators such as the Risk Adjustment using the Addactis IBNRS software Package.

Concerning the practical application, we must say that it is in fact a delimited illustration, in the sense that its purpose is simply to show a way to implement the guidelines provided by the standard, combining the relative ‘degrees of freedom’ that it contains with the need to be as accurate as possible. Moreover, because of the existing constraints on the length of the text, comments on results had to be abbreviated (but these are easily readable) and sensitivity analysis to the assumptions assumed (that would be interesting) has not been performed. Despite these limitations, the application makes proof of the complexity of the procedure, with all its successive steps and calculations, which is our main goal.

2. OVERVIEW OF IFRS17

Precisely, on 18 May 2017, IFRS17 was released for accounting reports concerning insurance contracts. The standard establishes the requirement that a company must apply in reporting information about insurance contracts it issues and reinsurance contracts it holds. IFRS17 will replace IFRS4 issued in 2005, as IFRS4 does not provide specific requirements for most aspects of the accounting for insurance contracts; companies using International Financial Reporting Standards (IFRS) typically have been developing and applying accounting policies for insurance contracts based on local accounting requirements (national GAAP - Generally Accepted Accounting Principles).

IASB's news publication at the beginning of 2017, explains the two main characteristics of the standard. The first one is that it permitted companies to continue their accounting practices. The second one is that it focuses on enhanced disclosure on the amount, timing, and uncertainty of future cash flows from insurance contracts. It was this that led to different accounting practices for insurance contracts. As a result, many companies started using a wide range of accounting practices in reporting, leading to the evolvement of many different accounting models, according to jurisdiction. Under IFRS4, an asset is valued at its fair value. However, this is not the case for the liabilities as they are valued at historical cost. A mismatch is formed resulting from the differences in the valuation methods between assets and liabilities.

The goal of IFRS17 is to solve all these problems and to provide more relevant and comparable information through two big pillars. According to IASB in 2017, the first pillar is about using current estimates and up-to-date information on cash-flows arising from insurance contracts while the second one is about providing more information related to the sources of profit or losses regarding what companies do with the premium from the customers, and also more information relating to the nature of risks arising from insurance contracts.

2.1. Analysis and comparison between IFRS17 and Solvency II

IFRS17 sets out the principles for the recognition, measurement, presentation, and disclosure of insurance contracts within the scope of the standard. The objective is to ensure that an entity provides relevant information that faithfully represents those contracts. This information gives a basis for users of financial statements to assess the effect that insurance contracts have on the entity's financial position, financial performance, and cash flows.

The Solvency II regime was introduced across Europe with the key objective of increasing the level of harmonization of solvency regulation, to establish a sensitive capital requirement in terms of the level of risk assumed by the insurers, ensuring the protection of policyholders and setting a robust prudential framework for insurance firms in Europe.

The introduction of the Solvency II regime was necessary because the Solvency I regime showed structural weaknesses as it was not risk-sensitive and several key risks (e.g. market, credit, and operational risks) were not considered in the capital requirement.

Therefore, the Solvency II framework proposes to remedy these shortcomings with the “three pillars”. Pillar 1 sets out the quantitative requirements (e.g. rules to calculate capital requirement, etc.), Pillar 2 sets out the requirements for risk management and Pillar 3 addresses issues like transparency, reporting, and disclosure to the public.

The key questions being asked by insurance companies are how to leverage the work done for Solvency II and explore the synergy between Solvency II and IFRS17. To do this, companies must have a deep understanding of both the differences and the similarities between the two approaches.

To start, the two approaches have different objectives. Solvency II focuses on enhancing policyholders’ protection while IFRS17 is for the benefit of the investors to increase comparability and transparency of financial statements. Both, however, do place increased emphasis on insurers’ assessment and risk management.

The calculation of the future cash-flows is among the most obvious similarities between IFRS17 and Solvency II, as both use Best Estimate probability-weighted measures. However, there are two key differences between the measurements of future cash-flows. The first is the definition of the contract boundary and the second is related to the expenses that are liable within these future cash-flows. Under IFRS17, expenses have to be directly attributed to a portfolio of contracts, which means that the general overhead inclusion as in Solvency II will no longer be permitted.

Discounting is a familiar concept in Solvency II, however, unlike Solvency II, the discount rate is not prescribed under IFRS17. The underline difference between the two is that IFRS17 has a principled-based approach while Solvency II has a prescriptive approach, where the rate is determined by EIOPA unless Long Term and Transitional measures apply. Under IFRS17, the insurer can apply either the Top-down approach or the Bottom-up approach (see Section 2.3.1 below) to determine the interest rate to use for discounting.

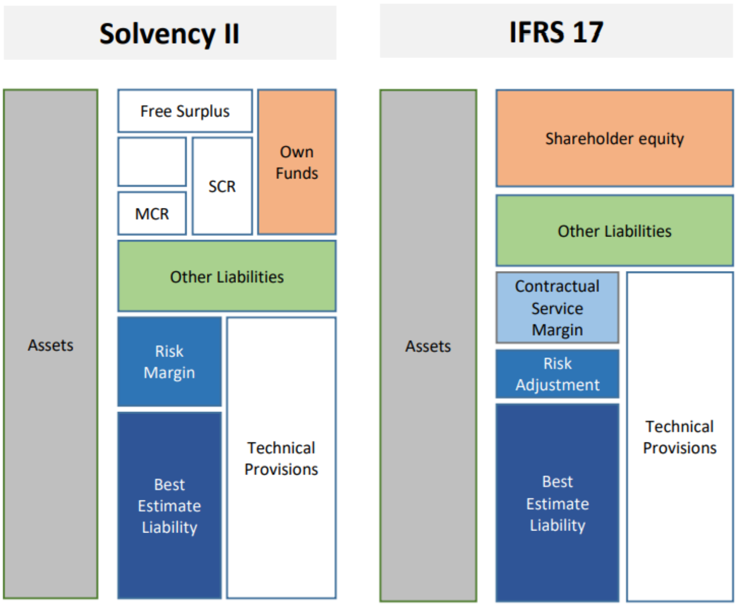
Finally, Risk Adjustment (RA) under Solvency II is determined and fixed in legislation. Whereas in IFRS17, judgment is required both in respect of the estimation technique as well as for the parameters that serve as inputs.

Table 1: Solvency II *vs.* IFRS17

Standards	Solvency II	IFRS17
Scope	European	International
Approach	Prescriptive	Principle-based
Group of contracts	Separating inhomogeneous risk groups	Grouping by issuance year and profitability
Profit	Immediate recognition in own funds	Amortized over the group of contracts' life
Risk Measure	Cost of capital 6% (RM)	Method decided by the company (RA)
Technical provisions	Best Estimate approach	

Source: Addactis Belus (2017) Risk & Insurance Solutions

Figure 1: Solvency II and IFRS17 Balance sheet



Source: Pawel, W., & Agnieszka , H. (2019)

2.2. Fulfilment cashflows and estimates of future cashflows

The fulfilment cash flows of insurance contracts result from the estimates of future cash flows, a discount rate which adjusts them for the time value of money and financial risks, and a Risk Adjustment which adjusts them for non-financial risks [IFRS 17§32-37].

The standard requires that all the future cash flows within the boundary of each contract in the group should be included in the measurement [IFRS 17§33]. Therefore, the future cash flow should be determined from market observations and the unbiased probability-weighted mean of possible outcomes. Specifically:

- To the extent that market observations are available and relevant, the estimate should be consistent with the observations.
- Realistic assumptions that reflect the perspective of the entity should be used when market observations are unavailable or irrelevant.

The estimates of future cash flows shall be current in the sense they should reflect the existing condition as at measurement date, including assumptions at that date about the future. It is expected that an entity reviews estimates to ensure that at each reporting period estimates faithfully represent the conditions at the end of the period.

2.3. Discount rates in IFRS17

The adjustment of the estimates of future cash flows with a discount rate is necessary to reflect the time value of money and other financial risks, such as currency and liquidity risk associated with those cash flows, unless the financial risks have been included in the estimates of cash flows. The discount rate should be determined such that [IFRS 17§36]:

- It reflects the time value of money, the characteristics of the cash flows, and the liquidity characteristics of the insurance contracts.
- it is consistent with observable current market prices (where available).
- Effect of factors influencing observable market prices, but not future cash flows, is excluded.

The discount rate should be blended to reflect the different characteristics of combined cash flows if an entity does not measure the cash flows separately and uses a single discount rate or a yield curve for the contract as a whole. The discount rate applied to those cash flows should be relevant to the characteristics of the cash flows being measured. However, this relies on the characteristics of the cash flows. For example, the time value of money and financial risk of an option is different from the time value of money and financial risk of a fixed cash flow. Cash flows that do not vary based on returns on underlying items should be discounted with a single discount rate with previously prescribed adjustment [IFRS 17 §B84].

However, cash flows that vary based on returns on underlying items should either:

- be discounted with a rate that adjusts for the variability [IFRS 17 §B75]; or
- be adjusted for the variability and discounted with the same rate as other cash flows [IFRS 17 §B77].

2.3.1. Analysis and comparison between Bottom-up & Top-down approaches

The standard gives a choice of two methodologies to set the discount rate: it may be calculated using a Bottom-up approach or a Top-down approach that will be briefly described in the next paragraphs.

