MASTER

ACTUARIAL SCIENCE

MASTER'S FINAL WORK

INTERNSHIP REPORT

Workers' Compensation: Actuarial Assessment of Claims Provisions under IFRS 17 and Solvency II

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ABSTRACT

This internship report presents my work at Gabinete da Função Atuarial (Actuarial Function Department) of Lusitania Seguros, where I was asked to develop a methodology for the calculation of Workers' Compensation (WC) claims provisions.

Aligned with the roles of the Actuarial Function Department, the objectives of the internship were set out as: the recalculation of the Workers' Compensation claims provisions under the Solvency II and the IFRS 17 regimes in an independent manner; and the validation of the technical provisions calculated by the company, comparing and justifying the differences in the obtained results.

The calculation of WC technical provisions was limited to the provision for claims outstanding in the Solvency II regime and the liability for incurred claims in the IFRS 17 framework. We also excluded from the calculation of the provision the expenses cash flows, the Solvency II risk margin and the IFRS 17 risk adjustment.

Our methodology used traditional actuarial techniques, such as: the chain-ladder method, which was used to estimate the outstanding general claims that are usually shorter term; traditional life actuarial techniques, which were used to estimate the reported but not settled claims provision of lifetime pensions and other long term liabilities; mixed life and non-life actuarial techniques, to estimate the incurred but not reported provision for long term claims (chain-ladder and long-term life methodologies).

The impacts of the differences in methodology between our model and that of the company were measured individually. The main conclusions of our analysis suggest that the limited life expectancy (EVL) processes, the treatment of bonuses, and the selection of mortality tables are the key factors influencing the calculation of Workers' Compensation (WC) claim provisions under both statutory and prudential frameworks, as they are the source of the largest discrepancies between the provisions calculated by the two methodologies.

Keywords: Workers' Compensation; Chain-Ladder; Similar and non-Similar to Life Techniques; Incurred Claims; Solvency II; IFRS 17.

RESUMO

O presente relatório de estágio detalha as atividades que realizei pelo Gabinete da Função Atuarial da Lusitania Seguros onde me foi solicitado o desenvolvimento de uma metodologia para o cálculo das provisões para sinistros de Acidentes de Trabalho (AT).
Em consonância com as responsabilidades do Gabinete da Função Atuarial, os objetivos do estágio foram definidos como: recálculo das provisões para sinistros de Acidentes de Trabalho de forma independente no âmbito do regime Solvência II e IFRS 17; a validação das provisões técnicas calculadas pela companhia, comparando e justificando as diferenças nos resultados obtidos.

O cálculo das provisões técnicas de AT limitou-se à melhor estimativa da provisão para sinistros no regime Solvência II e à responsabilidade por sinistros ocorridos no regime IFRS 17. Excluímos também do cálculo da provisão os cash-flows de despesas com sinistros e, ainda, a margem de risco Solvência II e o ajustamento de risco IFRS 17.

A metodologia recorreu a técnicas atuariais tradicionais, tais como: o método *chain-ladder*, que foi utilizado para calcular a melhor estimativa da provisão para sinistros simples, habitualmente de curto prazo; técnicas atuariais do ramo vida, que foram utilizadas para estimar a provisão de sinistros ocorridos de pensões vitalícias e outras responsabilidades de longo prazo; e técnicas atuariais mistas do ramo vida e não vida, que foram utilizadas para estimar a provisão para sinistros IBNR (incorridos mas não reportados) de longo prazo.

Identifiquei as diferenças entre o meu modelo e o da companhia e mensurei os impactos de cada. As principais conclusões da análise realizada indicam que os processos com esperança de vida limitada (EVL), o tratamento dos bónus e a seleção das tábuas de mortalidade são os principais fatores que influenciam o cálculo das provisões de sinistros de Acidentes de Trabalho (AT), tanto no âmbito contabilístico como no prudencial, uma vez que são as principais causas das diferenças entre as provisões dos dois modelos.

Palavras-chave: Acidentes de Trabalho; Chain-ladder; Técnicas atuariais dos ramos vida e não vida; Sinistros ocorridos; Solvência II; IFRS 17.

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CONTENTS

LIST OF ABBREVIATIONS AND ACRONYMS

ASF – Autoridade de Supervisão de Seguros e Fundos de Pensões/ Insurance and Pension Funds Supervisory Authority

AV – Assistência vitalícia/ Lifetime Assistance

BF – Bornhuetter Ferguson

CL – Chain-ladder

CRS – Convenção de Regularização de Sinistros/ Claims Settlement Convention

EIOPA - European Insurance and Occupational Pensions Authority

EVL - Esperança de vida limitada/ Limited life expectancy

FAT – Fundo de Acidentes de Trabalho/ Workers' Accidents Fund

IAS - Indexante de Apoios Sociais / Social Support Index

IASB - International Accounting Standards Board

IBNER – Incurred but not enough reported

IBNR – Incurred but not reported

IFRS 17 – International Financial Reporting Standard 17

INE – Instituto Nacional de Estatística/ Statistics Portugal

IPA – Incapacidade permanente absoluta para todo e qualquer trabalho/ Absolute Permanent Disability

IPATH – Incapacidade permanente absoluta para o trabalho habitual/ Absolute Permanent Disability for Regular Work

IPP – Incapacidade permanente parcial/ Partial permanent disability

LIC – Liability for incurred claims

LRC – Liability for remaining coverage

NOR – Não obrigatoriamente remível/ Not necessarily fully redeemable

OR – Obrigatoriamente remível/ Mandatory redeemable

RBNS – Reported but not settled

SLT – Similar to life techniques

WC – Workers' Compensation

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1. INTRODUCTION

This report describes the activities, tasks, experiences and achievements of my internship at the Gabinete da Função Atuarial (Actuarial Function Department) of Lusitania Seguros, from the 16th of January to the 30th of June, 2025.

Lusitania Seguros is a Portuguese insurance company founded in 1986 as the first insurance company financed entirely with Portuguese capitals. The main shareholder is Montepio Geral - Associação Mutualista and, together with Lusitania Vida, represents the insurance sector of the Grupo Montepio. Lusitania Seguros operates in Portugal and only in the non-Life insurance business, having a variety of products such as auto, health, and workers' compensation.

My work at the Gabinete da Função Atuarial focused specifically on the Workers' Compensation group of contracts, in alignment with the roles of the actuarial function. This group of contracts represents the second largest group of insurance contracts in terms of Premiums, and the largest in terms of Technical Provisions in the company.

As defined by the Portuguese Supervisor Authority (Autoridade de Supervisão de Seguros e Fundos de Pensões - ASF), cf Act No. 147/2015[1] (Assembleia da República. (2015)), article 76, one of the key roles of the Actuarial Function is:

a) to coordinate the calculation of technical provisions;
b) to ensure the adequacy of methodologies, models' basis and assumptions used in calculating technical provisions;
c) to evaluate the sufficiency and quality of the data used in the calculation of technical provisions;
d) to compare the amount of the best estimate of the technical provisions with the values actually observed;
e) to inform the management body about the degree of reliability and adequacy of the calculation of technical provisions.

With this role of the actuarial function as a framework, and given that Workers' Compensation (WC) is one of the most complex lines of business in the Portuguese insurance sector, the objectives set for the internship were:

1. to calculate WC technical provisions within the prudential (Solvency II) and statutory (IFRS 17) scopes, in an independent manner;
2. to analyse the differences between the results obtained in 1. and those calculated by the 'Direção Técnica' of Lusitania Seguros (its technical department).

Due to the extensive nature of the subject, the analysis was limited to the calculation of the provision for the expected present value of cash flows resulting from incurred claims. Also, the measurement of the risk adjustment under the IFRS 17 scope and the risk margin under the Solvency II scope were not performed. Consequently, there is no place for the calculation of the net present value of the cash flows from covered but not incurred claims and the contractual service margin in IFRS 17.

[1] https://pgdlisboa.pt/leis/lei_mostra_articulado.php?nid=2658&tabela=leis&ficha=1

The two scopes in 1. have different purposes. Solvency II is “the prudential regime for insurance and reinsurance undertakings in the EU” and it is used to “assess the overall solvency for the insurance and reinsurance undertakings”[2] (European Parliament, 2009). IFRS 17, see IASB (2022), is an international financial reporting standard that establishes the principles for the recognition, measurement, and presentation of insurance contracts, and allows for the assessment of the entity’s financial position and performance. As a result, there is a need to have a different methodology for the measurement of liabilities in each of the two approaches.

Within the prudential scope, the technical provisions are equal to the sum of the best estimate and the risk margin, as explained in articles 92-94 of the 147/2015 Act and article 28 of the Delegated Regulation 35/2015[3]. Within the statutory scope, the technical provisions are measured in accordance with paragraphs 32-59 of the IFRS 17 standard[4]. It is the sum of three amounts: the discounted expected future cash flows, the risk adjustment for non-financial risk, and the contractual service margin.

The measure of provision for insurance contracts under both scopes is also separated between the remaining coverage period and past incurred claims. Under the Solvency II regime they are called premium provision and provision for claims outstanding, as defined in article 36 of the Delegated Regulation 35/2015. Under the IFRS 17 these are called Liability for Remaining Coverage (LRC) and Liability for Incurred Claims (LIC), respectively, as defined in paragraph 40 of the IFRS 17 standard.

The expected present value resulting from incurred claims under Solvency II and IFRS 17 scopes also includes expenses cash flows. However, in this study we will not consider these type of cash flows in the two scopes.

Considering this, the only difference between the provision for both regimes is the applicable discount rate, as under Solvency II we discount the cash flows using a discount rate curve provided by EIOPA, in accordance with articles 93 1, 95 and 98 of the 147/2015 Act and the legal basis is found in point 1.2 of the technical documentation EIOPA-BoS-24-533 (3) (EIOPA, 2024), and under IFRS 17 the discount rate follows the methodology explained in paragraph 36 of the standard (2) (IFRS Foundation, 2022).

1.1 Roles and activities

The topic and the objectives of my internship were carefully chosen. The Actuarial Function Department was created by the end of 2024 to aggregate the actuarial function of Lusitania Seguros and Lusitania Vida. As such, it is developing new and updating old methodologies for the recalculation of the technical provisions independently. During my internship I developed the methodology to calculate WC technical provisions, but also the implementation process.

[2] https://www.eiopa.europa.eu/browse/regulation-and-policy/solvency-ii_en
[3] https://eur-lex.europa.eu/eli/reg_del/2015/35/oj/eng
[4] https://www.ifrs.org/content/dam/ifrs/publications/pdf-standards/english/2021/issued/part-a/ifrs-17-insurance-contracts.pdf

Before developing the methodology, I had to carefully study not only the legislation of Solvency II and IFRS 17, but most importantly the legislation concerning the WC line of business. The legislation is very extensive and many of the concepts are essential to calculate the provision.

A meticulous analysis of the data was also necessary to develop the methodology. In WC, the number and type of variables add substantial difficulty in choosing the right ones to use or in adapting the model to a particular variable.

The implementation was the most challenging aspect of my internship. Applying the models required the use of multiple software programs and the organization of various databases, all while ensuring that the process could be replicated at future reference dates and different databases.

After implementing the processes and calculating the provisions, an analysis was conducted . To fulfil the second objective of this study, the company provided me with a base model and technical provisions based on a fictitious methodology and data. This allowed me to validate and compare the model with my own and present my conclusions in this report.

1.2 Document structure

The structure of this report is:

Chapter 2 begins with an introduction to the WC legislation framework and the key concepts that will be used throughout the report. This is followed by an evaluation of WC claims provision using non-similar-to-life techniques, specifically run-off triangle methods. This includes reported but not settled claims and incurred but not reported claims, limited to a particular type of claim, usually short term.

Chapters 3, 4, and 5 comprise the calculation of the provisions for the reported but not settled claims (of pensions), lifetime assistance, and the Workers' Accidents Fund, which are long term claims. These are all determined using traditional life techniques. Chapter 3 provides an in-depth analysis of the WC legislation and defines the important variables and assumptions necessary for the subsequent chapters.

Chapter 6 covers the remaining incurred but not reported claims provision. This provision is calculated using both non-similar-to-life techniques and similar-to-life techniques.

Three analyses of the results are performed where we compare the base model with ours: one for Chapter 2, one for Chapters 3 to 5, and one for Chapter 6. In the end, we present the conclusions.

2. PROVISION OF WC CLAIMS - NON-SIMILAR TO LIFE TECHNIQUES

2.1 Setting the framework

2.1.1 Historical note about the worker's compensation legislation

There are three laws and two decree-law that mainly govern the Worker's Compensation pensions, Law No. 2127/65[5], Decree-Law No. 360/71[6], Law No. 100/97[7] and Decree-Law No. 143/99[8] and Law No. 98/2009[9]. Each of these laws introduced changes that affect the calculation of the provision.