The Bottom-up approach uses the risk-free yield to which a liquidity premium is added. The starting point is a liquid risk-free yield curve. The approach is only allowed for cash flows that do not vary based on the return on underlying items.

The Top-down approach uses the yield of a reference portfolio reduced for credit default risk. Under the Top-down approach, volatility is mainly driven by the actual yield of the reference portfolio and, particularly, its spreads over the reference rate. An entity first determines a yield curve reflecting the current market rates of return for a reference portfolio of assets (which could be the assets supporting the liability) and adjusts it for characteristics that are irrelevant for insurance contracts, such as duration mismatches, expected credit losses and the market premiums for credit risks.

2.4. Risk adjustment in IFRS17

The concept of Risk Adjustment in IFRS17 happens to be a predominant factor in determining how profit from insurance is reported and emerges over time. The Risk Adjustment is the compensation an entity requires for the uncertainty in cash flows from insurance contracts. The concept is a forward-looking component and therefore an entity should adjust the present value of the future cash flows to reflect the Risk Adjustment for non-financial risk. The Risk Adjustment for non-financial risk should be measured explicitly. Adjustments for financial risks are included either in the estimates of future cash flows or in the discount rate as seen before.

The Risk Adjustment is part of the fulfilment cash flows under the general model and is therefore relevant whether it is the Building Block approach or the Variable Fee approach. It is also indirectly relevant for the Premium Allocation approach [30]. The Risk Adjustment must reflect the degree of diversification benefit included by the entity when ascertaining the compensation that it requires for bearing risks. For example, the table below describes an insurance contract under a range of scenarios that reflect all possible outcomes. The table summarises information about net cash inflows and the probability of each scenario:

Table 2: RA for non-financial risks

Scenario	Net cash inflows/ (outflows) EUR	Probability	Probability Weighted Result, EUR
1	15,000	84%	12,600
2	20,000	16%	3,200
Total	35,000	100%	15,800

Source: adapted from PwC (2017).

The table gives expected probability-weighted future cashflows of €15,800 for the insurance contract. Two outcomes are possible because of the uncertainty that comes from insurance, lapse, persistency, expense, and other non-financial risks associated with the contract. Compensation is going to be required by the entity for the uncertainty if it has a choice between an insurance contract and a financial instrument (such as a deposit) that pays €15,800 with no uncertainty. The Risk Adjustment represents this compensation for non-financial risks arising from insurance contracts.

The method of calculation is solely the choice of the insurance company as no method is prescribed. It is required that one needs to apply and disclose a confidence level that corresponds to the Risk Adjustment [IFRS 17 §B92]. The confidence level needs to be disclosed to allow a transparent comparison of insurers by users of financial reports.

The following sections will focus on describing three calculation methodologies as well as examples of how they can be implemented. These methods are connected to other widely used reporting metrics or calculations that might already be carried out in an insurance company.

2.4.1. Cost of Capital approach

The Cost of Capital (CoC) approach considers how much capital should be held and charges a cost to that. This approach requires judgment to determine the appropriate capital level in the future and the cost of capital rate.

The CoC is the approach prescribed to calculate the Solvency II Risk Margin. Under Solvency II, the appropriate level of capital is required as the Risk Margin is meant to cover non-Hedgeable risks (usually interpreted as non-financial risks). The confidence level for the required capital is set at the 99.5th percentile. The cost of capital is set at 6%, and the risk-free rate (RFR) is set by EIOPA.

The Risk Adjustment is computed as the discounted value of the future risk capital considered sufficient to hold in respect of non-financial risks and multiplied by the entity's internal cost of capital rate.

Equation (1) below describes how the Risk Adjustment is calculated under the CoC approach:

$$RA = CoC \times \sum_{t} PV\ (RC_t) \qquad (1)$$

where:

PV is the Present Value calculated using the appropriate discount rate

CoC represents the internal cost of capital rate that is above the RFR

RC_t represents the risk capital for non − financial risk at time t

Under the CoC methodology, the discount rate is calculated using the major approaches which were mentioned in previous sections. The choice of discount rate used will depend on the asset selection for the risk capital and therefore should only reflect to a reasonable extent the return expected to be earned by an entity.

2.4.2. VaR approach

This is the value at risk, where we take a probability distribution at a particular confidence level. This approach is inserted in the standard formula for the solvency capital requirement (SCR) calculation under Solvency II. Many firms have also used this approach in their Solvency II internal models [17]. Under the VaR approach, SCR is calculated at a 99.5th percentile VaR on the amount of own funds over a 1-year time horizon.

The VaR approach requires an entity to do a calculation of the discounted value of the Best Estimate future cash flows considering different scenarios to produce a risk distribution. The entity also needs to specify a confidence level that is appropriate for the affected business. Therefore, the RA is equal to the VaR at that confidence level less the discounted value of the Best Estimate future cash flows.

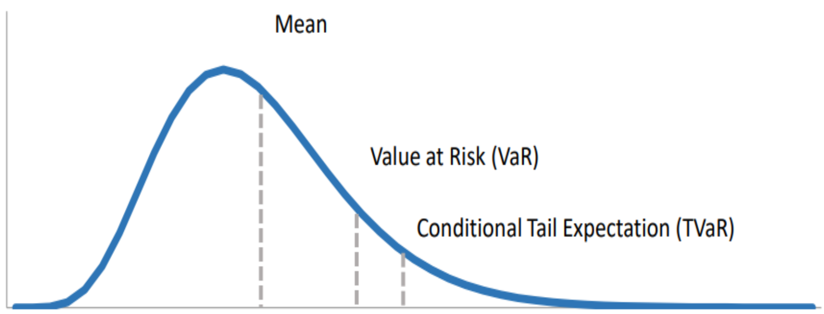
In the Solvency II Standard Formula calculation, a stress test and correlation approach is used, where the stress tests and correlations are calibrated by EIOPA. Under IFRS17, the present value of future cash flows is calculated for each contract group, this would be the Best Estimate part of a VaR calculation.

2.4.3. TVaR approach

By comparison with the VaR approach, the tail VaR approach looks at the average above this confidence level. In other words, the TVaR is calculated with reference to a particular confidence level [28]. This approach is not only used internally by some insurance companies to calculate the Risk Margin under economic capital reporting but is also used under some regulatory jurisdictions.

The below graph illustrates the 99.5% VaR and TVaR on a normal distribution.

Figure 2: TVaR approach *vs.* VaR approach



Source: Pawel, W., & Agnieszka , H. (2019)

2.4.4. Comparison with Risk Margin in Solvency II

Although the Risk Adjustment might seem like the Risk Margin under the directive Solvency II, there are major differences:

Table 3: Comparison between Risk Adjustment and Risk Margin

ITEMS	RISK ADJUSTMENT	RISK MARGIN
Underlying economic principle	Requires for bearing the uncertainty about the amount and timing of the Cash Flows that arises from non-financial risks	Estimated based on the transfer of all insurance liabilities to another insurance undertaking
Methodology	No method specified; however, confidence level associated with the RA must be provided in all cases	Cost of capital method
Parameter setting	Confidence level, risk measurement and methodology to be defined according to the risk aversion of the insurance entity	Cost of capital rate set at 6 % and applied to the net present value of the prospective SCRs underlying calculation. 99.5% confidence level implicit in the calculation of SCRs
Risk horizon	Must cover the duration of liabilities	One-year vision
Risk perimeter	Non-financial risks related to insurance contracts	Underwriting, counterparty, and operational risks (for NL business where Market Risk can be considered negligible)
Granularity	Portfolios x Group of contracts	Lines of business

Source: Addactis Volada Paper (2019)

2.5. Measurement of contracts in IFRS17

IFRS17 is a fundamental accounting change for the insurance sector. It will change insurers and the way their financial stakeholders, such as investors and rating agencies, look at them, because it will provide more clarity in the financial performance and position of insurance companies.

IFRS17 demands that a company must separate the non-insurance component from the insurance component, if a separate contract with the same features would be within the scope of another IFRS standard; the entity shall apply IFRS9 to account for the separated non-insurance component.

An insurance contract may include an investment component. The investment component shall be separated, and the entity shall apply IFRS9 for the separated investment component if and only if the investment component is distinct, thus:

- If the investment component and the insurance component are not highly interrelated; and
- If there is a contract with equivalent terms which is sold, or could be sold, separately on the same market [IFRS17 §11, §B31]. Any cash flows from a

separated component of the host insurance contract shall also be separated, thereafter IFRS17 shall apply to all the remaining components of the host insurance contract [IFRS17 §12, §13].

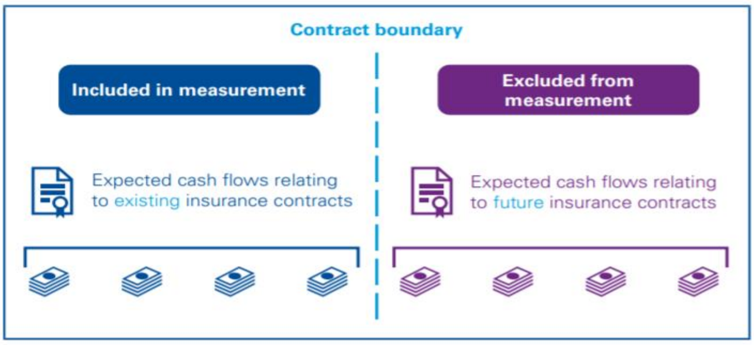
Since an insurance contract may contain one or more components that would be within the scope of another standard, if they were separate contracts, IFRS17 sets out principles on how to separate components of an insurance contract that, if removed, are seen as independent and covered by other accounting standards.