For over 30 years, Law No. 2127/65 formed the legal basis for workers' compensation in Portugal until it was replaced by Law No. 100/97. According to Decree-Law No. 143/99, the new legislation aimed to adapt to changes in the working environment and ensure adequate compensation for victims of work accidents. The new law was designed to improve protection and benefits for victims of work accidents, while maintaining equilibrium and stability within the insurance sector. For example, the law has broadened the definition of a work accident to include accidents that occur while travelling to and from work.

In 2009, Law No. 98/2009 replaced the previous law. While the differences between the two laws were relevant for the calculation of the provision, they did not represent a breakthrough compared to Law No. 100/97.

These pieces of legislation, along with others, will form the basis of the entire study. They will help us determine the model, assumptions and variables used throughout all chapters.

2.1.2 Key concepts

This chapter relates to WC claims estimated using non-similar to life techniques (non-SLT). These claims are defined internally as part of the 'simple processes' which is the type of process that is open right after the accident is reported. They comprise many types of claims, including in-kind and cash.

Claim in-kind are all the necessary expenses for the victim's recovery after the accident, while cash claims include compensations, and temporary pensions. All of these are considered in base IX of Law No. 2127/65, article 10 of Law No. 100/97 and article 23 of Law No. 98/2009.

Considering the scope of our study is to provision the totality of the incurred claims, we need to define two concepts: the first is the reported but not settled claims (RBNS); the second is the incurred but not reported claims (IBNR).

The RBNS respects to claim events that were already reported to the company, while the IBNR respects to the difference between the total amount the insurer will have to pay (this is also called the ultimate amount), and the total paid claims.

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[5] https://diariodarepublica.pt/dr/detalhe/lei/2127-1965-292536
[6] https://diariodarepublica.pt/dr/detalhe/decreto/360-635246
[7] https://diariodarepublica.pt/dr/legislacao-consolidada/lei/1997-888844349
[8] https://diariodarepublica.pt/dr/detalhe/lei/143-1999-581977
[9] https://diariodarepublica.pt/dr/legislacao-consolidada/lei/2009-58661980-58661843

The provision should measure the total of RBNS and IBNR, which is the outstanding claims amount, see EIOPA (2014, pp. 82-83).

Before calculating the provision, we should also be aware of the difference between models and methods. In ASB (2007) the definition for model and method is the following.

Method: "A systematic procedure for estimating the unpaid claims".

Model: "A mathematical or empirical representation of a specified phenomenon".

Some authors, for example Sahasrabuddhe (2008, p.570) consider this definition reductive as it implies that methods are simply algorithms without proper mathematical representation, in contrast to models; however, this is not the case.

Neither the non-SLT nor the SLT parts of this study delve into underlying distributions or advanced statistics, which lead us to define our approaches as methods. Nevertheless, we attempted to define them mathematically and ensure they were statistically sound.

2.2 Calculating the provision

In this section we apply traditional 'run-off triangles' techniques to estimate the provision. These types of techniques have been used extensively by actuaries over the years (Schmidt & Zocher, 2008, p.86). Two of the most famous, that we will test, are Chain-Ladder (CL) method, see Verall (1994), and the Bornhuetter-Ferguson (BF) method, see Bornhuetter & Ferguson (1972).

2.2.1 Run-off triangle

Before presenting the methods, it is crucial to understand what a run-off triangle is, and how it is built, since it is the basis of our methods. Schmidt & Zocher (2008, p.88) briefly introduce this concept. Consider a Portfolio of risks where the claims are settled either in the accident year or in the following development years, the run-off triangle takes the shape as in Figure 1.

	DEVELOPMENT YEARS						
ACCIDENT YEAR	**0**	**1**	**2**	**…**	**N-3**	**N-2**	**N-1**
1	$Obs_{1,0}$	$Obs_{1,1}$	$Obs_{1,2}$	…	$Obs_{1,N-3}$	$Obs_{1,N-2}$	$Obs_{1,N-1}$
2	$Obs_{2,0}$	$Obs_{2,1}$	$Obs_{2,2}$	…	$Obs_{2,N-3}$	$Obs_{2,N-2}$	
3	$Obs_{3,0}$	$Obs_{3,1}$	$Obs_{3,2}$	…	$Obs_{3,N-3}$		
…	…	…	…	…			
N-2	$Obs_{N-2,0}$	$Obs_{N-2,1}$	$Obs_{N-2,2}$				
N-1	$Obs_{N-1,0}$	$Obs_{N-1,1}$					
N	$Obs_{N,0}$						

Figure 1: Run-Off Triangle Example - Own elaboration.

A run-off triangle contains observed claims for N consecutive accident years and for a maximum of $N-1$ development years. After this period, we assume that all claims are settled. The accident year is the development year 0. The observed data has a triangular shape because all the values on the last diagonal represent the observed values in year N, the current year.

Run-off triangles are usually presented in two different forms: incremental claims and cumulative claims, each of which is useful depending on the methods. Incremental claims triangles consider that $Obs_{n,d}$ represents claims from accident year n and development year d. Cumulative claims triangles consider that $Obs_{n,d}$ represent the claims from accident year n and all development years up to d. We can always transform an incremental claims triangle into a cumulative claims triangle, or vice versa, without any loss of information. For example, if $Obs_{n,d}^{c}$ and $Obs_{n,d}^{i}$ are the observed cumulative claim and the observed incremental claim in accident year n and development year d, respectively, they respect the following equation:

$$Obs_{n,d}^{c} = Obs_{n,d}^{i} + Obs_{n,d-1}^{c} \tag{1}$$

Before considering applying the methods, I was asked by the company to adjust the past values of the triangle to the reference date, because our methodology uses a paid claims triangle. To do that, we consider the inflation curve obtained from the bank of Portugal that is in Appendix 6 (Banco de Portugal. (n.d.)). It is the year-to-year inflation curve for general goods, and we assume all payments occurred at the midpoint of the year.

With this understanding we can present the two methods' frameworks, starting with the chain-ladder method.

2.2.2 Chain-ladder

We apply the chain-ladder methodology, as formalized by Mack (1994), to a cumulative paid claims run-off triangle with accident years 2010 to 2024. The method predicts the evolution of the paid claims over the development period. At the last development period, the model assumes that there will be no more payments for processes of that accident year. The outstanding amount, which is the cash flows we want to provision, is the difference between that ultimate amount and the paid claims to date 31 December 2024.

Let $C_{i,j}$ denote the cumulative claims of accident year $i = 1, 2, \dots, N$, in development year $j = 0,1, \dots, N-1$, and $R_i = C_{i,N-1} - C_{i,N-i}$, the outstanding claims reserve of accident year i.

Then D = $\left\{C_{i,j}, i = 1, 2, \dots, N,\ j = 0, 1, \dots, N-1,\ i + j \leq N\right\}$ is the set of all the observed data.

The chain-ladder method, by Thomas Mack, has the underlying assumptions:

$$(CL1) \quad \{C_{i,0}, C_{i,2}, C_{i,3}, \dots, C_{i,N-1}\}, \{C_{j,0}, C_{j,2}, C_{j,3}, \dots, C_{j,N-1}\}\ independent, \quad i \neq j\,; \tag{2}$$

$$(CL2)\ E\left[C_{i,j} \middle| C_{i,0}, \dots, C_{i,j-1}\right] = C_{i,j-1} \times f_j\ , i = 1, 2, \dots, N, j = 0, 1, \dots, N-1, i + j \leq N; \tag{3}$$

$$(CL3) \quad Var\left[C_{i,j} \middle| C_{i,0}, \dots, C_{i,j-1}\right] = C_{i,j-1} \times {\alpha_j}^2, i = 1, \dots, N, j = 0, \dots, N-1, i + j \leq N. \tag{4}$$

The values f_j and $\hat{\alpha}_j^2, 1 \leq j \leq N-1$ are unknown parameters of the model. f_j are called the development factors and are used to estimate the evolution of the paid amounts. The author provides the following unbiased estimators.

$$\hat{f}_j = \frac{\sum_{i=1}^{N-j} C_{i,j}}{\sum_{i=1}^{N-j} C_{i,j-1}}, \qquad j = 0,1, \dots, N-1\,. \tag{5}$$

$$\hat{a}_j^2 = \frac{1}{N-j-1} \times \sum_{i=1}^{N-j} C_{i,j-1}\left(\frac{C_{i,j}}{C_{i,j-1}} - \hat{f}_j\right)^2, \qquad j = 0,1,\dots,N-1, \tag{6}$$

$$\hat{a}_{N-1}^2 = \begin{cases} \min\left(\frac{\hat{a}_{I-2}^4}{\hat{a}_{I-3}^2}, a_{N-1}^2\, min(\hat{a}_{I-3}^2, \hat{a}_{I-2}^2)\right), & \hat{f}_{N-1} \neq 1 \\ 0, & \hat{f}_{N-1} = 1 \end{cases}. \tag{7}$$

Afterwards it is possible to estimate unbiased predictors for the future cumulative claims and reserve, see Schmidt & Zocher (2008).

$$\hat{C}_{i,N-i+1} = C_{i,N-i} \times \hat{f}_{N-i+1}, \qquad i = 1, 2, \dots, N. \tag{8}$$

$$\hat{C}_{i,k} = C_{i,N-i} \times \prod_{j=1}^{k-N+i} \hat{f}_{N-i+j}, \qquad N-i < k \leq N-1, 2 \leq i \leq N. \tag{9}$$

$$\hat{R}_i = \hat{C}_{i,N-1} - C_{i,N-i}, \qquad i = 2, 3, \dots, N. \tag{10}$$

Besides the estimators for the parameters of the model, the author also provides an estimator for the mean square error of the reserve, by accident year and portfolio, that respects the following equations.

$$mse(\hat{R}_i) = E\left[(\hat{R}_i - R_i)^2 \middle| D\right] = \hat{C}_{i,N-1}^2 \times \sum_{k=N-i}^{N-2}\left(\frac{\hat{a}_k^2}{\hat{f}_k^2}\left(\frac{1}{\hat{C}_{i,k}} + \frac{1}{\sum_{j=1}^{N-1-k} C_{j,k}}\right)\right), i = 2,\dots,N; \tag{11}$$

$$mse\left(\sum_{i=2}^{N} \hat{R}_i\right) = \sum_{i=2}^{N-1}\left(mse(\hat{R}_i) + \hat{C}_{i,N-1}\left(\sum_{j=i+1}^{N} \hat{C}_{j,N-1}\right)\sum_{k=N+1-i}^{N-1} \frac{\frac{2 \times \hat{a}_k^2}{\hat{f}_k^2}}{\sum_{n=1}^{N-k} C_{n,k}}\right). \tag{12}$$

2.2.3 Bornhuetter-Ferguson

We also tested the Bornhuetter-Ferguson method, more specifically one extension of it called Cape Cod method as described in Schmidt & Zocher (2008). The presentation of the method is in Appendix 1. However, when we had to choose between this and the CL, we chose the CL. The criterium was based on the mean absolute error (MAE) and root mean squared error (RMSE) that is on Table A1 of Appendix 1, and the CL presented better results in both metrics.

2.2.4 Interest rate spot curve

In this subsection, we calculate the spot curves for the interest rates. In Appendix 4 we have the yearly spot rates for the Solvency II and IFRS 17 regime. The yearly spot rates in the Solvency II regime are the risk-free interest rate with volatility adjustment provided by EIOPA (2024), while the IFRS 17 yearly spot rates were calculated using a bottom-up approach (IFRS Foundation, 2022) by the company.

However, our model requires cash flows on a monthly basis. Defining $s_{t,scope}$ as the t-year spot rate related to the specific regime, we can calculate the required spot rates using the following method:

Let $k \in \mathbb{N}_0$;

$$\forall t \in [k, k+1[, \quad s_{t,scope} = (k+1-t)s_{k,scope} + (t-k)s_{k+1,scope}. \tag{13}$$

Following the assumption we defined earlier, we are interested in $s_{t,scope}$ for $t = \left\{k + \frac{1}{12}, k + \frac{2}{12}, \dots, k + \frac{11}{12}\right\}$ to discount the cash flows at the end of each month.

2.2.5 The provision

Before applying the chain-ladder method to calculate the development factors, we apply two methods of selecting claim developing factors, they are the 'Average of Recent Observations' and the 'Ex-Hi/Low Averages' (Sahasrabuddhe, 2008, p. 572). These methods of selection suggest that while estimating the development factors, we should only include observations of the n most recent years and exclude the highest and lowest observations for a given development year. The derivation of the methods is in Appendix1.

Applying the chain-ladder with the methods of selection derived in Appendix 1, we can finally calculate the estimates for *incremental* claims $\hat{C}_{i,j}, j = 15 - i + 1, \dots, N - 1, i = 2, \dots, N$. Considering the interest rate spot curves, the provision can finally be calculated following equation 15. All future incremental payments are at the midpoint of the year, and the future inflation taken from the Bank of Portugal (2024) is 2.1% in 2025 and 2% in the years afterwards. Let $C_{i,j}^{inf}$ be the incremental payment adjusted for future inflation.

$$\hat{C}_{i,j}^{inf} = \begin{cases} \hat{C}_{i,j} \times 1.021^{0.5}, & i + j - 15 = 1 \\ \hat{C}_{i,j} \times 1.021 \times 1.02^{i+j-15-1.5}, & i + j - 15 > 1 \end{cases}; \tag{14}$$

$$Prov.NSLT_{scope} = \sum_{i=2}^{15} \sum_{j=15-i+1}^{14} \frac{\hat{C}_{i,j}^{inf}}{\left(1 + s_{i+j-15.5,scope}\right)^{i+j-15.5}}. \tag{15}$$

2.3 Results

The Tables 1 to 4 were obtained considering equations 1 to 10, and equation A4 from Appendix 1.

The following Table 1 and Table 2 present the amounts of the claims provisions, excluding expenses, under both the statutory regime (IFRS 17) and the prudential framework (Solvency II). These results reflect the treatment of non-SLT Workers' Compensation claims provisions and provide a consistent view of liabilities across accounting and regulatory perspectives.

SOLVENCY II | GENERAL COMPARISON				
				(m.u. euros)
SOLVENCY II CLAIMS PROVISIONS, WITHOUT EXPENSES	**DISCOUNTED CASH FLOWS COMPANY 31/12/2024**	**RECALCULATED DISCOUNTED CASH FLOWS 31/12/2024**	**DIF.**	**DIF (%)**
2025	8 331 806	8 331 107	698	0%
2026	2 167 599	2 129 300	38 298	2%
2027	966 857	954 755	12 102	1%
2028	573 257	533 677	39 580	7%
2029	417 638	330 405	87 233	26%
2030	370 904	246 339	124 566	51%
2031	262 216	185 611	76 604	41%
2032	246 307	174 396	71 911	41%
2033	197 393	126 940	70 453	56%
2034	160 160	112 060	48 099	43%
2035	160 202	86 815	73 388	85%
2036	0	47 923	-47 923	-100%
2037	0	24 735	-24 735	-100%
2038	0	14 065	-14 065	-100%
Subtotal	**13 854 339**	**13 298 130**	**556 209**	**4%**
Check Lusitania	*0,0000*	*0,0000*	*0,0000*	*0,0000*

Table 1: Solvency II Claims Provision - Own elaboration.

IFRS 17 | GENERAL COMPARISON				
				(m.u. euros)
IFRS 17 CLAIMS PROVISIONS, WITHOUT EXPENSES	**DISCOUNTED CASH FLOWS COMPANY 31/12/2024**	**RECALCULATED DISCOUNTED CASH FLOWS 31/12/2024**	**DIF.**	**DIF (%)**
2025	8 310 826	8 320 422	-9 596	0%
2026	2 154 667	2 120 442	34 225	2%
2027	956 966	947 124	9 842	1%
2028	564 474	526 914	37 560	7%
2029	408 794	324 408	84 386	26%
2030	360 596	240 331	120 265	50%
2031	253 006	179 789	73 217	41%
2032	235 692	167 591	68 101	41%
2033	187 193	120 936	66 258	55%
2034	150 408	105 763	44 646	42%
2035	148 897	81 115	67 782	84%
2036	0	44 299	-44 299	-100%
2037	0	22 607	-22 607	-100%
2038	0	12 704	-12 704	-100%
Subtotal	**13 731 520**	**13 214 445**	**517 075**	**4%**
Check Lusitania	*0,0000*	*0,0000*	*0,0000*	*0,0000*

Table 2: IFRS 17 Claims Provision - Own elaboration.

As expected, the provisions calculated under IFRS 17, and Solvency II are very much aligned. The only notable difference arises from the use of different discount curves under each regime, which leads to marginal variations in present value estimates.

When comparing these technical provisions with the Company's own reported results, the overall differences amount to approximately €0.5 million. These variations are fully explainable and stem from methodological nuances, assumption sets, and data calibrations applied under the IFRS 17 and Solvency II frameworks, as opposed to those used in the Company's internal regulatory or accounting processes.

The following Tables 3 and 4 summarize the origins and causes of the observed differences.

SOLVENCY II | DRILL - DOWN DIFFERENCES

(m.u. euros)

RECALCULATED DISCOUNTED CASH FLOWS	DISCOUNTED CASH FLOWS 31/12/2024	IMPACT CASH FLOW TIMING	IMPACT PAST INFLATION	IMPACT DIFFERENT INFLATION FOR 2026	IMPACT FUTURE INFLATION	IMPACT UNIVERSE CONSIDERED	DEVELOPMENT FACTORS 1-10 IMPACT	DEVELOPMENT FACTORS 11-14 & TAIL IMPACT	IMPACT CASE RESERVES	IMPACTS TOTAL	% JUSTIFIED
2025	8 331 107	-137 525	10 841	35 717	0	-56 503	-71 546	169 413	50 301	698	100%
2026	2 129 300	-40 087	5 908	12 958	4 080	-27 360	-80 929	163 729	0	38 298	100%
2027	954 755	-21 829	3 657	4 020	3 638	-13 820	-84 259	120 695	0	12 102	100%
2028	533 677	-11 044	2 755	450	3 099	0	-45 579	89 898	0	39 580	100%
2029	330 405	-5 617	2 299	-536	2 569	0	-17 580	106 099	0	87 233	100%
2030	246 339	-4 948	1 900	26	2 395	0	28 112	97 080	0	124 566	100%
2031	185 611	-3 430	1 453	-302	2 167	0	5 240	71 475	0	76 604	100%
2032	174 396	-3 753	1 275	737	2 384	0	-26 361	97 631	0	71 911	100%
2033	126 940	-3 206	942	1 849	1 998	0	-30 361	99 231	0	70 453	100%
2034	112 060	-2 670	531	1 489	1 982	0	-23 968	70 735	0	48 099	100%
2035	86 815	-1 925	304	1 043	1 706	0	0	72 260	0	73 388	100%
2036	47 923	-1 199	144	859	1 040	0	0	-48 767	0	-47 923	100%
2037	24 735	-364	18	247	586	0	0	-25 223	0	-24 735	100%
2038	14 065	-172	0	0	358	0	0	-14 251	0	-14 065	100%
Subtotal	**13 298 130**	**-237 768**	**32 026**	**58 558**	**28 002**	**-97 683**	**-347 232**	**1 070 005**	**50 301**	**556 209**	**100%**
Check Lusitania	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	

Table 3: Solvency II Claims Provision - Drill-Down - Own elaboration.

IFRS 17 | DRILL - DOWN DIFFERENCES

(m.u. euros)

RECALCULATED DISCOUNTED CASH FLOWS	DISCOUNTED CASH FLOWS 31/12/2024	IMPACT CASH FLOW TIMING	IMPACT PAST INFLATION	IMPACT DIFFERENT INFLATION FOR 2026	IMPACT FUTURE INFLATION	IMPACT UNIVERSE CONSIDERED	DEVELOPMENT FACTORS 1-10 IMPACT	DEVELOPMENT FACTORS 11-14 & TAIL IMPACT	IMPACT CASE RESERVES	IMPACTS TOTAL	% JUSTIFIED
2025	8 320 422	-147 456	10 813	35 626	0	-56 431	-71 362	168 979	50 236	-9 596	100%
2026	2 120 442	-43 643	5 872	12 881	4 056	-27 246	-80 446	162 752	0	34 225	100%
2027	947 124	-23 711	3 620	3 979	3 601	-13 710	-83 397	119 460	0	9 842	100%
2028	526 914	-12 288	2 712	443	3 052	0	-44 881	88 521	0	37 560	100%
2029	324 408	-6 498	2 250	-525	2 514	0	-17 208	103 852	0	84 386	100%
2030	240 331	-5 649	1 847	26	2 328	0	27 331	94 382	0	120 265	100%
2031	179 789	-4 006	1 402	-291	2 091	0	5 056	68 965	0	73 217	100%
2032	167 591	-4 302	1 220	705	2 281	0	-25 225	93 423	0	68 101	100%
2033	120 936	-3 595	893	1 754	1 895	0	-28 792	94 103	0	66 258	100%
2034	105 763	-3 033	499	1 399	1 861	0	-22 509	66 429	0	44 646	100%
2035	81 115	-2 216	282	970	1 586	0	0	67 160	0	67 782	100%
2036	44 299	-1 351	133	789	956	0	0	-44 825	0	-44 299	100%
2037	22 607	-463	17	225	532	0	0	-22 917	0	-22 607	100%
2038	12 704	-231	0	0	322	0	0	-12 795	0	-12 704	100%
Subtotal	**13 214 445**	**-258 443**	**31 560**	**57 979**	**27 074**	**-97 386**	**-341 434**	**1 047 489**	**50 236**	**517 075**	**100%**
Check Lusitania	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	

Table 4: IFRS 17 Claims Provision - Drill-Down - Own elaboration.

All differences between the provisions calculated in this study and those reported by the Company have been identified and are fully explainable. The sources of these differences are summarised below:

- Cash Flow Timing:

The Company assumes that all payments occur at the end of each year, whereas we assume that payments occur at the midpoint of the period. This impacts the present value of future cash flows due to the different discounting effect.

- Past Inflation Adjustment

Differences arise in the adjustment for historical inflation to the paid claims run-off triangles:

- The Company assumes payments are made at the beginning of each year;
- We assume the payments occur at the midpoint of the year, for consistency with other timing assumptions;
- Additionally, different sources were used for historical inflation (Company: INE; this study: Banco de Portugal). Both sources are credible, and the impact is not material.

- Inflation Rate for 2026

A difference in the future inflation assumption for calendar year 2026:

- Company assumption: 2.2%;
- Study assumption: 2.0% (based on BP projections).

- Future Inflation Application Timing

In projecting future claims payments, this study assumes payments occur at the middle of the year, and inflation is applied accordingly. The Company, in contrast, applies future inflation under the assumption that payments occur at the end of the year.

- Modelling Universe

The Company's projection is based on a claims development triangle spanning accident years 2014 to 2024, with a 10-year development horizon. In contrast, this study uses a broader dataset, covering accident years 2010 to 2024, which introduces several key differences:

- Extended Development Horizon: the inclusion of accident years prior to 2014 allows for three additional development years with future payments being projected beyond the Company's 10-year window.
- Development Factors (Years 1–10): differences in triangle structure and calibration lead to slightly different development factors for the overlapping development years (1 to 10), impacting the early projection pattern.
- Tail Factor Methodology (Years 11–14): the treatment of the tail differs significantly:
    i. The Company fits an inverse power curve to the observed development factors to extrapolate the tail, which typically yields higher tail factors.
    ii. A penalty adjustment is then applied by the Company to dampen the extrapolated values.
    iii. This study uses empirically derived development factors from actual experience over years 11–14, resulting in a more data-driven tail assumption.
- Case Reserves: due to the extended accident year window, this study only incorporates case reserves for claims originating prior to 2010, which are lower than the ones considered by the Company (previous to 2014).

3. PROVISION OF REPORTED BUT NOT SETTLED CLAIMS - SIMILAR TO LIFE TECHNIQUES

3.1 Setting the framework

In this chapter we will start calculating the provision using traditional actuarial similar-to-life techniques. The provision relating to reported but not settled claims applies to claims that result in pensions. These pensions are either currently being paid or are expected to be paid in the future. When this is the case, we consider that the 'simple process' evolves into a 'severe process'. Unlike in the non-SLT case, we have more detailed information on each pension and the biggest factors to consider are the timing of the cash flows and the longevity.

Also, while in the non-SLT case the provision was net of reimbursements, in the SLT case we do not consider the reimbursements from other insurance companies, particularly under the CRS (*Convenção de Regularização de Sinistros* - Claims Settlement Convention). We will not go deeper into them as they are outside the scope of the study and are estimated independently from the WC provision.

Before considering the methodology, we need to define some key concepts that will be used in the formulation of our models.

3.1.1 Degree of disability and disability coefficient

A WC pension is payable in two scenarios.

In the first scenario, the pension is payable if the accident results in a temporary or permanent disability (temporary disabilities are estimated under the non-SLT). In the case of permanent disability, articles 9 and 10 of Decree-Law No. 143/99 and articles 20 and 21 of Law No. 98/2009 define two concepts: the disability coefficient, and the degree of disability.

The disability coefficient ($Coef$) ranges from 0 to 1, with a higher coefficient indicating greater disability. The degree of disability for permanent disability pensions can be classified into three types:

- Partial permanent disability (IPP);
- Absolute permanent disability for regular work (IPATH);
- Absolute permanent disability (IPA).

Articles 9 and 10 of Decree-Law No. 143/99 refer to the National Table of Disabilities (TNI), which correlates the extent of physical impairment with these two factors.

In the second scenario, one or more pensions are payable to legal beneficiaries if the work accident results in death, as stipulated by Base XIX of Law No. 2127/65, Article 20 of Law No. 100/97, and Article 57 of Law No. 98/2009. In this case, no disability coefficient or degree of disability is defined.

3.1.2 Pension types

Pensions can be separated into two types. The first type is called *Não Obrigatoriamente Remível* (NOR), meaning pensions that are not necessarily fully redeemable. The second type is called *Obrigatoriamente Remível* (OR), meaning pensions that must be fully redeemable by law. This means that OR pensions are paid as a lump sum, whereas NOR pensions are typical annuities.