2.5.1. Contract boundaries

The establishment of the contract boundary is crucial in determining the cash flows that should be considered in the measurement of an insurance contract. The contract boundary is that point beyond which both the policyholder and the insurer no longer have substantial rights under the contract and substantial obligation to provide services, respectively. It is the point when the insurer can terminate the contract, refuse premium, stop claims payment or change the premium so it fully reflects the risk at renewal.

Cashflows arising from substantial rights and commitments 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 substantial commitment to provide the policyholder with services are within the contract boundary. Any amounts relating to the expected premiums or expected claims outside the contract boundary shall not be recognised as a liability or as an asset by the insurer/ entity because such amounts relate to future insurance contract (e.g., those outside the boundary of existing insurance contracts).

Figure 3: Contract boundary



Source: KPMG (2020) First Impressions.

From the above diagram, any cash flows relating to a particular policy and beyond the boundary are not recognised in the measurement of liabilities. However, for many products, the contract boundary is the same in SII and IFRS17, however, there are certain cases where some cash flows are beyond IFRS17 and still are measured under SII.

2.5.2. Level of aggregation

Insurance contracts with similar risk are grouped and managed together as a portfolio. The standard requires that these portfolios should be identified [IFRS17 §14]. A portfolio of insurance contracts issued should be divided into a minimum of three groups [IFRS17 §16]:

- group of contracts that are onerous on initial recognition.
- group of contracts with no significant risk of becoming onerous on initial recognition.
- group of contracts that have significant risk of becoming onerous on initial recognition.

Contracts issued more than one year apart in the same group are not allowed to be included [IFRS17 §22].

Therefore, it is a requirement by the standard that insurance contracts should be assessed and divided into portfolios and groups. A portfolio is made up of a group of insurance contracts subject to similar risks and managed together. This simply means that contracts within the same product line are expected to be within the same portfolio.

In some instances, the entity's practical ability to set a different price or level of benefits for policyholders with different characteristics is specifically constraint by law or regulation. If applying the level of aggregation requirements would result in contracts within a portfolio falling into different groups only because of such constraints, then the entity may include those contracts in the same group [24].

A portfolio is further disaggregated into groups of insurance contracts that are, on initial recognition: onerous; profitable, with no significant risk of becoming onerous; and profitable, with significant possibility of becoming onerous (remaining contracts). As a fact, the key feature of the standard is that surpluses are captured in the Contractual Service

Margin (CSM) as future profit, whereas losses are recognized instantly; this separation is vital to accurately release profits and losses. Therefore, one can further subdivide the contracts with respect to profitability or to which extent different contracts are to be onerous under different scenarios [IFRS17 §21]. However, it is not permitted to reassess the composition of a group subsequently [IFRS17 §24]. Hence, an accurate assessment at initial recognition is important.

2.6. IFRS17 measurement models

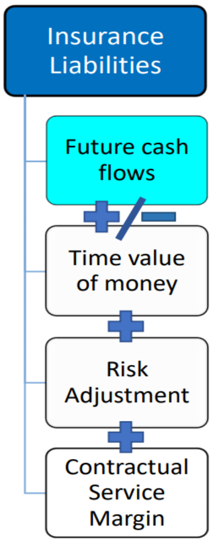
There are three possible measurement models under IFRS17: the General Measurement Model (GMM), the Premium Allocation Approach (PAA), and the Variable Fee Approach (VFA) [24]. For insurance contracts, the default model used for measurement is the GMM. VFA is the modification of GMM as it is used for contracts with direct participation features. The PAA is a simplified measurement model for insurance contracts with short coverage of one year. This report will not examine the VFA as it is a variation of the GMM and follows its principles but is amended to reflect the measurement of investment profit an insurer might earn.

2.6.1. GMM approach

IFRS17 general measurement is a comprehensive accounting procedure where estimates are re-measured in each reporting period. It is a standard measurement approach that can be used for any insurance contract, including reinsurance, that is covered by IFRS17 unless an insurance company chooses to use any of the other variations. The IFRS17 general measurement model relies on the following:

- a current estimate of future cash flows expected to arise during the life of the contract.
- an adjustment to reflect the time value of money and other financial risks such as liquidity and currency risks (discounting) and.
- lastly, an explicit Risk Adjustment for non-financial risks; and a contractual service margin representing the unearned profit from the contract.

Figure 4: General Measurement Model

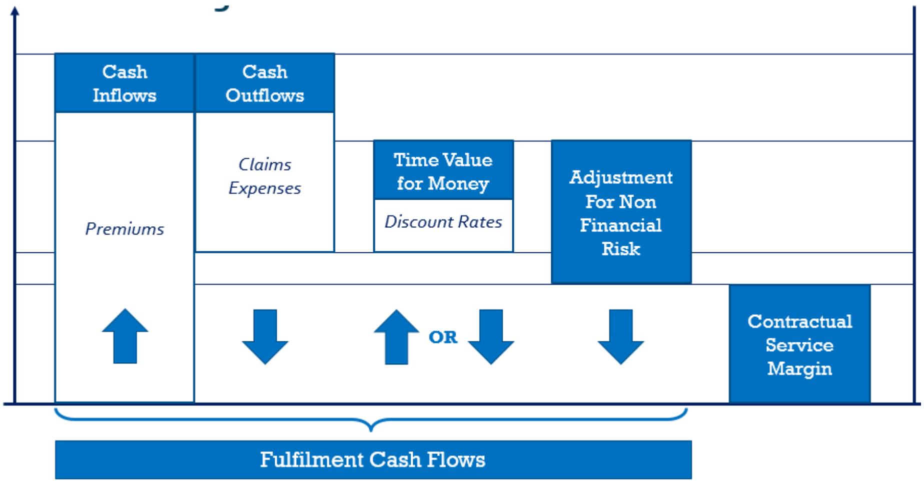


Source: Pawel, W., & Agnieszka , H. (2019).

The CSM represents the unearned profit the entity will recognize as it provides services in the future. Under IFRS17 insurers are not allowed to recognize as profit the gain estimated at initial recognition.

Consequently, at initial recognition, the CSM is established to capture any gain at inception if the group of contracts is non-onerous. Also, loss is recognized in the Profit & Loss account, a loss component is established and the CSM is zero if the group of contracts is onerous. An entity shall measure the group of insurance contracts at the total of fulfilment cash flows (FCF) and CSM at initial recognition.

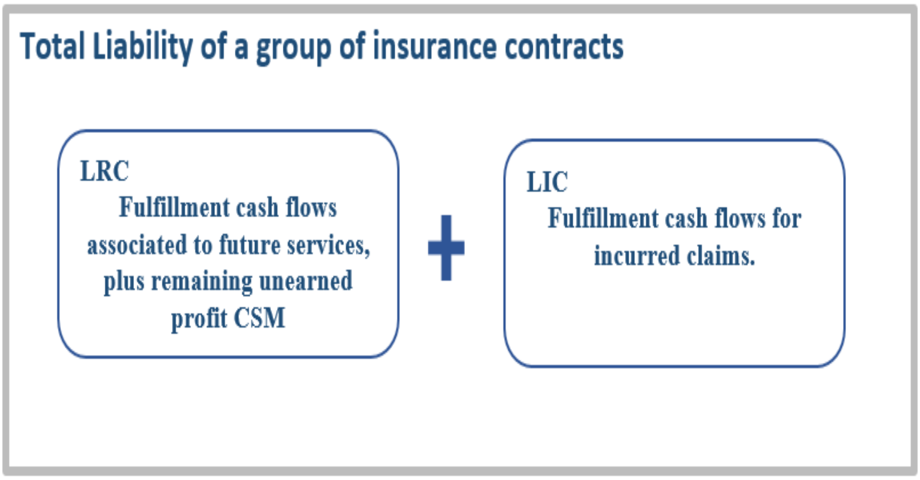
Figure 5: Initial Recognition



Source: Addactis Belus (2017) Risk & Insurance Solutions

Also, the subsequent measurement composed of the total liability of a group of insurance contracts. The composition has been presented by the diagram below; where LRC is liability for remaining coverage and LIC is liability for incurred claims.

Figure 6: Subsequent Measurement – Composition



Source: KPMG (2020) First Impressions.

2.6.2. PAA model

The PAA model is a simplified approach, designed primarily for insurance contracts with a coverage of 12 months or less. It is a simplification of the normal measurement model, optional for measuring liability for remaining coverage. The PAA can be used if at the inception of a group of contracts:

- The entity expects the resulting liability for remaining coverage to be materially in line with the result expected using the GMM approach. The conditions are not met if significant variability in the fulfilment cash flows is expected to occur, in a manner that would affect the measurement of the liability for remaining coverage, during the period before a claim has been incurred.
- The coverage period of each contract in the groups is one year or less.

Under the PAA model, the liability for remaining coverage is approximated; the contractual service margin and Risk Adjustment are not calculated and the liability for incurred claims is computed as in the GMM.