According to No. 1 of article 33 of Law No. 100/97 and No. 1 of article 75 of Law No. 98/2009, the conditions for a pension to be classified as OR are as follows:

- Decree-Law No. 143/99.
  IPP pensions such that the disability coefficient is less than 30% *or* the annual amount is not higher than six times the minimum wage.
  Lifetime pensions payable to legal beneficiaries such that the annual amount is not higher than six times the minimum wage.
- Law No. 98/2009
  IPP pensions such that the disability coefficient is less than 30% *and* the annual amount is not higher than six times the minimum wage.
  Lifetime pensions payable to legal beneficiaries such that the annual amount is not higher than six times the minimum wage.

Clearly, the conditions for classifying IPP pensions as OR are more restrictive in the most recent law, since both the disability coefficient and the pension amount conditions must be met. The conditions for lifetime pensions paid to the legal beneficiaries in case of death are the same in both laws.

While we only introduced the conditions for a pension to be classified as OR for the two most recent laws, the concept was not strange to Law No. 2127/65, as base XXXIX states that pensions of reduced amount are necessarily redeemable. However, there is not a clear threshold for what is considered a reduced amount. This did not prove to be a problem since the law was revoked on 1 January 2000 and all current pensions in our portfolio under this law are NOR. Nevertheless, all three laws are based on the same philosophy: pensions of reduced amount or with a low disability coefficient should be redeemable. This can be viewed positively from the perspective of both the pensioner and the insurance company, since a lump sum potentially provides protection against the decrease of the real value of a small annuity over time, and management costs are significantly reduced.

Other sections of the same articles stipulate conditions for partial redemption under the pensioner's discretion. We do not consider such possibility under the RBNS provision for the sake of prudence, as we will explain later. There also other sections exploring exceptions for pensions that may or may not be redeemable, but these are rare cases of no material interest.

3.1.3 Calculation of the annual pension amount

In the case of permanent disability, the annual pension amount is calculated according to base XVI of Law No. 2127/65, article 17 of Law No. 100/97 and article 48 of Law No. 98/2009. The formulas for each degree of disability, where $Salary$ represents the annual salary and $Coef$ represents the disability coefficient, are in Table 5.

	1965	1997 and 2009
IPP	$Salary \times 70\% \times Coef$	$Salary \times 70\% \times Coef$
IPATH	$Salary \times (0.5 + Coef/6)$	$Salary \times (0.5 + Coef \times 0.2)$
IPA	$Salary \times 80\%$	$Salary \times 80\%$

Table 5: Pension Amount According to the Legislation - Own Elaboration

There is also the possibility, in all laws, for an IPA pension to increase an additional 10% of the victim's salary for each dependent.

In the event of death, the annual pension paid to legal beneficiaries is defined by Base XIX of Law No. 2127/65, Article 20 of Law No. 100/97, and Articles 59 to 63 of Law No. 98/2009. There can be more than one beneficiary, but the total annual pension amount paid cannot exceed 80% of the victim's annual salary at the time of the accident. When the calculation results in an amount exceeding this limit, the 80% of the victim's annual salary is divided proportionally between all beneficiaries, as stipulated in article 21 of Law No. 100/97 and article 64 of Law No. 98/2009.

Due to the variety and number of potential legal beneficiaries in the event of death, there are many particular cases that need to be approached per se.

3.1.4 Payment method

To understand the payment method, it is essential to distinguish between NOR and OR pensions since they imply different payment schemes.

3.1.4.1 NOR

NOR pensions are traditional life annuities, and the law regulates the frequency and timing of the payments.

- Article 57 of Decree-Law No. 360/71 - An amount of $\frac{1}{12}$ of the annual pension amount must be paid every month.
- Article 51 of Decree-Law No. 143/99 - An amount of $\frac{1}{14}$ of the annual pension amount must be paid until the third day of each month, and an additional $\frac{1}{14}$ in May and November.
- Article 72 of Law No. 98/2009 - An amount of $\frac{1}{14}$ of the annual pension amount must be paid until the third day of each month, and an additional $\frac{1}{14}$ in June and November.

This will determine the timing of the cash flows. For simplicity, we will divide the cash flows into monthly payments, paid in advance.

It is also necessary to understand when the pension becomes payable. According to No. 4 of article 17 and article 20 of Law No. 100/97 and No. 2 of articles 50 and 56 of Law No. 98/2009, in the case of a permanent disability pension, it is due the day after the injured person is discharged, and, in the case of death, the day after death. Estimates of both the disability coefficient and degree of disability are available after the day of discharge, enabling the calculation of the pension amount. However, until the court's final decision, they are not definitive.

Since the pension amount will only be definitive on a later date, article 47 of Decree-Law No. 143/99 and article 52 of Law No. 98/2009 entitle pensioners to a provisional pension, from the moment the pension is due until it is defined, of an amount calculated according to the same articles. This provisional amount is proportional to the disability coefficient.

Once the pension is defined, the difference between the provisional amount and the pension amount will be reimbursed to the relevant party. When calculating the provision of a NOR pension not yet defined, we neglect this difference and calculate all pensions based on the estimated pension amount.

3.1.4.2 OR

Contrary to NOR pensions, that are annuities, OR pensions are paid in a single lump sum.

The value of the lump sum should represent an annuity where the annual pension amount is calculated according to the rules seen above. It is obtained by multiplying the annual pension amount by a factor that represents the fair value of the annuity according to article 57 of Decree-Law No. 143/99 and article 76 of Law No. 98/2009. These articles allude to the tables from Portaria No. 11/2000[10] (Ministério das Finanças, 2000). The technical bases supporting these factors are the mortality table TD88/90 and a constant interest rate of 5.25%.

The payment of an OR lump sum is due on the day after the injured person is discharged and, in the case of death, on the day after death. They are also eligible for provisional pensions, while the court has not yet decided, but it is the company's policy to wait for the pension to be defined before paying the full lump sum. If a pensioner requests a provisional pension, it will be granted, but these are exceptions and will not be considered when calculating the provision of OR pensions.

3.1.5 Revision of the pension amount

Pensioners have the right to ask for a revision of their disability status, under Base XXII of Law No. 2127/65, Article 25 of Law No. 100/97 and Article 70 of Law No. 98/2009. The purpose is to address cases where the disability has evolved, either improving or worsening to the extent that the new conditions require a change in the degree of disability, or the disability coefficient, as defined in the TNI. It must be initiated by submitting a request for a revision to the court, either by the insurance company or by the injured person.

As the effects of revision are hard to capture individually, they will not be included in the RBNS provision, although they are measured in the provision of Chapter 6, with one exception. Point 5 of the General Instructions in Annex I of the TNI (Ministério do Trabalho e da Solidariedade Social., 2007) introduces the concept of *Bonificação* (Bonus). It stipulates that a victim with a permanent disability who is not retrainable for the job or is aged 50 or over, and has not previously benefited from the application of this factor, is entitled to a 50% increase in the disability coefficient, with the coefficient limit still being 1. This only applies during the process of determining the disability, which occurs when the pension is first defined, or during a revision process.

Currently the company does not consider the Bonus directly on the IFRS 17/Solvency II RBNS provision, but instead under the IBNER liability. First, although pensioners are entitled to it, the process is not automatic, which means that they must request a disability revision from the court, a fact that pensioners have historically been unaware of. Second,

[10] https://pgdlisboa.pt/leis/lei_mostra_articulado.php?nid=1173&tabela=leis

pensioners who have previously redeemed their pensions are also entitled to this bonus by requesting a disability revision, as stipulated by Article 58 of Decree-Law No. 143/99 and Article 77 of Law 98/2009. However, OR pensions that have been redeemed are particularly difficult to provision, as once the capital is paid, the processes are removed from the company's portfolio and the company loses track of the status of these pensioners.

The application of this norm has not been consistent over the years too, which has made provisioning the bonus difficult. Recently, the Supremo Tribunal de Justiça issued judgements on the correct application of the norm in Acórdãos do Supremo Tribunal de Justiça No. 16/2024 and No. 1/2015.

In this report, we will attempt to assess the impact on all pensions in the portfolio at the reference date. Due to the lack of data concerning pensions that have already been redeemed, we will not evaluate their impact.

Another key detail about the bonus, and the revision process in general, is that if the bonus is applied to OR pensions, there is not a guarantee that after that application, the conditions for a pension to be classified as OR will be met. For instance, if a pensioner with a disability coefficient of 25% was paid the capital and later asks for the bonus when reaching the age of 50, then the new disability coefficient will be 37.5%. Under the new regime, Law No. 98/2009, a situation like this does not meet the conditions of an OR pension, which means that the pensioner should be awarded an annuity with respect to the increment of 50%.

The situation may not be intuitive, but it is not unheard of, and courts have decided in favor of this solution, as exemplified by Tribunal da Relação de Coimbra (2024).

3.2 Calculating the provision

3.2.1 Variables and assumptions on pension amount and time

Having introduced some core concepts and legal background for the SLT provision, we will now define the variables and describe the assumptions that will help formulate the RBNS provision and others.

- $Pens_i$ is the amount of the annual pension i;
- x_i is the current age of the pensioner i measured in discrete years;
- m_i is the number of months since the pensioner i's last birthday;
- sex_i is the gender of pensioner i, male (M) or female (F);
- $coef_i$ is the coefficient of disability of pensioner i;
- $group_i$ denotes the degree of disability of pensioner i, and assumes the value of 1 if the degree of disability is IPP, 2 if it is IPATH, and 3 if it is IPA;
- bn_i indicates if the bonus was already considered in the calculation of $Pens_i$: $bn_i = 1$ when the bonus was considered; $bn_i = 0$, when the bonus was not considered.

3.2.1.1 NOR

Additional to the above, we need to define some other variables, according to the type of pension. For the NOR we have the following, where i still represents the pensioner and t represents the future time, measured in years:

- $widasc_{i,t}$ is the variable that models the increase in the monthly pension associated to surviving widows/widowers and ascendants after 65 years or retirement age;
- $month_{i,t}$ is the factor by which the annual pension amount should be multiplied at time t, to ensure the annual pension i is correctly divided across each month;
- $Bonus_{i,t}$ represents the bonus factor at time t;
- $Limit_i$ represents the last moment in time a pensioner may receive a payment.

Next, we detail these four variables.

- $widasc_{i,t}$

$widasc_{i,t}$measures the increase from 30% to 40% of the salary for widows/widowers, or from 15% to 20% of the salary for ascendants, as stipulated by Base XIX of Law No. 2127/65, articles 17 and 20 of Law No. 100/97 and articles 58 and 61 of Law No. 98/2009. It is the factor by which the current annual pension amount should be multiplied at time t. The assumptions are:

- It is assumed that the widow(er) will not remarry in the future;
- If the pensioner is already aged 65 or 66 and 7 months, depending on the law the pension is regulated by, the increment is already considered in the annual amount;
- The future retirement age is fixed at the current one;
- After the pensioner reaches the age of 65 or 66 and 7 months, the pension will increase immediately for all future moments t;

$$widasc_{i,t} = \begin{cases} 4/3, & Law = 1965 \wedge x_i + \frac{m_i}{12} < 65 \wedge x_i + \frac{m_i}{12} + t \geq 65 \wedge \ i\ is\ widow(er) or\ ascendant \\ 4/3, & Law \neq 1965 \wedge x_i + \frac{m_i}{12} < 66.7 \wedge x_i + \frac{m_i}{12} + t \geq 66 + \frac{7}{12} \wedge i\ is\ widow(er) or\ ascendant \\ 1, & other\ cases \end{cases} \quad (16)$$

- $month_{i,t}$

$month_{i,t}$ is a factor used to correctly distribute the annual pension amount of pensioner i across all months of the year, at moment t.

$$month_{i,t} = \begin{cases} 1/12, & Law_i = 1965 \\ 2/14, & Law_i = 1997 \wedge (12 \times t (mod\ 12) = 4 \vee 12 \times t (mod\ 12) = 10) \\ 2/14 & Law_i = 2009 \wedge (12 \times t (mod\ 12) = 5 \vee 12 \times t (mod\ 12) = 10) \\ 1/14, & other\ cases \end{cases} \quad (17)$$

- $Bonif_{i,t}$

This factor only affects pensioners that have not benefited from the bonus before, and only the ones with IPP or IPATH, as these are the only ones where the pension amount depends on the disability coefficient. It measures the increase in the current annual pension amount at moment t considering the disability coefficient has a limit of 1.

$$Bonif_{i,t} = \begin{cases} min\left(\frac{1}{coef_i}, 1.5\right), & bn_i = 0 \wedge group_i = 1 \wedge x_i + \frac{m_i}{12} + t \geq 50 \\ min\left(\frac{0.7}{0.5 + coef_i \times 0.2}, \frac{0.5 + coef_i \times 0.3}{0.5 + coef_i \times 0.2}\right), & bn_i = 0 \wedge group_i = 2 \wedge x_i + \frac{m_i}{12} + t \geq 50 \\ 1, & else \end{cases} . \quad (18)$$

- $Limit_i$

$Limit_i$ is used to distinguish cases where the beneficiaries are the victim's children from other cases. It represents the final date on which the pension will be paid. According to the two most recent laws, in the event of the victim's death, their children are eligible to receive a pension until they turn 18, although this can be extended until they turn 25, provided they meet certain criteria (Article 20 of Law No. 100/97 and Article 60 of Law No. 98/2009). The only pensions that are not lifetime pensions are those paid to the victim's children, unless the child is affected by a disability. Two assumptions are made in the definition of this variable:

- To ensure prudence, and because it is hard to analyse the conditions for the extension of the pension, we consider that all the victim's children will receive payments until they are 25 years old;
- Children affected by a disability or chronic illness are well documented in the portfolio.

$$Limit_i = \begin{cases} 25 - x_i - \dfrac{m_i}{12}, & pensioner\ i\ is\ a\ child\ with\ no\ disability\ or\ illness \\ +\infty, & else \end{cases} \quad (19)$$

3.2.1.2 OR

For the OR we have the following four additional variables:

- $startage_t$ is the age of pensioner i rounded to the nearest integer when a pension is first due;
- $age_{i,t}$ is the age of pensioner i rounded to the nearest integer, at moment t;
- $Factor_{type,age}$ is the factor in the tables from annex X, where $type$ and age are the type of pensioner and their age in the respective table;
- $pat_{i,t}$ is the probability that the lump sum associated to the OR pension i is paid at time t.