Figure 7: Measurement Models under IFRS17

	General Measurement Model	**Premium Allocation Approach**	**Variable Fee Approach**
Liability for Remaining Coverage	Estimates of Future Cash flows Time Value of Money Risk Adjustment Contractual service Margin	Alike to Unearned Premiums (Time Value of Money)	Estimates of Future Cash flows Time Value of Money Risk Adjustment Contractual service Margin
Liability for Incurred Claims	Estimates of Future Cash flows Time Value of Money Risk Adjustment	Estimates of Future Cash flows Time Value of Money Risk Adjustment	Estimates of Future Cash flows Time Value of Money Risk Adjustment

Source: adapted from Addactis Belus (2017) Risk & Insurance Solutions

The PAA can be applied to direct written and ceded reinsurance for both life and non-life contracts. Although non-life business more often covers shorter terms, life insurers also offer group protection and multi-year contracts for a year or less at a time, on a renewable term basis.

3. WORKERS` COMPENSATION NSLT

The history of Workers' Compensation can be traced to as far back as the late 1800s. Several countries in Europe adopted laws to protect employees from work-related accidents. Germany became the first pioneer country and subsequently became a model for the industrialized world [18].

In Europe, Portugal is one of the countries where Workers' Compensation insurance is made mandatory as it is mainly regulated by (Law 98/2009)[1] to protect beneficiaries with well-detailed benefits and liabilities, contracted by the employer to an insurance company with strict rules to be applied, followed by the Portuguese Insurance Supervisor (ASF). All employers and self-employees are obliged to insure the risk (of all employees) with an insurance company. As far back as 1913, employers in Portugal have the legal obligation to take over the cost resulting from work-related accidents suffered by their employees.

Workers' compensation is characterized as a line of business with one of the highest negative technical results in the Portuguese market [6][2]. However, it is one of the most important lines of business in the Portuguese insurance market given that it is considered a social risk, and it contributed to the evolution of non-life business results [9][3]. Its liabilities' diversity and high loss ratio make it one of the most interesting lines of business to study.

Workers' Compensation provides coverage for two types of contingencies:

- Work-related injuries (entire risk of any accident occurring at the workplace and at working time that causes, directly or indirectly, personal injury, etc.) and
- occupational illnesses.

However, in Portugal WC liabilities are covered by separate distinct entities: work-related injuries are insured by insurance undertakings while on the other hand the

[1] [8] WC is strongly regulated by the law to protect beneficiaries with a fully detailed specification of all benefits and liabilities.

[2] Decomposition of the Technical result of the Work Accidents modality

[3] The 2018 data point to a technical result of around 16 million euros, which represents the restoration of the technical balance of a sport that since 2010 had chronically negative results and since then had accumulated losses of over EUR 560 million.

occupational illnesses are managed by the National Social Security, which is heavily regulated (Law 98/2009).

Basically, WC is designed to provide medical expenses cover for employees during their professional activities and to compensate them for loss of wages - or their dependents if they die or become permanently disabled as a result of work-related accidents. Being a compulsory insurance, it represents a significant part of the health business.

Under Solvency II, the liabilities for WC are of two major types, namely:

- workers compensation insurance managed using non-similar to life techniques (NSLT).
- life-time assistance and annuities originating from non-life insurance contracts and relating to health insurance obligations managed using similar life techniques (SLT).

The characterization of the NSLT and SLT is dependent on the modalities of the benefits arising from them as seen below:

- The medical and surgical, general or specialized, including all elements of diagnosis and treatment as well as home visits, drug and pharmaceutical services, nursing care, rehabilitation services, and professional and social reintegration, including the adaption of the workplace, medical and functional rehabilitation services for working life, psychotherapeutic support where necessary. These claims are uncertain both in terms of timing and frequency of occurrence. Therefore, they are managed using the NSLT techniques.
- Payment arising from life annuities, Compensation for wage loss, disability and death benefits for beneficiaries if the insured person is killed in work-related accident. The amount stemming from these claims is pre-defined and the uncertainty comes from the survival of the individual resulting on a type of obligation that is managed with SLT.

3.1. Best Estimates

Best Estimate should represent the probability-weighted average of all future cash flows that relate to the past, present, and future exposure of existing contractual obligations.

The Best Estimate calculation allows for the uncertainty in the future cash flows, meaning that it accounts for the variability of future cash flows to ensure that the Best Estimate corresponds to the mean of those cash flows. Allowance for uncertainty is without prudence margin. The Best Estimate calculation therefore shall rely upon up-to-date and credible information as well as on realistic assumptions.

Under nonlife insurance obligations, the Best Estimate is composed of Best Estimate in respect of the premium provision and Best Estimate in respect of claim provision. The two estimates should be calculated separately.

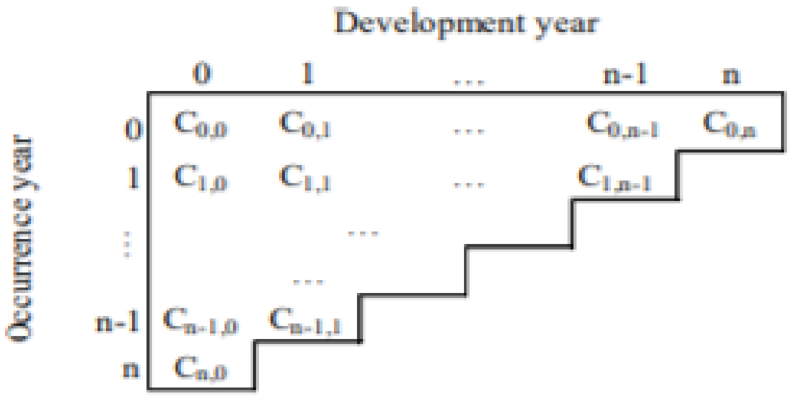
3.2. WC NSLT claims provision

The simplicity of the Chain Ladder method (CLM) makes it the most widely and logical method used in non-life insurance obligations (for example the Workers' compensation NSLT which composes of liabilities relating to medical expenses and temporary compensation of salary) [26].

The chain ladder is built on the assumption that the expectations underlying the columns and the rows in the run-off triangle are proportional, i.e., $i =$ accident year, $j =$ development year. However, it is an intuitive methodology that does not have a probability distribution for the data, calculated using the average of the individual development factors between $j - 1$ and j, with $j = 0,1 \ldots., n,$ n being the number of development years.

The chain ladder is used by creating a common ratio of losses between subsequent development years [26]. An assumption is that subsequent claim years are independent [25]. Some variations on the basic method [16] can also be used to estimate other values such as reserves and current excess reserves, as well as estimating the standard error of these predictions. Quantifying the uncertainty with these different variations in the CLM is a helpful way of evaluating the differences between CLM and other methods [26].

Figure 8: Run off triangle



Source: Author's, based on Internal Addactis Presentation

run-off triangle $C = (C_{ij})_{ij}$: where C_{ij} represents the accumulated claims paid amount as well as allocated loss adjustment expenses after j years, regarding accidents that occurred in year i.

At its fundamental, the chain ladder method operates under the assumption that past claims activities patterns will continue to be seen in the future. For this assumption to hold, there must be accuracy as regards past loss experience data. Various factors can impact accuracy, including changes to the product offerings, regulatory and legal changes, periods of high severity claims, and changes in the claims settlement process. If the assumptions built into the model differ from observed claims, insurers may have to make adjustments to the model.

Creating estimations can be difficult because random fluctuations in claims data and a small data set can result in forecasting errors. To smooth over these problems, insurers combine both company claims data with data from the industry in general.

Age-to-age factors, also called loss development factors represent the ratio of loss amounts from one valuation date to another, and they are intended to encapsulate growth patterns of losses over time. These factors are used to project the point at which ultimate amount of losses will settle.

4. PRACTICAL APPLICATION

This chapter will begin with the description of the different steps necessary in computation of the RA and related formulas (Sections 4.1 – 4.3), followed by a numerical illustration in (Section 4.4).

4.1. Inputs and assumptions

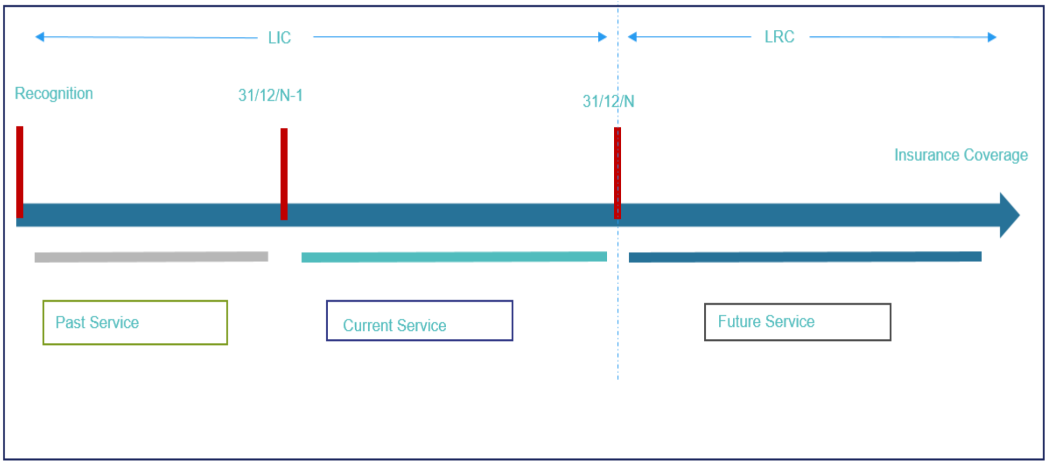
Three measurement models have been defined by IASB to assess future cashflows and Risk Adjustment. For this report, the PAA model is used in addactis® IBNRS®.