3.2.2 Probability of survival

Since our model involves SLT, we need to define the required probabilities of survival. We use the mortality table in Appendix 4 (Instituto Nacional de Estatística, 2025) calculated by INE for the period of 2021 to 2023. It contains $q_{x,sex}$ for both genders and integer ages x. To estimate the future cash flows, we need to calculate monthly probabilities of survival from the mortality rates in the life table. Consider that ${}_tp_{x,sex}$ is the probability that a person of a given gender and age x will survive for t years, and ${}_tq_{x,sex}$ is the probability that a person of a given gender and age x will die in t years. Using traditional actuarial life techniques, that can be found, for instance, in Dickson D, Hardy M, Waters H (2019), we can estimate the required probabilities. In annex X, we show step by step how they can be obtained, using equations A14 to A18 of Appendix 3.

3.2.3 Provision for NOR

To complete the final formula of the NOR pensions provision, it is important to address some final assumptions.

- The year is divided equally into 12 months;

- All monthly cash flows are discounted as if they were paid in advance, given that the law requires all payments to be made by the third day of each month;
- All NOR pensions are currently in payment and follow the standard payment pattern set out in the law;
- Whether the annual pension amount is definitive or an estimate, we calculate the annuity based on it;
- The annual pension amount does not change aside from the bonus. In the case of death, where there are multiple beneficiaries, it is possible that the death of one beneficiary will change the annual pension amount of the others. This effect is not considered.

The provision for the specific pensioner i under the scope of Solvency II or IFRS 17 is determined using equation 20 below. This formula aggregates all expected cash flows, calculated based on survival probabilities, and discounts them at the beginning of each month, starting from 1 January 2025 (time 0).

$$Prov.NOR_{i,scope} = \sum_{t=\left\{0,\frac{1}{12},\dots,Limit_i\right\}} Pens_i \times {}_tp_{x_i+\frac{m_i}{12},sex_i} \times \left(1+s_{t,scope}\right)^{-t} \times month_{i,t} \times Bonif_{i,t} \times widasc_{i,t}. \quad (20)$$

The RBNS provision for NOR pensions is the sum of all the individual provisions.

3.2.4 Provision for OR

OR pensions introduce a new challenge when it comes to calculating provisions. Since they are paid as a lump sum, it is important to determine the timing of the cash flow to accurately discount it in the model. The company's history shows that the length of time it takes to redeem varies, so this variability must be modelled. To address this issue, we conducted a survival analysis using the Kaplan–Meier estimator, which was first derived in Kaplan & Meier (1958). The explanation of this method is in Appendix 1. Also in Appendix 1, we define the probabilities of pensioner i receiving the lump sum at moment t, $pat_{i,t}$, under some assumptions. We define $pat_{i,t}$ as the payment pattern, and it is derived from the equations A5 to A10.

By estimating the patterns, we can calculate the OR pension provision for each individual pension. As the OR provision is more challenging, we will divide it into two parts. The first part is the provision without considering the bonus. The assumptions are:

- If a payment occurs in any month, it is discounted as if it were made at the end of the month;
- We disregard the probability of death in this case, because if the pensioner or beneficiary dies the capital amount is always owed to the family.

The provision amount for an OR pension i under the regime $scope$ is given by equation 21. The capital is obtained by multiplying the annual amount by the respective factor, while the discount considers the payment pattern.

$$Prov.OR.1_{i,scope} = \sum_{t=\left\{0,\frac{1}{12},\dots\right\}} Pens_i \times \left(1+s_{t,scope}\right)^{-t} \times pat_{i,t} \times Factor_{type,startage_i}. \quad (21)$$

The second part measures the bonus provision, which is more complex. This is divided into two categories. The first comprises pensions that remain under the conditions of an OR pension after receiving the bonus, meaning they can be redeemed. The second comprises pensions that initially qualify as OR pensions, but become NOR pensions after receiving the bonus. This was discussed in subsection 3.1.5.

For the first category, the bonus will be paid as a lump sum, calculated according to OR pension rules. In this case, we must consider the possibility of the pensioner dying before requesting the bonus. If the bonus has already been considered in the calculation, $(1 - bn_i)$ will have a value of 0, meaning this provision will also be 0.

We consider the following assumptions:

- If the pensioner receives the original capital before the age of 50, then they will request and receive the bonus once they reach the age of 50. If the pensioner receives the original capital only after the age of 50, then they will receive the bonus at the same date they receive the original capital;
- The additional annual pension amount after the bonus is always 50% of the original;
- For the age factor we consider the age at the latest time between the time the pensioner reaches 50 years of age or when the original lump sum is paid;

The formula for an OR pension i under the regime $scope$, that maintains the conditions required for it to be an OR pension after the bonus, is the following:

$$Prov.OR.2_{i,scope} = \sum_{t=\left\{\frac{1}{12},\dots\right\}} 0.5 \times Pens_i \times \left(1 + s_{\max(50-x_i-\frac{m_i}{12},t),scope}\right)^{-\max(50-x_i-\frac{m_i}{12},t)} \times {}_{\max(50-x_i-\frac{m_i}{12},t)}p_{x_i+\frac{m_i}{12},sex_i} \times pat_{i,group_i,12\times t} \times Factor_{type,age_{i,t}} \times (1 - bn_i) \quad (22)$$

The second category encompasses the remaining cases, when the conditions for redemption are no longer verified after the bonus is considered. This means that the increment of the annual pension amount will be paid as a NOR pension. Again, if the bonus is already considered in the calculation, the bonus provision will be 0.

The following assumptions are made:

- The pensioner requests and receives the bonus at the same dates as in the previous case. The annuity starts immediately;
- The additional annual pension amount after the bonus is always 50% of the original.

The formula for an OR pension i under each regime, that does not meet the conditions required for it to be an OR pension after the bonus, is the following:

$$Prov.OR.3_{i,scope} = \sum_{t=\left\{0,\frac{1}{12},\dots\right\}} 0.5 \times Pens_i \times \left(1 + s_{\max(50-x_i-\frac{m_i}{12},t),scope}\right)^{-\max(50-x_i-\frac{m_i}{12},t)} {}_{\max(50-x_i-\frac{m_i}{12},t)}p_{x_i+\frac{m_i}{12},sex_i} \times \left(1 - \widehat{S^F}_{i,group}\left(365 \times \max\left(50 - x_i - \frac{m_i}{12}, t\right)\right)\right) month_{i,t}(1 - bn_i), \quad (23)$$

where $\widehat{S^F}_{i,group}(t)$ is the probability of the pension being paid after t or more days since the accident date.

4. PROVISION OF LIFETIME ASSISTANCE CLAIMS - SIMILAR TO LIFE TECHNIQUES

4.1 Setting the framework

In this work, the concept of lifetime assistance (Assistência Vitalícia - AV) includes two different realities. The first is typical lifetime assistance, and the second is a supplementary pension.

Typical lifetime assistance covers medical and other claims for which the insurance company is liable. These expenses fall into the same category as those included in the non-SLT case and are included in the reparations mentioned in base IX a) of Law No. 2127/65, article 10 a) of Law No. 100/97, and article 23 a) of Law No. 98/2009.

Most non-SLT claims fall within the period of temporary disability because the insurance company is liable for any expenses that guarantee the victim's best possible health recovery and work capacity. When the disability coefficient and degree of disability are defined, this suggests that the victim's condition is stable, which in turn suggests that there is less need for additional medical assistance. This is not always the case. Even after the disability is defined, the characteristics of the disability often require lifetime medical care.

It is also important to calculate the provision individually using life expectancy techniques, because the financial burden can be significant; in many cases of severe disability, such as IPA, the provision far outweighs the pension's provision.

The second case is a supplementary pension, which is paid when an injured person requires the assistance of a third person due to the extent of their disability. This is set out in Base XVIII of Law No. 2127/65, Article 19 of Law No. 100/97, and Article 53 of Law No. 98/2009.

4.2 Calculation of the provision

4.2.1 Traditional lifetime assistance

Traditional AV processes are modelled as a monthly annuity where the future monthly payments are adjusted for future inflation. If $X_{i,n}^{m}$ is the value of monthly AV expenses for pensioner i in month n, then the AV provision of process i for either $scope$ is calculated according to the equation below.

$$Prov.AV_{i,scope} = \sum_{n=1}^{+\infty} \frac{X_{i,n}^{m}}{\left(1 + s_{n/12,scope}\right)^{n/12}}. \qquad (24)$$

To calculate the provision, we need to compute $X_{i,n}^{m}$. We will consider three kinds of AV processes that have different methods for calculating $X_{i,n}^{m}$, they are:

- Processes with historical data – processes that registered at least one payment on previous years;
- Processes without historical data – processes that have been considered AV but did not register payments on previous years;
- Processes with technical means – processes that have been specifically analysed by the claims management department, and for which the average annual AV expenses are known.

All methods, although different, have one similarity. The future monthly payments $X_{i,n}^{m}$ are obtained by including future inflation, assuming it follows the same pattern as the one defined in Chapter 2: 2.1% in 2025 and 2% afterwards. Then

$$X_{i,n}^{m} = \begin{cases} X_i^{m,adj} \times (1.021)^{\frac{n}{12}}, & n \leq 12 \\ X_i^{m,adj} \times 1.021 \times (1.02)^{\frac{n-12}{12}}, & n > 12 \end{cases}, \tag{25}$$

where $X_i^{m,adj}$ is the average adjusted monthly amount.

- Processes with historical data

In the case of processes with historical data, there are two steps.

The first step is to adjust the observed data to 31 December 2024. For each process with historical data, the observed data we have is the total amount of AV expenses per year m. Assuming that the payments were made at the midpoint of the year, we adjust the observed values the same way we did in subsection 2.2.1. In this chapter, however, we use the historical inflation curve in Appendix 6, Table A5. This curve is equal to the homologous variation rate of the CPI for health goods (Bank of Portugal, n.d.), for years 2012 to 2024; for years before 2012, it corresponds to the homologous variation rate of the CPI for consumer goods (Bank of Portugal, n.d.).

The second step is to define $X_i^{m,adj}$. Considering the adjusted yearly payments, we calculate a sample average of the most recent observations, starting from: (i) the fifth most recent year in which the payment was not zero; (ii) the year of the first payment, for processes with fewer than five observations higher than zero. Considering this is an average of the yearly payments, if we assume that all adjusted payments are uniformly distributed throughout the year, then we can define $X_i^{m,adj}$ as the previous result divided by 12.

This method was chosen for two reasons: (i) the observed data does not show a pattern of increase or decrease over the years, but the payments seem to stabilize, which means the most recent observations are more reliable; (ii) in many cases, the period of the payments is not annual, and this method avoids undervaluing $X_i^{m,adj}$ when there are several years without payments in the recent observations.

- Processes without historical data

It is common practice in the company for the claims management department to open an AV process if it predicts that the pensioner will require it in the future. This is the reason why some processes do not have historical data.

Since these processes do not have information of their own, we need to use the only reliable information we have: the processes with historical data and the technical means processes. I was asked by the company to calculate $X_i^{m,adj}$ using only the historical data.

We calculate $X_i^{m,adj}$ considering the degree of disability of the pensioner. The method is straightforward, as we separate all the processes with historical data by the degree of disability and calculate the average of the amounts $X_i^{m,adj}$ of these processes. In the end, we will have three different averages according to each degree of disability.

- Processes with technical means

Processes with technical means are those that have been analysed by the claims management department, which proposed an average annual cost of the process for the future. Since these processes are usually outliers and are carefully analysed, we must consider these costs in the calculation of the provision. Because of this, in the cases where there are technical means, $X_i^{m,adj}$ is equal to the technical mean divided by 12.

After calculating the values of $X_i^{m,adj}$ for all three types of processes, the individual provisions can be determined using equations 24 and 25.

4.2.2 Supplementary pension

The supplementary pensions provision is easily calculated since the supplementary pension is just a monthly annuity that follows the same payment pattern as the NOR pensions, and the annual amount is SP_i.

The monthly supplementary pension amount has a maximum defined by law: when base XVIII of Law No. 2127/65 is the applicable legislation, it cannot exceed 25% of the pensioner's disability pension; if article 19 of Law No. 100/97 is applicable, it cannot exceed the guaranteed minimum monthly wage for domestic service workers; when it is calculated following article 54 of Law No. 98/2009, it cannot exceed 1.1IAS (Indexante de Apoios Sociais - Social Support Index). The analysis of the evolution of the minimum monthly wage for domestic service workers and the IAS was beyond the scope of this report. Although an increase is expected, we consider that both will remain constant, as will SP_i.

The provision for the supplementary pension i under the specified $scope$ is $Prov.Sup_i$, and it is calculated according to the equation below.

$$Prov.Sup_{i,scope} = \sum_{t=\left\{\frac{1}{12},\frac{2}{12},\dots\right\}} SP_i \times {}_tp_{x_i+\frac{m_i}{12},sex_i} \times \left(1+s_{t,scope}\right)^{-t} \times month_{i,t}. \qquad (26)$$

5. PROVISION FOR THE WORKERS' ACCIDENTS FUND - SIMILAR TO LIFE TECHNIQUES

5.1 Setting the framework

The Workers' Accidents Fund (*Fundo de Acidentes de Trabalho* – FAT) was created by the Decree-Law No. 142/99, replacing the old *Fundo de Actualização de Pensões de Acidentes de Trabalho* (FUNDAP). Its main responsibilities are to guarantee payment of compensation for workplace accidents when employers are unable to do so, reimburse insurance companies for pension updates they are liable for, and pay worker's compensation premiums for companies undergoing reorganization[11] (ASF, n.d.).

Article 3 of the Decree-Law introduces the sources of revenue of the FAT. Among these sources are contributions from insurance companies, as set out in sections 1(a) and 1(b). Our report focuses on section 1(b) of article 3, which outlines the revenue arising from incurred claims. This section establishes that insurance companies must pay a percentage of the capital amount (as calculated in the OR pensions) of all pensions and the mathematical provision of supplementary pensions, by 31 December each year. The percentage value is in accordance with section 2 of the article and is fixed by the minister of finance yearly. It was last reviewed in 2007, when it was set at 0.85%, and has remained constant since (Ministério das Finanças e da Administração Pública, 2007).

5.2 Calculating the provision

We need to consider the NOR, OR and supplementary pensions cases separately because of the individual details. For simplicity, we assume the percentage mentioned before will be constant in the future, and that the payment is done at the end of June.

5.2.1 NOR

For NOR pensions, the payment to the FAT will be the annual pension amount multiplied by the relevant factor from Portaria 11/2000 (Ministério das Finanças, 2000), considering the pensioner's age at the end of each year and the type of pensioner.

The FAT provision for a NOR pension i under the Solvency II or IFRS 17 regimes is calculated as follows:

$$Prov.FAT.NOR_{i,scope} = \sum_{t=\{0,1,\dots,M_i-1\}} \begin{matrix} 0.85\% \times Pens_i \times Factor_{age_{i,t}} \times {}_tp_{x_i+\frac{m_i}{12},sex_i} \left(1+s_{\left(t+\frac{1}{2}\right),scope}\right)^{-\left(t+\frac{1}{2}\right)} \\ \times Bonif_{i,t} \times widasc_{i,t} \end{matrix} . \quad (27)$$

5.2.2 OR

We defined a payment pattern for OR pensions, meaning that some pensions remain payable longer than others. It can take years for the capital to be fully paid, and, therefore, we must consider the possibility of OR pensions being payable on 31 December in future years.

We also considered two scenarios, one where the OR conditions are met and one where the OR conditions are not met after applying the bonus. We are only interested in the scenario for which the conditions are not met. That is because in such scenario, we

[11] https://www.fat.asf.com.pt/fat/apresenta%C3%A7%C3%A3o

will have a new annuity, and we must make yearly payments to the FAT until the death of the pensioner. In the other scenario, we assumed, when defining the methodology in Chapter 3, that the bonus payment would be made on the later of the following dates: when the person reaches the age of 50, or when the original payment is made. There is no time interval between the bonus becoming due and it being paid. Unless any of the previous dates coincide with 31 December, which we can disregard, the bonus will not impact the FAT.

Considering all this, the FAT provision for an OR pension i is calculated in two parts: the first part is common for all OR processes, and the second one is added to the first only in the scenario we discussed.

The first part of the FAT provision for process i under the particular $scope$ is given by:

$$Prov.FAT.OR.1_{i,scope} = \sum_{t=\{0,1,\dots,M_i-1\}} 0.85\% \times Pens_i \times Factor_{type,age_{i,t}} \times \widehat{S^F}_i(365 \times t) \times \left(1 + s_{t,scope}\right)^{-t}. \quad (28)$$

Time t is measured in years. However, since the argument of the survival function of the future time until payment, $\widehat{S^F}_i(.)$ (see Appendix 1, equations A5 to A9), is measured in days, we multiply t by 365 for simplicity. $\widehat{S^F}_i(365 \times t)$ is the probability that the process is still in the portfolio after t years, which means the company is liable to pay the FAT.

The second part of the FAT provision for process i (if it applies) under the particular $scope$ is:

$$Prov.FAT.OR.2_{i,scope} = \quad (29)$$

$$\sum_{t=\{0,1,\dots,M_i-1\}} \frac{0.85\% \times Pens_i}{2} \times Factor_{type,age_{i,t}} \left(1 + s_{\max\left(50-x_i-\frac{m_i}{12},t\right),scope}\right)^{-max\left(50-x_i-\frac{m_i}{12},t\right)}$$
$$\times {}_{max\left(50-x_i-\frac{m_i}{12},t\right)}p_{x_i+\frac{m_i}{12},sex_i}\left(1 - \widehat{S^F}_{i,group}\left(365 \times max\left(50 - x_i - \frac{m_i}{12}, t\right)\right)\right).$$

5.2.3 Supplementary pension

The last provision of the FAT pertains to the supplementary pension. The law mandates insurance companies to pay a percentage of the supplementary pensions mathematical provision to the FAT. However, it is common practice within the company and the Portuguese insurance market to interpret the law by applying the same principles used for the other pensions; this means calculating the capital with the annual supplementary pension amount and the factor pertaining to pensioner i.

The FAT provision of the supplementary pension of pensioner i under the regime in $scope$ is given by:

$$Prov.FAT.Sup_{i,scope} = \sum_{t=\{0,1,2,\dots\}} 0.85\% \times SP_i \times Factor_{type,age_{i,t}} \times {}_tp_{x_i+\frac{m_i}{12},sex_i}\left(1 + s_{t,scope}\right)^{-t}. \quad (30)$$

5.3 Results

The following Tables 6 to 9 were obtained using equations 16 to 30 and equations A5 to A10 of Appendix 1. They present the obtained claims provisions, excluding expenses, under both Solvency II and IFRS 17. These results reflect the treatment of SLT Workers' Compensation RBNS claims provisions, explained previously, and provide a consistent view of these liabilities across accounting and regulatory perspectives.

The RBNS SLT provisions calculated under Solvency II and IFRS 17 show a more material difference compared to what is observed for non-SLT provisions. This divergence is primarily driven by the long-term nature of the SLT liabilities, which increases the sensitivity of the present value to the discount curves applied under each regime. The use of different discount rates, particularly over longer projection horizons, amplifies the impact and leads to a more pronounced gap between the two frameworks.

When comparing these technical provisions with the Company's own reported results, the overall differences range between €20 million and €22 million. These significant variations are largely explainable and arise from methodological choices and differences in key assumptions, as detailed in the Tables 8 and 9:

SOLVENCY II | GENERAL COMPARISON

(u.m. euros)

SOLVENCY II SLT Claims	DISCOUNTED CASH FLOWS COMPANY 31/12/2024	RECALCULATED DISCOUNTED CASH FLOWS 31/12/2024	DIF.	DIF (%)
PENSIONS NOR	132 090 342	137 331 243	-5 240 901	-4%
PENSIONS OR	11 517 676	16 607 860	-5 090 184	-31%
LIFELONG ASSISTANCE	34 163 461	43 860 675	-9 697 214	-22%
FAT	7 998 630	10 411 118	-2 412 488	-23%
Subtotal	**185 770 109**	**208 210 896**	**-22 440 787**	**-11%**
Check Lusitania	*0,0000*	*0,0000*	*0,0000*	*0,0000*

Table 6: Solvency II SLT Claims Provision - Own elaboration.

IFRS 17 | GENERAL COMPARISON

(u.m. euros)

IFRS 17 SLT CLAIMS	DISCOUNTED CASH FLOWS COMPANY 31/12/2024	RECALCULATED DISCOUNTED CASH FLOWS 31/12/2024	DIF.	DIF (%)
PENSIONS NOR	120 876 773	125 577 421	-4 700 648	-4%
PENSIONS OR	11 465 727	16 380 699	-4 914 971	-30%
LIFELONG ASSISTANCE	30 764 900	38 990 529	-8 225 630	-21%
FAT	7 447 529	9 672 052	-2 224 523	-23%
Subtotal	**170 554 929**	**190 620 701**	**-20 065 772**	**-11%**
Check Lusitania	*0,0000*	*0,0000*	*0,0000*	*0,0000*

Table 7: IFRS 17 SLT Claims Provision - Own elaboration.

SOLVENCY II | DRILL-DOWN DIFFERENCES						
						(u.m. euros)
RECALCULATED SOLVENCY II SLT CLAIMS	DISCOUNTED CASH FLOWS 31/12/2024	BONUS IMPACT	EVL IMPACT	MORTALITY TABLE IMPACT	MAIN IMPACTS TOTAL	% JUSTIFIED
PENSIONS NOR	137 331 243	-4 286 265	-1 518 955	-982 096	-6 787 317	130%
PENSIONS OR	16 607 860	-3 355 917	0	0	-3 355 917	66%
LIFELONG ASSISTANCE	43 860 675	0	-9 068 602	-324 049	-9 392 652	97%
FAT	10 411 118	-489 199	-117 933	-54 722	-661 855	27%
Subtotal	**208 210 896**	**-8 131 381**	**-10 705 491**	**-1 360 868**	**-20 197 740**	**90%**
Check Lusitania	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	

Table 8: Solvency II SLT Claims Provision Drill-Down - Own elaboration.

IFRS 17 | DRILL-DOWN DIFFERENCES						
						(u.m. euros)
RECALCULATED IFRS 17 SLT CLAIMS	DISCOUNTED CASH FLOWS 31/12/2024	BONUS IMPACT	EVL IMPACT	MORTALITY TABLE IMPACT	MAIN IMPACTS TOTAL	% JUSTIFIED
PENSIONS NOR	125 577 421	-3 851 110	-1 317 040	-847 869	-6 016 018	128%
PENSIONS OR	16 380 699	-3 168 788	0	0	-3 168 788	64%
LIFELONG ASSISTANCE	38 990 529	0	-7 724 443	-271 797	-7 996 240	97%
FAT	9 672 052	-447 890	-104 216	-46 703	-598 808	27%
Subtotal	**190 620 701**	**-7 467 788**	**-9 145 698**	**-1 166 369**	**-17 779 855**	**89%**
Check Lusitania	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	

Table 9: IFRS 17 SLT Claims Provision Drill-Down - Own elaboration.

All differences between the provisions calculated in this study, and those reported by the Company, have been thoroughly identified and are fully explainable. The main sources of these differences are summarized below:

1. Bonus treatment: In this study, since it is a right reserved to the insured party, the bonus was directly considered under the RBNS provisions;
2. EVL treatment: These pensioners have a truncated mortality rate in the base model (all are IPA and have an AV pension). In our model we consider the normal mortality rates;
3. Mortality table considered: The most recent INE mortality table (2021–2023) was used, replacing the previously applied INE mortality table for 2020–2022;
4. Additional small differences, not quantified: Slightly different OR pension claims payments, recalculated average lifetime assistance annual costs, and a slightly different FAT universe.

6. PROVISION FOR INCURRED BUT NOT REPORTED CLAIMS

6.1 Setting the framework

In Chapter 2, we estimated the IBNR for a category of claims that we defined as simple processes; however, we must apply the same reasoning to the severe processes. IBNR is the typical nomenclature used in the insurance market, but the concept of 'not reported' is more in line with the company's identification of processes that have not yet evolved to a certain state. In our case, this would be a simple process, evolving into a severe process.

Also, although we name this chapter IBNR, in fact we are calculating a distinct concept called Pure IBNR.