The cashflows considered are from the Chain Ladder method in addactis® IBNRS® software. As we are evaluating in PAA, only the Liability for Incurred Claims (LIC) will be considered. The LIC consists of the Paid Claims triangle input which has been analyzed and projected using the CLM in addactis® IBNRS®.

As already seen, IFRS17 requires the split of the contracts at initial recognition into a minimum of three groups of contracts (GoCs), namely: onerous, profitable with no significant risk of becoming onerous, and profitable with significant risk of becoming onerous [3].

For the GoC, an assumption has been made to define the underwriting year. We have assumed that each contract has one year duration which implies that the gap between the underwriting year and the occurrence year/date should not exceed one year. It has also been assumed that the LoB is a profitable business as seen in Table 18 of the Appendix, which contains the definition of the IFRS 17 GoC, SII LoB name and underwriting date. The RA of each origin will be allocated depending on the GoC.

Figure 9: LIC-LRC Definition



Source: Author's, based on Internal Addactis Document (2021)

The cashflows shall be obtained by the PAA model, therefore making it necessary for us to consider only the LIC. The cashflows are directly imported from the CLM. The attention will be on RA and not on the FCF that in this case are analysed only for the LIC, since the assumption of this work is the application of the PAA model.

4.2. Risk Adjustment calculation for Non-financial risk

There are several risk measures available for the calculation of the RA. These risk measures are derived from a probability distribution of the reserves that can be generated using a parametric approach or a simulation-based approach. For this report, the VaR risk measure under the parametric approach will be used, because of its extensive use by insurers even though the TVaR is a more better risk measure as it satisfies all the properties of a good risk measure [5].

- Value at Risk: *Parametric Approach (Calculation of the Aggregated RA)*

$$RA_{Total} = VaR^{\alpha}_{Total} - CF^{hTotal,disc}_{RA\,Total} \qquad (2)$$

$$RA_{LIC} = VaR^{\alpha}_{LIC} - CF^{hTotal,disc}_{RA\,LIC} \qquad (3)$$

where

$$CF^{hTotal,disc}_{RA\,(i,j)Total} = r_j \times CF^{h}_{RA\,(i,j)\,Total}, \qquad (4)$$

r_j representing the selected discount curve

Two practical cases of interest are the normal and lognormal distributions, representing VaR_X^α as the Value at Risk at confidence level $\alpha \in [0,1]$, X as the risk, $\mu = CF_{RA\,X}^{hTotal,disc}$ as the expectation and $\sigma = \sigma_X^{hTotal,disc}$ as the standard deviation. It follows that:

- If the distribution is Normal,

$$\mathrm{VaR}_X^\alpha = \mu + \sigma * \emptyset^{-1}(\alpha) \qquad (5)$$

- If the distribution is Log-Normal,

$$\mathrm{VaR}_X^\alpha = \mu + \sigma * \frac{\varphi\left(\emptyset^{-1}(\alpha)\right)}{1-\alpha} \qquad (6)$$

$\emptyset$ and φ being respectively the cumulative distribution function and the density function of the standard normal law. For this report, we will assume a normal distribution.

4.3. Diversification effect on liability risk and origin period

The RA_{Total} is diversified taking into account correlation and it is reallocated back to each liability components as well as origin period. Each amount calculated is referring to a line *l* which is associated to either a liability selection *L* or origin period *i (accident year)*. The liability selection refers to LIC.

4.3.1. Reallocation

The reallocation of RA will be carried out proportionally using the *RA before aggregation method*. The calculation method depends on the Risk Adjustment method selected for the calculation of RA_{Total} / global risk. The goal is to calculate and allocate the RA depending on the accident period. We calculate by liability selection/ origin period using the distribution law, as well as the $CF_{RA\,i,L}^{hTotal,disc}$ and $\sigma_{i,L}^{hTotal,disc}$, in the same way we calculate the total Risk Adjustment. Below equation helps us to obtain the RA before aggregation by lower level/origin/accident period:

$$RA_{Bef\_Agg} = VaR_{i,L}^\alpha - CF_{RA\,i,L}^{hTotal,disc} \qquad (7)$$

with RA_{Bef_Agg} Representing RA before aggregation depending on the accident period.

where $VaR_{i,L}^\alpha$ the Value at Risk at confidence level $\alpha \in [0,1]$ of a distribution of expectancy $\mu = CF_{RA\,i,L}^{hTotal,disc}$ and standard deviation $\sigma = \sigma_{i,L}^{hTotal,disc}$.

4.3.2. Allocation Percentage

An allocated percentage will be calculated for each line to compute the diversified Risk Adjustment. This will be dependent on the RA before aggregation. We calculate the allocated percentage with the below formula:

$$Allocated\ \ Percentage_l = \frac{Key_{L,i}}{\sum_k Key_{L,k}} \qquad (8)$$

- $Key_{L,i}$: The reallocation key corresponding to a liability selection L / origin period *i*. It represents the RA before aggregation at each origin period.
- $Key_{L,k}$: Presents the sum of RA before aggregation in all origin period

4.3.3. Allocated Diversified RA

The diversified Risk Adjustment is calculated depending on the global RA and allocated percentage by period of the RA before aggregation. The diversified RA is presented below:

$$RA_L^{div} = \ RA_{Total}\ *\ Allocated\ Percentage_l \qquad (9)$$

The above eq. (9) presents the allocation of the global RA to the different origin period depending on the allocated percentage calculated using eq. (8).

4.3.4. Risk Adjustment Percentage

$$RA\ (\%) = \frac{RA\ diversified_l}{BE\ (0)} \qquad (10)$$

where $RA\ (\%)$ is the total RA percentage total and $BE\ (0)$ represents the best estimate at time 0.

$$RA\ (\%)_l = \frac{RA\ diversified_l}{Av\ PV.Future\ CFs_l} \qquad (11)$$

with $RA\ (\%)_l$ representing the RA percentage at different origin period

4.4. Allocation of Risk Adjustment back to each GoC

The previous sections have shown us the RA risk measure method to be used in the report analysis. In this section, we use allocation matrices to allocate RA amounts to each GoC. We shall define an allocation matrix whose coefficients correspond to an allocation percentage. For the matrix, the amounts from the origin period *i* will be allocated to the GoC g with a percentage $Alloc_{g,i}^{m}$.

The allocation matrix will be defined from the paid cash flows amounts, $\mathrm{Amount}_{\mathrm{g,i}}^{\mathrm{paid}}$. The allocation matrix will help us to further allocate the RA by GoC in a matrix table as well. We can define the allocation matrix using the below formula:

$$Alloc_{g,i}^{m} = \begin{cases} \dfrac{Amount_{g,i}}{\sum_{g'} Amount_{g',i}} & if \ \sum_{g'} Amount_{g',i} \neq 0 \\ 0 \ else. \end{cases} \qquad (12)$$

$$RA_{g,LIC}^{Allocated} = Alloc_{g,i}^{RA,m} * RA_{i,LIC}^{div} \qquad (13)$$

$$RA_{g,LRC}^{Allocated} = Alloc_{g,i}^{RA,m} \times RA_{i,LRC}^{div} \ : NB: This\ is\ not\ considered. \qquad (14)$$

$$RA_{g,Total}^{Allocated} = RA_{g,LIC}^{Allocated} + RA_{g,LRC}^{Allocated} \qquad (15)$$

Where:

$Alloc_{g,i}^{m}$ represents Coefficient of allocation ($Alloc^{m}$) from origin period i to group of contracts g

$Alloc_{g,i}^{RA,m}$ represents Coefficient of allocation ($Alloc^{RA,m}$) from origin period i to GoC g

$RA_{g,Total}^{Allocated}$, $RA_{g,LIC}^{Allocated}$ and $RA_{g,LRC}^{Allocated}$ Represents the RA allocated to group of contracts g

4.4.1. RA Allocated percentage to GoC

After the determination of the allocation matrix that provides the relationship between each accident period and each GoC, we then calculate the allocated percentage to be used to distribute the global RA to the different GoCs. The below formula presents the allocated percentage by GoC:

$$Allocated\ \%\ by\ GoC^{RA} = \frac{RA_{g,Total}^{Allocated,m}}{Global\ RA^{div}} \qquad (16)$$

We can then, based on equation (16), allocate the RA into the different GoCs with the below formula:

$$RA_{g,LIC}^{Allocated} = Allocated\ \%\ by\ GoC^{RA} \times RA_{i,LIC}^{div}. \qquad (17)$$

4.5. *IBNRS IFRS17: Analysis and Results for WC NSLT LoB*

Next, we want to do a practical application using claims paid data information processed on addactis® Dataflow® software package to generate the Paid Triangle in addactis® IBNRS® software package using the CLM. The following table will present the generated claims paid triangle for the WCNSLT LoB:

Table 4: CL Cumulative / Paid

	1	2	3	4	5	6	7	8	9
01/2011	9 212 910,10	13 741 162,70	14 614 266,10	14 991 411,70	15 034 854,95	15 335 377,80	15 520 585,25	15 271 281,85	15 294 168,40
01/2012	4 265 711,25	5 986 780,30	6 372 059,50	6 448 369,60	6 540 378,80	6 523 850,25	6 578 287,60	6 698 318,45	
01/2013	4 696 095,75	7 642 240,70	8 151 500,85	8 306 973,85	8 486 444,10	8 608 858,95	8 696 228,40		
01/2014	4 341 732,70	6 474 510,35	6 867 389,70	7 056 344,75	7 080 231,15	7 029 154,00			
01/2015	7 381 830,25	13 609 313,90	15 334 403,15	15 784 977,15	16 074 642,25				
01/2016	11 546 339,85	20 328 992,50	21 371 583,75	21 697 505,20					
01/2017	18 502 930,70	27 376 084,85	28 545 577,90						
01/2018	16 495 124,35	26 399 207,75							
01/2019	18 774 513,10								

Source: Author's Calculation.