The Pure IBNR only includes claims that are *unreported*, or in this case, processes not identified as severe, here we must assess the impact that new arising severe processes will cause.

The Pure incurred but not enough reported (IBNER) claims are adjustments to reported severe processes. Together, they represent the broader term IBNR. Ideally, it would measure the impact on the provision of all the underlying assumptions of our model. It is the difference between the initial estimate (RBNS) and the actual claim cost.

Together the Pure IBNR and the Pure IBNER represent he broader term IBNR (EIOPA, 2014).

6.2 Pure incurred but not reported

To estimate the Pure IBNR we will consider two dimensions:

- WC pensions;
- Lifetime assistance pensions.

Due to significantly greater uncertainty around both the number of pensions that will emerge and the specific characteristics of such pensions, it is impractical to estimate the IBNR provision with the same level of granularity as in the RBNS or AV analysis. Our methodology, therefore, aims to: (i) predict the number of new pensions for each type of pension; and (ii) assume that each pension within a type is well represented by the average case. This methodology will be applied to both WC and AV pensions.

6.2.1 WC pensions

There are four types of WC pensions that may arise in the IBNR:

- IPP pensions;
- IPATH pensions;
- IPA pensions;
- Death pensions.

In this section, we will estimate the number of WC pensions of each type that will arise in the future, as well as the average cost of each pension. However, before doing so, we should present our understanding of the IBNR concept in more detail. For WC pensions, IBNR relates to new pensions arising from accidents that have already occurred. These pensions can have two origins: they can either originate from accidents that have not yet been reported to the company or from accidents that have been reported but have not yet resulted in a pension. Analysis of company data shows that the latter situation is the most common.

This concept is key to our methodology because most accidents are reported in the year of the accident, as expected. In fact, Article 87 of Law No. 98/2009 states that employers have 24 hours to notify insurance companies from the moment they become aware of an accident. Furthermore, Article 86 states that victims or legal beneficiaries have only 48 hours to notify employers, if the employer did not witness the accident or became aware of it in the meantime, so there is a very small-time window for accidents not to be reported in the year they occur.

Considering all of this, it is required to use metrics of the reported accidents in each year, such as the percentage of each gender and the average salary, as they will certainly impact the IBNR.

6.2.1.1 Number of pensions by type

We have opted for a two-step method to estimate the number of IBNR WC pensions. First, we calculate the total number of pensions. Second, we use percentages to allocate them to each pension type.

To calculate the total number of pensions, we consider the chain-ladder estimator (Mack, 1994) as we have used in the non-SLT provision, however with a cumulative claims count run-off triangle instead of a cumulative claims amount run-off triangle.

First and foremost, we should define what a claim count is. While the first three types of pensions - IPP, IPATH and IPA - can be uniquely identified with a specific accident, death pensions cannot, since one death can result in multiple pensions. For this reason, we have decided not to count the total number of pensions opened in a given accident year, over a given development period, but rather the number of severe processes (the ones resulting in at least one pension). This means that multiple death pensions arising from the same accident will only appear as one.

To model the total number of processes arising we make the following assumptions:

- The triangle considers fifteen accident years from 2010 to 2024 and fifteen development periods;
- The chain-ladder methodology is exactly the same as the one used for the claims amount run-off triangle in the non-SLT case;
- The outstanding claims count, defined as the difference between the ultimate claims count and the observed claims count for each accident year, represents the number of IBNR processes;
- For the sake of simplicity, we assume all IBNR processes will arise at the beginning of 2025.

We denote the outstanding claims by accident year n as $num.ibnr_n$, $n = 2011, \dots, 2024$, because year 2010 will not have any new processes due to the assumptions of the chain-ladder.

Having obtained the number of IBNR processes by accident year, we must consider the proportion that each type contributes to the total number, and for that we consider a simple historical proportion.

We should also note that it is common for the company to open processes before it is certain that they will lead to a pension. Later, the process is closed if the accident does not result in any pension. This means that although there are only four types of pensions, the sum of their proportions does not equal one.

The proportion for a given type is calculated dividing the total number of pensions of that type by the total number of severe processes opened, considering as data all processes from accident years 2010 to 2024.

The proportion of each type is denoted $prop_{type}$.

6.2.1.2 Average pension

In this sub section we estimate the average case pension for each of the four types. This average should consider not only the company's historical experience, but also use the information of simple processes from every accident year. A simple process is opened immediately after the accident was reported to the company. When a simple process is expected to result in at least one pension is classified as a severe process.

We will derive the average case for the first three types: IPP, IPATH and IPA. Some additional notation must first be set:

- $\Delta_{type}(Sal, coef)$ represents the annual pension amount for any of the three types calculated according to Law. No. 98/2009 and Table 5.
- $\overline{Sal}_{n,sex}$ represents the average salary of the victims in simple processes, conditional on the gender and accident year n.
- $\overline{coef}_{type,sex}$ represents the historical average disability coefficient, conditional on the type of pension (which coincides to the degrees of disability in this case) and gender.
- $\overline{Pens}_{type,n,sex} = \Delta_{type}(\overline{Sal}_{n,sex}, \overline{coef}_{type,sex})$ represents the average pension amount for a pensioner of a given type, gender, and accident year n.
- $\overline{age}_{n,sex}$ represents the average age of the victim in simple processes, conditional on the gender and accident year n. From this result we can also obtain $\bar{x}_{n,sex}$ and $\bar{m}_{n,sex}$ which are the complete years and months of $\overline{age}_{n,sex}$.
- $\overline{gp}_{sex,n}$ represents the proportion of each gender in the total number of simple processes, conditional on the accident year n.

Finally, to calculate the IBNR provision of the first three type of WC pensions, our method uses the formulas of the total provision derived in the RBNS chapter, only considering a hypothetical pensioner with the characteristics above. In the end, because we consider the type, gender and accident year, there will be $3 \times 2 \times 14 = 84$ different 'average pensioners'. The total number of outstanding processes will be proportionally divided by them. The provision for each of the 84 cases given the regime in $scope$ is given by:

$$Prov.case_{type,sex,n,scope} = \begin{cases} Prov.OR_{scope}\left(\overline{Pens}_{type,n,sex}; \overline{age}_{n,sex}; \overline{coef}_{type,sex}; sex; victim\right), & if\ type\ is\ IPP \\ Prov.NOR_{scope}\left(\overline{Pens}_{type,n,sex}; \overline{age}_{n,sex}; \overline{coef}_{type,sex}; sex; victim\right), & other\ cases \end{cases} \quad (31)$$

$Prov.OR_{scope}$ and $Prov.NOR_{scope}$ are particular cases of equations 20 and 21 and 22 respectively, using as arguments the averages we calculated above as the characteristics of the pensioner. The last argument indicates what kind of pensioner it is.

Regarding the IPP, we assume that the average case is an OR pension, and that the accident occurred at the midpoint of the accident year. We then calculate the time from the accident to the reference date (necessary for calculating the payment pattern). The other two types consider a NOR pension.

$$Prov.IBNR.WC_{scope} = \sum_{\substack{sex \in \\ \{M,F\}}} \sum_{\substack{type \in \\ \{IPP, IPATH, IPA\}}} \sum_{n=2010}^{2024} num.ibnr_n \times prop_{type} \times \overline{gp}_{sex,n} \times Prov.case_{type,sex,n}. \quad (32)$$

The methodology for death pensions is slightly different, as one death may result in several pensions. According to the legislation, there are three potential kinds of beneficiaries: the spouse, the children, and the ascendants. We then need to establish, on average, how many of each kind are associated with one death.

To achieve this, we analyse the company's historical accident data from 2010 to 2024, calculating the proportion of pensions for spouses, children and ascendants relative to the total number of death pensions registered during this period.

Again, we need to set some additional notation and two assumptions:

- $\Delta_{lb}^{d}(Salary)$ represents the annual pension amount for any specified legal beneficiary lb (the spouse, children, or ascendants; we assume that it is possible to have up to four children and up to two ascendants);
- $\overline{Pens}_{lb,sex,n}^{d} = \Delta_{lb}^{d}(\overline{Sal}_{n,sex})$ is the average pension amount paid to the legal beneficiary lb for a death pension, considering the victim's gender and the accident year n;
- $\overline{plb}_{lb,m}^{d}$ is the proportion of death pensions with m legal beneficiaries of type lb;
- $\overline{diff.acs}$ is the average age difference between the victim and the ascendant, considering the historical data;
- $\overline{age.child}$ is the average age of a child at the moment the pension is due;
- We assume that the spouse is the same age as the victim;
- We assume that the probability of a child being male or female is 50% and the probability of an ascendant being male or female is 50% (when there are two ascendants one is male and the other is female).

These pensions are cumulative, and if the proportions of each pension kind are independent, this means that the total number of pensions on average arising from one death process is the sum of all the proportions. It is reasonable to say that the proportion for spouses and the proportion for children is correlated, however we consider they are independent. Because of the extension of the formulas, we must provision each kind of pension separately. The provision for the spouse, children and ascendants of accident year n and under the Solvency II or IFRS 17 regime is $Prov.kind.spouse_{n,scope}$, $, Prov.kind.children_{n,scope}$, and $Prov.kind.asc_{n,scope}$ respectively, and are estimated according to equations A11 to A13 in Appendix 2.

Finally, the total IBNR provision for death pensions under the respective $scope$ is calculated according to the equation 33 below:

$$Prov.IBNR.Death_{scope} = \sum_{n=2010}^{2024} \left(Prov.kind.spouse_{n,scope} + Prov.kind.children_{n,scope} + Prov.kind.asc_{n,scope}\right) \times num.ibnr_n \times prop_{death}. \quad (33)$$

6.2.2 AV pensions

Different from WC pensions, AV processes do not usually arise from simple processes. In fact, they only typically appear once a disability pension has been defined. For this reason, the IBNR for AV depends not only on new severe cases arising, but also on severe cases that have already been reported. In this section, we begin by evaluating the ultimate claim count for all IPP, IPATH and IPA pensions. This is the total number of reported pensions by type, with the IBNR claim total by type estimated in sub-subsection 6.2.2.1.

It is also true that AV processes are very hard to predict, partly because few are established each year, with noticeable differences between accident years. To calculate the provision for arising AV processes we used a method similar to the one used by the technical team, that we consider to be prudent. First, we must consider the following:

- $Prop.AV_{group}$ is the proportion of the ultimate number of pensions with a given degree of disability – IPP, IPATH and IPA – that will result in an AV process;
- $Avg.AV_{group}$ is the average monthly cost of an AV process for a given degree of disability, adjusted to the reference date; their amounts are the ones calculated in subsection 4.2.1;
- $num.ult_{group,n}$ is the ultimate number of severe claims obtained from the run-off triangle methodology for all three degrees of disability, and accident year n;
- $num.AV_{group,n}$ is the total number of reported AV processes with a given degree of disability and accident year n;

To calculate $Prop.AV_{group}$ we consider only the accident years 2010 to 2014, since in the company it is assumed (expert judgement) that there will be no new AV processes from accidents in this period. The proportion is given by the total amount of AV processes with a given degree of disability divided by the ultimate number of severe processes with that same degree of disability.

Once we have calculated $Prop.AV_{group}$, the total ultimate number of AV processes by degree of disability and accident year n is calculated according to equation 34. This formula calculates the temporary ultimate number of AV processes multiplying $num.ult_{group,n}$ by $Prop.AV_{group}$, and then taking a weighted average of this result and the reported number of AV processes $num.AV_{group,n}$. The weighting system gives more relevance to the temporary ultimate number for recent accident years, with decreasing relevance for older ones.

$$ult.AV_{group,n} = (num.ult_{group,n})(Prop.AV_{group})\frac{(n-2014)}{10} + num.AV_{group,n}\frac{(2024-n)}{10}. \quad (34)$$

The total provision, $Prov.IBNR.AV_{scope}$ under the $scope$ is calculated as follows. The average age of the pensioner and the proportion of each gender are the same as for the first three types of WC pension IBNR provision. Then,

$$Prov.IBNR.AV_{scope} = \sum_{\substack{sex\in\\ \{M,F\}}} \sum_{\substack{dod\in\\ \left\{\substack{IPP,\\ IPATH,\\ IPA}\right\}}} \sum_{n=2014}^{2024} \begin{matrix} max\left(ult.AV_{dod,n} - num.AV_{dod,n}; 0\right) \times \\ \overline{gp}_{sex,n} \times Prov.AV_{scope}(Avg.AV_{dod}; \bar{x}_{n,sex}; \bar{m}_{n,sex}) \end{matrix} \quad (35)$$

6.3 Pure Incurred but not enough reported

6.3.1 Calculating the provision

The methodology to calculate the provision is very simple. We apply the chain-ladder methodology (Mack, 1994), as we did before, but to an incurred cost run-off triangle. To understand the methodology, we must address the definition of incurred claims and the difference to the ultimate claims. Incurred claims are the sum of the paid claims with the RBNS claims, which is the estimated total cost of the reported processes. Ultimate claims are the sum of the paid claims with RBNS claims and IBNR claims, and represent the final amounts that the insurer will pay, when the process is settled (EIOPA, 2014, p.83).