As we are considering the LIC, the chain ladder claims paid will be used as our past coverage calculation method in the IFRS17 RA calculation. Also, as earlier mentioned in the previous chapters, PAA measurement model will be considered in this practical section

Table 5: Aggregated RA

Risk measure	Parameter	AV. PV of future CF	Risk adjustment	Risk adjustment (%)	Fulfillment Cash Flows
Value-At-Risk	**0,75**	**20 019 577,42**	**2 551 362,23**	**0,13**	**22 570 939,65**

Source: Author's Calculation.

The above Table 5 presents the aggregated RA result. The risk measure used is VaR at 75% confidence level and $\sigma = 3.782.655{,}30€$. The Risk Adjustment (%) is 13% calculated as the proportion of the RA in average PV of future cashflows. The aggregated RA is 2.551.362,23€.

Table 6: Selected Parameter Summary

Origin	01/2011	01/2012	01/2013	01/2014	01/2015	01/2016	01/2017	01/2018	01/2019	Total
Av. PV of future CF	-	10 038,54	- 37 914,13	44 469,09	256 451,27	609 598,50	1 437 445,67	3 106 180,79	14 593 307,68	20 019 577,42
Standard error	-	18 083,04	257 995,81	227 715,46	441 648,35	575 326,20	735 333,83	978 798,34	2 582 388,04	3 782 655,30
Standard error (%)	-	1,80	6,80	5,12	1,72	0,94	0,51	0,32	0,18	0,19

Source: Author's Calculation.

The above table is required to compute the RA before aggregation using eqs (5) & (7). Both the average PV of future Cashflows and standard error are required or necessary in the computation. Table 6 presents the following concepts:

- Av. PV of future CF: is the average present value of future cashflows. It is calculated by applying the discount curve on undiscounted future cashflows
- Standard error: The standard deviations by origin period are computed with the Mack's uncertainty assessment methodology. Please see Mack (1993) [26] to understand the Mack's uncertainty assessment methodology.

Table 7: RA Reallocation to lower level

IFRS 17					
Level	Av. PV of Future CF	RA before aggregation	Allocated percentage	RA diversified	Risk Adjustment (%)
01/2011	-	-	-	-	
01/2012	10 038,54	12 196,82	0,003108	7 930,91	0,79
01/2013	- 37 914,13	174 015,53	0,044350	113 152,49	- 2,98
01/2014	44 469,09	153 591,74	0,039145	99 872,05	2,25
01/2015	256 451,27	297 887,29	0,075920	193 699,32	0,76
01/2016	609 598,50	388 051,62	0,098899	252 328,11	0,41
01/2017	1 437 445,67	495 975,13	0,126405	322 504,68	0,22
01/2018	3 106 180,79	660 189,45	0,168257	429 284,00	0,14
01/2019	14 593 307,68	1 741 794,27	0,443916	1 132 590,67	0,08

Source: Author's Calculation.

Table 7 represents the reallocation of RA to the origin/occurrence period (accident year). The following concepts are explained:

- The RA before aggregation: It is computed as the based level of the calculation of the RA using equation (7). This has been calculated not considering correlation. The RA before aggregation is aggregated to obtain the global RA using a correlation matrix.
- Allocated percentage: It is obtained using equation (8). It is the proportion of the RA before aggregation (depending on the accident period) in the total RA before aggregation.
- RA diversified: it is obtained by applying the allocated percentage on the global/ total RA (refer to equation (9)).
- Risk Adjustment (%): Obtained using equation (11). It is RA diversified divided by the average present value of future cashflows. The method of reallocation used here is called the Proportional – RA before aggregation [1].

For this report, we have defined the GoC according to what is acceptable by [IFRS17 §14]. Referring to Table 18 of the Appendix, GoC is defined as LoB, underwriting year (depending on the assumption earlier stated in this report) and assumption that the LoB is profitable.

Table 8: Paid CFs to date by GoC

Origin period	01/2011	01/2012	01/2013	01/2014	01/2015	01/2016	01/2017	01/2018	01/2019
Workers' compensation insurance_2010_Profitable	7 403 531,95	-	-	-	-	-	-	-	-
Workers' compensation insurance_2011_Profitable	7 890 636,45	3 469 503,70	-	-	-	-	-	-	-
Workers' compensation insurance_2012_Profitable		3 228 814,75	4 126 703,05	-	-	-	-	-	-
Workers' compensation insurance_2013_Profitable			4 569 525,35	3 095 539,90	-	-	-	-	-
Workers' compensation insurance_2014_Profitable				3 933 614,10	5 600 194,25	-	-	-	-
Workers' compensation insurance_2015_Profitable					10 474 448,00	9 987 371,45	-	-	-
Workers' compensation insurance_2016_Profitable						11 710 133,75	13 341 282,50	-	-
Workers' compensation insurance_2017_Profitable							15 204 295,40	11 957 461,25	-
Workers' compensation insurance_2018_Profitable								14 441 746,50	10 240 895,40
Workers' compensation insurance_2019_Profitable									8 533 617,70

Source: Author's Calculation.

The values in the above matrix Table 8 represent the last diagonal of the paid CFs. The last diagonal CFs in each origin period are distributed/allocated to respective GoCs.

Table 9: Amount Allocation Matrix (%)

Origin period	01/2011	01/2012	01/2013	01/2014	01/2015	01/2016	01/2017	01/2018	01/2019
Workers' compensation insurance_2010_Profitable	0,48	-	-	-	-	-	-	-	-
Workers' compensation insurance_2011_Profitable	0,52	0,52	-	-	-	-	-	-	-
Workers' compensation insurance_2012_Profitable		0,48	0,47	-	-	-	-	-	-
Workers' compensation insurance_2013_Profitable			0,53	0,44	-	-	-	-	-
Workers' compensation insurance_2014_Profitable				0,56	0,35	-	-	-	-
Workers' compensation insurance_2015_Profitable					0,65	0,46	-	-	-
Workers' compensation insurance_2016_Profitable						0,54	0,47	-	-
Workers' compensation insurance_2017_Profitable							0,53	0,45	-
Workers' compensation insurance_2018_Profitable								0,55	0,55
Workers' compensation insurance_2019_Profitable									0,45

Source: Author’s Calculation.

Table 9 computed depending on Table 8. The amount percentages are obtained using equation (12). It is the percentage of the last diagonal CFs belonging to the GoCs. For example, 48% represents the percentage of paid CFs in 2011 origin period that belong to GoC 2010 while 52% belongs to GoC 2011. The amount allocation matrix will be used to allocate and build RA matrix by GoC.

Table 10: RA Allocation Matrix by GoC

Origin period	01/2011	01/2012	01/2013	01/2014	01/2015	01/2016	01/2017	01/2018	01/2019
Workers' compensation insurance_2010_Profitable	-	-	-	-	-	-	-	-	-
Workers' compensation insurance_2011_Profitable	-	4 107,94	-	-	-	-	-	-	-
Workers' compensation insurance_2012_Profitable	-	3 822,96	53 695,32	-	-	-	-	-	-
Workers' compensation insurance_2013_Profitable	-	-	59 457,18	43 982,24	-	-	-	-	-
Workers' compensation insurance_2014_Profitable	-	-	-	55 889,82	67 482,30	-	-	-	-
Workers' compensation insurance_2015_Profitable	-	-	-	-	126 217,02	116 146,74	-	-	-
Workers' compensation insurance_2016_Profitable	-	-	-	-	-	136 181,36	150 728,29	-	-
Workers' compensation insurance_2017_Profitable	-	-	-	-	-	-	171 776,39	194 443,21	-
Workers' compensation insurance_2018_Profitable	-	-	-	-	-	-	-	234 840,79	617 791,92
Workers' compensation insurance_2019_Profitable	-	-	-	-	-	-	-	-	514 798,74

Source: Author’s Calculation.

Above table presents the RA allocation matrix by GoC. This has been computed by applying the amount allocation matrix percentage in table 9 to the RA diversified. Note that this has been obtained with equation (13).

Table 11: RA by GoC

Level	Av. PV of Future CF	Allocated percentage	Risk Adjustment	Fulfillment Cash Flows
Workers' compensation insurance_2010_Profitable	-	-	-	-
Workers' compensation insurance_2011_Profitable	5 199,63	0,00	4 107,94	9 307,57
Workers' compensation insurance_2012_Profitable	- 13 152,83	0,02	57 518,28	44 365,45
Workers' compensation insurance_2013_Profitable	- 338,82	0,04	103 439,42	103 100,59
Workers' compensation insurance_2014_Profitable	114 229,79	0,05	123 372,11	237 601,90
Workers' compensation insurance_2015_Profitable	447 705,48	0,09	242 363,76	690 069,24
Workers' compensation insurance_2016_Profitable	1 000 815,78	0,11	286 909,65	1 287 725,44
Workers' compensation insurance_2017_Profitable	2 172 567,46	0,14	366 219,61	2 538 787,07
Workers' compensation insurance_2018_Profitable	9 659 425,05	0,33	852 632,71	10 512 057,76
Workers' compensation insurance_2019_Profitable	6 633 125,88	0,20	514 798,74	7 147 924,62

Source: Author's Calculation.

The above table presents the RA by GoC. As seen in the table, the RA is highest for the GoC "Workers's compensation insurance_2018_Profitable" whereas it is lowest for the GoC "Workers's compensation insurance_2011_Profitable". The reason for both behaviour is that the oldest claims are in their latest moment of their lives, therefore they have less variability in the estimate as they are next to being closed while the earliest claims have more variability in the estimate as they still have longer development period.

Table 12 below presents the result for RA by GoC and LIC. The third column shows the RA allocated to each GoCs and liability components.

Table 12: RA by GoC & LIC

Level	Av. PV of Future CF	Allocated percentage	Risk Adjustment	Fulfillment Cash Flows
Workers' compensation insurance_2010_Profitable	-	-	-	-
Past coverage (Related to incurred events)	-	-	-	-
Remaining coverage (Related to future events)	-	-	-	-
Workers' compensation insurance_2011_Profitable	5 199,63	0,00	4 107,94	9 307,57
Past coverage (Related to incurred events)	5 199,63	1,00	4 107,94	9 307,57
Remaining coverage (Related to future events)	-	-	-	-
Workers' compensation insurance_2012_Profitable	- 13 152,83	0,02	57 518,28	44 365,45
Past coverage (Related to incurred events)	- 13 152,83	1,00	57 518,28	44 365,45
Remaining coverage (Related to future events)	-	-	-	-
Workers' compensation insurance_2013_Profitable	- 338,82	0,04	103 439,42	103 100,59
Past coverage (Related to incurred events)	- 338,82	1,00	103 439,42	103 100,59
Remaining coverage (Related to future events)	-	-	-	-
Workers' compensation insurance_2014_Profitable	114 229,79	0,05	123 372,11	237 601,90
Past coverage (Related to incurred events)	114 229,79	1,00	123 372,11	237 601,90
Remaining coverage (Related to future events)	-	-	-	-
Workers' compensation insurance_2015_Profitable	447 705,48	0,09	242 363,76	690 069,24
Past coverage (Related to incurred events)	447 705,48	1,00	242 363,76	690 069,24
Remaining coverage (Related to future events)	-	-	-	-
Workers' compensation insurance_2016_Profitable	1 000 815,78	0,11	286 909,65	1 287 725,44
Past coverage (Related to incurred events)	1 000 815,78	1,00	286 909,65	1 287 725,44
Remaining coverage (Related to future events)	-	-	-	-
Workers' compensation insurance_2017_Profitable	2 172 567,46	0,14	366 219,61	2 538 787,07
Past coverage (Related to incurred events)	2 172 567,46	1,00	366 219,61	2 538 787,07
Remaining coverage (Related to future events)	-	-	-	-
Workers' compensation insurance_2018_Profitable	9 659 425,05	0,33	852 632,71	10 512 057,76
Past coverage (Related to incurred events)	9 659 425,05	1,00	852 632,71	10 512 057,76
Remaining coverage (Related to future events)	-	-	-	-
Workers' compensation insurance_2019_Profitable	6 633 125,88	0,20	514 798,74	7 147 924,62
Past coverage (Related to incurred events)	6 633 125,88	1,00	514 798,74	7 147 924,62
Remaining coverage (Related to future events)	-	-	-	-

Source: Author's Calculation.

5. CONCLUSION

This research has presented the importance of IFRS17 and the implementation of the WC NSLT under the standard with particular attention on the RA. As the WC is a principal LoB not because of its mandatory nature but because it constitutes a larger share of the insurance business in Portugal [9], we have decided to analyse how this LoB is being modelled under IFRS17 and its potential complexity.

The report has shown the three-measurement used depending on some characteristics of the individual LoB. We have used in our analysis the PAA measurement model. This is because the PAA for the RA, unlike the other two measurement models, considers only the LIC, i.e., incurred claims or expired risks. Furthermore, the insurance liabilities composition has been presented to include the future cashflows, time value of money, and the RA.

Another important point that can be seen in this research, is the importance of the estimated/calculated RA on the financial performance of the insurance companies. The IFRS17' RA is principle based as against the RM in SII. This makes it an essential component of the standard that may be used to steer the financial results of an insurance business. The RA, as a quantity covering the uncertainties linked with insurance risks, must also mirror the diversification benefits.

Despite the conceptual proximity of the concepts of IFRS17 RA and the Solvency II RM, there are still many nuances in the assessment of their parameters. The additional granularity being provided by the RA makes it more unique as compared with the RM. The RA can be measured as well as allocated to different GoC. Also, it should be noted that the RA allows for different discount rates to be used, unlike the RM, that only uses a fixed discount rate published by EIOPA.

It is pertinent to note that there are other parametric and non-parametric methodologies and different Risk Measures to be used. We used in our analysis the VaR approach but nonetheless other approaches like TVaR and or Standard Deviation are available in the software to obtain the final aggregated RA. An illustration of the procedures has also made clear the complexity inherent in the implementation of the work in this lob.

The development of this report has been made possible thanks to several readings of articles and online books as well as discussion with IFRS 17 team and qualified individuals within the company. Not to mention that the development of our model is still being updated, and we frequently stop and think about how we can improve it, through the feedback from our clients.

To conclude, future developments of this topic include improvement regarding the calculation. New methodologies would emerge on how we compute the RA and there will be more integration in the system of the company. Another future development will be improvement in the business of the company with respect to how we manage business and products. There will be more impact and need for actuaries to do more accurate calculation because it will reflect in accounting. Efficient work on the reserving part is expected as it will influence the pricing part, and this will help insurance companies avoid onerous business. This will result into transparency in the pricing.

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APPENDIX A – CHAIN LADDER METHODOLOGY

Table 13: Standard Errors

	2/1	3/2	4/3	5/4	6/5	7/6	8/7	9/8
Average on history selection	0,054	0,010	0,003	0,004	0,007	0,001	0,017	0,002
Average s.e.	0,054	0,010	0,003	0,004	0,007	0,001	0,017	0,002
Weighted average on history selection s.e.	0,050	0,011	0,003	0,004	0,007	0,001	0,016	0,001
Weighted average s.e.	0,050	0,011	0,003	0,004	0,007	0,001	0,016	0,001
Weighted average last diagonal excluded s.e.	0,061	0,012	0,003	0,005	0,006	0,002	0,000	NAN
Weighted average min and max excluded s.e.	0,046	0,003	0,003	0,004	0,008	0,008	NAN	NAN
User-defined standard errors	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Suggested standard errors	0,050	0,011	0,003	0,004	0,007	0,001	0,016	0,001
Selected standard errors	0,050	0,011	0,003	0,004	0,007	0,001	0,016	0,001

Source: Author's Calculation.

Table 14: Completed Triangle

	1	2	3	4	5	6	7	8	9	10
01/2011	9 212 910	13 741 163	14 614 266	14 991 412	15 034 855	15 335 378	15 520 585	15 271 282	15 294 168	15 294 168
01/2012	4 265 711	5 986 780	6 372 060	6 448 370	6 540 379	6 523 850	6 578 288	6 698 318	6 708 357	6 708 357
01/2013	4 696 096	7 642 241	8 151 501	8 306 974	8 486 444	8 608 859	8 696 228	8 645 358	8 658 314	8 658 314
01/2014	4 341 733	6 474 510	6 867 390	7 056 345	7 080 231	7 029 154	7 104 598	7 063 038	7 073 623	7 073 623
01/2015	7 381 830	13 609 314	15 334 403	15 784 977	16 074 642	16 228 426	16 402 606	16 306 655	16 331 094	16 331 094
01/2016	11 546 340	20 328 992	21 371 584	21 697 505	21 956 810	22 166 868	22 404 785	22 273 723	22 307 104	22 307 104
01/2017	18 502 931	27 376 085	28 545 578	29 163 661	29 512 193	29 794 532	30 114 317	29 938 156	29 983 024	29 983 024
01/2018	16 495 124	26 399 208	28 090 842	28 699 079	29 042 058	29 319 900	29 634 590	29 461 236	29 505 389	29 505 389
01/2019	18 774 513	29 855 022	31 768 101	32 455 960	32 843 838	33 158 050	33 513 936	33 317 888	33 367 821	33 367 821

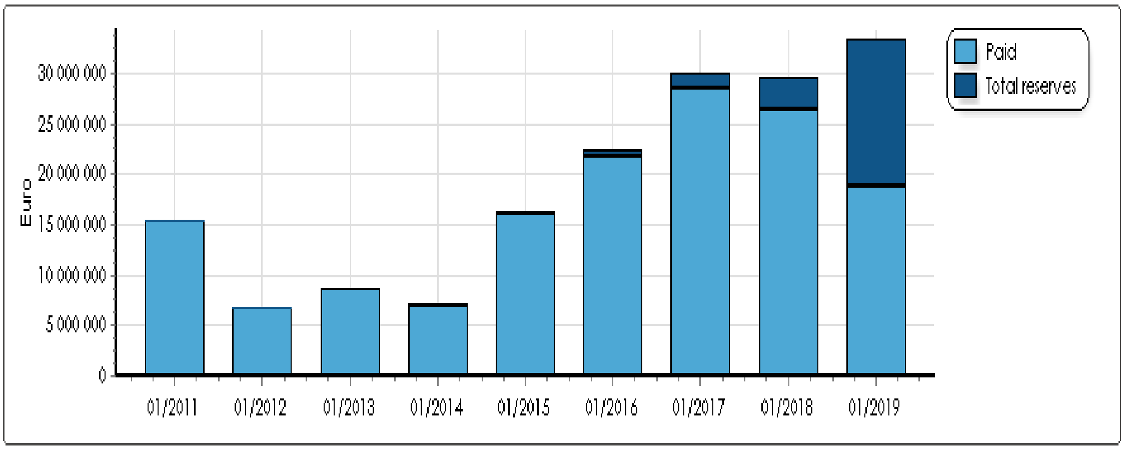
Source: Author's Calculation.

Table 15: Reserves Results

	01/2011	01/2012	01/2013	01/2014	01/2015	01/2016	01/2017	01/2018	01/2019	Total
Paid	15 294 168,40	6 698 318,45	8 696 228,40	7 029 154,00	16 074 642,25	21 697 505,20	28 545 577,90	26 399 207,75	18 774 513,10	149 209 315,45
Ultimate projected	15 294 168,40	6 708 356,99	8 658 314,27	7 073 623,09	16 331 093,52	22 307 103,70	29 983 023,57	29 505 388,54	33 367 820,78	169 228 892,87
Total reserves	-	10 038,54	- 37 914,13	44 469,09	256 451,27	609 598,50	1 437 445,67	3 106 180,79	14 593 307,68	20 019 577,42
Reserves standard error	-	18 083,04	257 995,81	227 715,46	441 648,35	575 326,20	735 333,83	978 798,34	2 582 388,04	3 782 655,30
Reserves standard error	-	1,80	6,80	5,12	1,72	0,94	0,51	0,32	0,18	0,19
Reserves one year standard error	NAN	18 083,04	257 202,30	61 992,72	237 020,75	258 998,79	322 457,86	713 542,98	2 378 493,04	2 964 515,29
Reserves one year standard error	NAN	1,80	6,78	1,39	0,92	0,42	0,22	0,23	0,16	0,15

Source: Author’s Calculation.

Figure 10: Graph Paid Vs. Reserve



Source: Author’s Calculation.

APPENDIX B – IFRS 17 GoC REALLOCATION

Table 16: FCF Discounted Aggregated Results

	01/2020	01/2021	01/2022	01/2023	01/2024	01/2025	01/2026	01/2027	01/2028	Total
01/2011	0,000									0,000
01/2012	10 038,542	0,000								10 038,542
01/2013	-50 870,632	12 956,503	0,000							-37 914,128
01/2014	75 443,973	-41 560,015	10 585,134	0,000						44 469,092
01/2015	153 784,093	174 179,845	-95 950,900	24 438,229	0,000					256 451,267
01/2016	259 304,447	210 058,053	237 917,189	-131 062,054	33 380,870	0,000				609 598,504
01/2017	618 083,077	348 531,635	282 339,457	319 784,979	-176 160,774	44 867,295	0,000			1 437 445,669
01/2018	1 691 633,897	608 236,901	342 979,463	277 841,738	314 690,746	-173 354,501	44 152,551	0,000		3 106 180,794
01/2019	11 080 509,200	1 913 078,914	687 858,757	387 877,531	314 212,887	355 885,651	-196 047,645	49 932,385	0,000	14 593 307,681
Total	13 837 926,595	3 225 481,836	1 465 729,102	878 880,423	486 123,729	227 398,445	-151 895,094	49 932,385	0,000	20 019 577,420

Source: Author's Calculation.

Table 17: FCF Discounted Results by GoC

	01/2020	01/2021	01/2022	01/2023	01/2024	01/2025	01/2026	01/2027	01/2028	Total
Workers' compensation insurance_2010_Profitable	-	-	-	-	-	-	-	-	-	-
Workers' compensation insurance_2011_Profitable	5 199,63	-	-	-	-	-	-	-	-	5 199,63
Workers' compensation insurance_2012_Profitable	- 19 301,20	6 148,37	-	-	-	-	-	-	-	- 13 152,83
Workers' compensation insurance_2013_Profitable	6 493,95	- 11 494,31	4 661,54	-	-	-	-	-	-	- 338,82
Workers' compensation insurance_2014_Profitable	95 795,87	37 424,40	- 27 504,44	8 513,96	-	-	-	-	-	114 229,79
Workers' compensation insurance_2015_Profitable	219 565,69	210 187,69	46 990,52	- 44 403,65	15 365,23	-	-	-	-	447 705,48
Workers' compensation insurance_2016_Profitable	428 818,59	276 260,68	260 360,16	78 723,05	- 64 316,22	20 969,53	-	-	-	1 000 815,78
Workers' compensation insurance_2017_Profitable	1 095 432,72	461 138,71	305 734,87	296 175,58	48 709,55	- 54 622,76	19 998,80	-	-	2 172 567,46
Workers' compensation insurance_2018_Profitable	6 969 474,93	1 376 260,63	562 832,61	363 568,72	343 545,35	99 290,25	- 82 783,96	27 236,52	-	9 659 425,05
Workers' compensation insurance_2019_Profitable	5 036 446,43	869 555,66	312 653,84	176 302,76	142 819,82	161 761,43	- 89 109,94	22 695,87	-	6 633 125,88
Total	13 837 926,60	3 225 481,84	1 465 729,10	878 880,42	486 123,73	227 398,45	- 151 895,09	49 932,38	-	20 019 577,42

Source: Author's Calculation.

Table 18: GoC Definition

SII_LoB Name	Triangles segmentation	GoC	Min_Underwriting_Year
Workers' compensation insurance	Acidentes de Trabalho	Workers' compensation insurance_2010_Profitable	01/02/2010
Workers' compensation insurance	Acidentes de Trabalho	Workers' compensation insurance_2011_Profitable	01/01/2011
Workers' compensation insurance	Acidentes de Trabalho	Workers' compensation insurance_2012_Profitable	01/01/2012
Workers' compensation insurance	Acidentes de Trabalho	Workers' compensation insurance_2013_Profitable	01/01/2013
Workers' compensation insurance	Acidentes de Trabalho	Workers' compensation insurance_2014_Profitable	01/01/2014
Workers' compensation insurance	Acidentes de Trabalho	Workers' compensation insurance_2015_Profitable	01/01/2015
Workers' compensation insurance	Acidentes de Trabalho	Workers' compensation insurance_2016_Profitable	01/01/2016
Workers' compensation insurance	Acidentes de Trabalho	Workers' compensation insurance_2017_Profitable	01/01/2017
Workers' compensation insurance	Acidentes de Trabalho	Workers' compensation insurance_2018_Profitable	01/01/2018
Workers' compensation insurance	Acidentes de Trabalho	Workers' compensation insurance_2019_Profitable	01/01/2019

Source: Author's Calculation.

APPENDIX C – IFRS 17 GROSS NOTATIONS

GROSS AMOUNTS	Undiscounted Amounts	Discounted Amounts
Gross cash flows at node h, at origin period i, calendar period j	$CF^{h}_{(i,j),LFIC}$ $CF^{h}_{(i,j),LFRC}$ $CF^{h}_{(i,j),Total}$	$CF^{h,disc}_{(i,j),LFIC}$ $CF^{h,disc}_{(i,j),LFRC}$ $CF^{h,disc}_{(i,j),Total}$
Gross total cash flows at node h, at origin period i	$CF^{h}_{(i,\bullet),LFIC}$ $CF^{h}_{(i,\bullet),LFRC}$ $CF^{h}_{(i,\bullet),Total}$	$CF^{h,disc}_{(i,\bullet),LFIC}$ $CF^{h,disc}_{(i,\bullet),LFRC}$ $CF^{h,disc}_{(i,\bullet),Total}$
Gross total cash flows at node h	CF^{h}_{LFIC} CF^{h}_{LFRC} CF^{h}_{Total}	$CF^{h,disc}_{LFIC}$ $CF^{h,disc}_{LFRC}$ $CF^{h,disc}_{Total}$
Gross StdDev at node h, at origin period i	$\sigma^{h}_{i,LFIC}$ $\sigma^{h}_{i,LFRC}$ $\sigma^{h}_{i,Total}$	$\sigma^{h,disc}_{i,LFIC}$ $\sigma^{h,disc}_{i,LFRC}$ $\sigma^{h,disc}_{i,Total}$
Gross total StdDev at node h	σ^{h}_{LFIC} σ^{h}_{LFRC} σ^{h}_{Total}	$\sigma^{h,disc}_{LFIC}$ $\sigma^{h,disc}_{LFRC}$ $\sigma^{h,disc}_{Total}$

RISK ADJUSTMENT	
Gross of reinsurance risk adjustment (all cash flows aggregated)	RA_{Total} RA_{LFIC} RA_{LFRC}

Source: Author's Calculation.