The paid claims measure only past cash flows and the RBNS measure future cashflows; if the RBNS exactly provisions the future cash flows, this would imply that the incurred claims would remain constant over time. If the development of the incurred claims consistently suggests a pattern over the years, we have reasons to believe that the RBNS does not accurately capture the liability and needs to be adjusted. Our methodology estimates the adjustment using the development factors of the chain-ladder method applied to the incurred cost run-off triangle.

The difference between ultimate and incurred claims is important to build the triangle, as we need to separate the processes by *reporting year* instead of by *accident year*. The reason for this is that, when we divide the processes by reporting year, IBNR is not included in future developments, which is required.

We consider two different incurred cost run-off triangles, one for the permanent disability pensions, and another for death pensions. For both cases it is calculated as the sum of two other triangles: a cumulative paid amounts triangle and a RBNS provision triangle, which are obtained as follows:

- Applying the methodology from Chapter 3, we estimate the *undiscounted* RBNS provision, excluding the bonus (the necessary data is not available), at the reference data of 31 December, in years 2010 to 2024. We also exclude all pensions that, at the reference date of 31 December 2024, have already benefited from the bonus;
- We separate the RBNS provision for each process by reporting year n and year of reference m;
- The RBNS triangle is built by aggregating all provisions by reporting year n and the development year $m - n$;

- After the RBNS triangle is built, we register which specific processes were identified in each reporting year n;
- The cumulative paid amounts triangle is obtained by matching the processes from reporting year n to the payment receipts, considering the year of reference m in which the claims were paid.

Applying the chain-ladder methodology to the incurred cost run-off triangles we obtain the development factors $f.IBNER_{type,m}, m = 1,2, \dots ,14, type = 1,2,$ where $type = 1$ relates to the permanent disability case, and $type = 2$ relates to the death case.

If $RBNS_{n,type}, n = 2010, \dots ,2024,$ denotes the total provision (including the bonus) of the RBNS of processes reported in year n, per type, at the reference date 31 December 2024, then the IBNER provision for both regimes is $Prov.IBNER_{scope}$:

$$Prov.IBNER_{scope} = \sum_{type=1}^{2} \sum_{n=2011}^{2024} \left(RBNS_{n,type} \left(\left(\prod_{j=n-2010}^{14} f.IBNER_{type,j} \right) - 1 \right) \right). \quad (36)$$

Put simply, the method applies a factor to the processes reported over the past fourteen years. We also apply this factor to the bonus, as we assume that most IBNER for permanent disability pensions steam from the common disability revision, which will reflect in the bonus as well.

6.4 Results

The following Tables 10 to 13 present the Pure IBNR claims provisions obtained, excluding expenses, under both Solvency II and IFRS 17. These results reflect the quantification of the SLT Workers' Compensation Pure IBNR claims provisions, previously detailed. The equations 1 to 10, 31 to 35, A10 of Appendix 1 and A11 to A13 of Appendix 2 were used.

SOLVENCY II | GENERAL COMPARISON

(m.u. euros)

SOLVENCY II PURE IBNR CLAIMS	DISCOUNTED CASH FLOWS COMPANY 31/12/2024	RECALCULATED DISCOUNTED CASH FLOWS 31/12/2024	DIF.	DIF (%)
PENSIONS NOR	1 509 200	2 590 989	-1 081 789	-42%
PENSIONS OR	1 436 319	3 541 378	-2 105 059	-59%
LIFELONG ASSISTANCE	5 120 892	3 156 163	1 964 729	62%
Subtotal	**8 066 410**	**9 288 530**	**-1 222 119**	**-13%**

Table 10: Solvency II Pure IBNR Claims Provision - Own elaboration.

IFRS 17 | GENERAL COMPARISON

(m.u. euros)

IFRS 17 PURE IBNR CLAIMS	DISCOUNTED CASH FLOWS COMPANY 31/12/2024	RECALCULATED DISCOUNTED CASH FLOWS 31/12/2024	DIF.	DIF (%)
PENSIONS NOR	1 339 555	2 307 310	-967 754	-42%
PENSIONS OR	1 423 988	3 500 295	-2 076 307	-59%
LIFELONG ASSISTANCE	4 429 189	2 777 532	1 651 656	59%
Subtotal	**7 192 732**	**8 585 138**	**-1 392 405**	**-16%**

Table 11: IFRS 17 Pure IBNR Claims Provision - Own elaboration.

SOLVENCY II | DRILL-DOWN DIFFERENCES						
						(m.u. euros)
RECALCULATED SOLVENCY II PURE IBNR CLAIMS	DISCOUNTED CASH FLOWS 31/12/2024	DISCOUNTED CASH FLOWS WITHOUT BONUS 31/12/2024	BONUS IMPACT	MORTALITY TABLE IMPACT	MAIN IMPACTS TOTAL	% JUSTIFIED
PENSIONS NOR	2 590 989	2 361 595	-229 393	-12 756	-242 150	22%
PENSIONS OR	3 541 378	2 480 618	-1 060 760	0	-1 060 760	50%
LIFELONG ASSISTANCE	3 156 163	3 156 163	0	-24 236	-24 236	-1%
Subtotal	**9 288 530**	**7 998 376**	**-1 290 153**	**-36 992**	**-1 327 146**	**109%**

Table 12: Solvency II Pure IBNR Claims Provision Drill-Down-Own elaboration.

IFRS 17 | DRILL-DOWN DIFFERENCES						
						(m.u. euros)
RECALCULATED IFRS 17 PURE IBNR CLAIMS	DISCOUNTED CASH FLOWS 31/12/2024	DISCOUNTED CASH FLOWS WITHOUT BONUS 31/12/2024	BONUS IMPACT	MORTALITY TABLE IMPACT	MAIN IMPACTS TOTAL	% JUSTIFIED
PENSIONS NOR	2 307 310	2 111 254	-196 056	-9 892	-205 948	21%
PENSIONS OR	3 500 295	2 471 113	-1 029 182	0	-1 029 182	50%
LIFELONG ASSISTANCE	2 777 532	2 777 532	0	-19 661	-19 661	-1%
Subtotal	**8 585 138**	**7 359 899**	**-1 225 238**	**-29 553**	**-1 254 791**	**90%**

Table 13: IFRS 17 Pure IBNR Claims Provision Drill-Down-Own elaboration.

As presented, the differences observed are primarily explained by two main factors:

- Bonus treatment: In this study, the bonus effect was also considered under the IBNR claims provision;
- Mortality table: Consistently with the RBNS provision, the most recent INE mortality table (2021–2023) was applied, replacing the previously used 2020–2022 version.

The results of Table 14 and Table 15 were obtained considering equation 36, equations 1 to 10, equation A4 from Appendix 1, and the result of the RBNS SLT provision. The Pure IBNER claims provision, excluding expenses, under both the statutory and prudential frameworks:

SOLVENCY II | GENERAL COMPARISON				
				(m.u. euros)
Solvency II PURE IBNER CLAIMS	DISCOUNTED CASH FLOWS COMPANY 31/12/2024	RECALCULATED DISCOUNTED CASH FLOWS 31/12/2024	DIF.	DIF (%)
PENSIONS NOR	1 408 195	949 706	458 488	48%
PENSIONS OR	2 417 833	1 512 006	905 827	60%
Subtotal	**3 826 028**	**2 461 712**	**1 364 316**	**55%**

Table 14: Solvency II Pure IBNER Claims Provision- Own elaboration.

IFRS 17 | GENERAL COMPARISON				
				(m.u. euros)
IFRS 17 PURE IBNER CLAIMS	**DISCOUNTED CASH FLOWS COMPANY 31/12/2024**	**RECALCULATED DISCOUNTED CASH FLOWS 31/12/2024**	**DIF.**	**DIF (%)**
PENSIONS NOR	1 260 774	852 851	407 923	48%
PENSIONS OR	2 406 568	1 489 423	917 145	62%
Subtotal	**3 667 342**	**2 342 274**	**1 325 068**	**57%**

Table 15: IFRS 17 Pure IBNER Claims Provision – Own elaboration.

The main differences observed are primarily explained by the exclusion, in this study, of all historical claims involving bonuses, as these were accounted for directly under the RBNS claims provisions.

7. CONCLUSIONS

In summary, this internship report aimed to: (i) recalculate the technical provisions for WC group of contracts, in an independent manner, under Solvency II and IFRS 17 regime, particularly the best estimate for the cash flows arising from incurred claims; (ii) assess the company's model and measure the impact of the different methodologies applied.

The WC line of business revealed to be very complex and extensive. It required the use of several different actuarial methods, each adapted to a specific type of claim.

The provision calculated in Chapter 2 was derived using the chain-ladder method, which is an industry standard approach that is referenced in numerous academic papers. The methodology applied in this work resulted in an overall difference of approximately €0.5 million between the company's model and ours, which is fully explainable and arises from methodological nuances, assumption sets, and data calibrations specific to the IFRS 17 and Solvency II frameworks. The most significant drivers of the difference were found to be the differing development factors (notably the tail factor in the base model) and the timing of cash flows.

Chapters 3, 4 and 5 show the WC claims provision relating to pensions and other long-term claims, using traditional SLT. The difficulty with SLT lies in formulating a mathematical model that can address far-reaching legislation. Disregarding certain variables or considering certain assumptions can significantly impact the individual and total provision, which is the reason why it is mandatory to consider many of the legal concepts in depth.

The technical provisions under Solvency II and IFRS 17 calculated in these chapters were found to be between €20 million and €22 million higher in our model compared to the data provided by the Company. Through our analysis, we were able to explain approximately 90% of the observed differences under both reporting frameworks. The remaining 10% appears to arise from elements that could not be fully quantified, potentially due to differences in modelling methodologies or underlying data sets.

The key contributors to the discrepancies include: (i) the application of a truncated lifetime for EVL processes in the company's model; (ii) the treatment of the Bonus within the RBNS provision in our model, whereas it is considered under the Pure IBNER provision in the base model; and (iii) the use of different mortality tables.

The methodology outlined in Chapter 6 adopts the chain-ladder method as well as the SLT methodology derived in Chapter 3 to calculate the IBNR of pensions and lifetime assistance. To the best of our knowledge, there are no specific references that could assist in calculating the claims in study, or similar groups of contracts. The intrinsic uncertainty of the IBNR claims, coupled with the scarce data available, lead me to decide on the methods that relied on the previous chapters' methodology. The underlying assumption is that the IBNR will behave like the RBNS has historically.

The results showed that the company's Pure IBNR provision was around €1.3 million lower than ours, mainly explained by the bonus effect that this work also treated under IBNR.

In the case of the Pure IBNER provision, as expected, the Company's model estimated a higher liability under both regimes. This difference is fully attributable to the treatment of the bonus effect: in the Company's model, the bonus is included under the IBNER provision, whereas in this analysis, it was considered under the RBNS provision. As a result, the universe underlying the respective calculations differ significantly, since this analysis excluded from the scope all pensioners who had ever received the bonus.

The main conclusions of our analysis indicate that the EVL processes, the treatment of bonuses, and the choice of mortality tables are the primary factors influencing the calculation of Workers' Compensation (WC) claim provisions under both statutory and prudential frameworks.

As potential areas for improvement in this work, the following points are highlighted: (i) bonus cash flows should be weighted by the probability of payment, informed by historical company data and relevant market trends; and (ii) a backtesting analysis should be conducted to ensure the accuracy and robustness of all estimates.

To conclude, I would like to emphasize the positive experience I had during my internship. As my first professional experience in the workplace, it was truly enriching, I learned a great deal from my colleagues, and am indebted to them for all their support. Additionally, I feel a sense of achievement, knowing that I was up to the task and made a positive contribution to the team. The internship truly enriched the Master's program by allowing me to apply all the knowledge I had gained, which proved more useful every day.

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APPENDIX 1

- Bornhuetter-Ferguson method

The Bornhuetter-Ferguson method framework was originally proposed by Bornhuetter & Ferguson (1972). There are several ways to apply this method, but the one we considered is the Cape Cod method as described in Schmidt & Zocher (2008). We use an incremental paid claims run-off triangle with accident years from 1 to N. This means $C_{i,j}$ are the incremental claims from accident year i and development year j.

The general Bornhuetter-Ferguson method has the following assumptions:

$(BF1)$ $\exists \boldsymbol{\beta} = (\beta_1, \beta_2, \dots, \beta_N), \exists \boldsymbol{\gamma} = (\gamma_0, \gamma_1, \dots, \gamma_{N-1}),\ \gamma_{N-1} = 1$

$(BF1)$ $\hat{C}_{i,j} = \beta_i \times \gamma_j\ , \quad i = 1,2, \dots, N, j = 0,1, \dots N-1$

The parameters of the model $\beta_i, 1 \leq i \leq N$, are called the prior expected ultimate losses, in our model we assume they are the number of registered policies during accident year i. And $\gamma_j\ , 0 \leq j \leq N-1$, are the prior cumulative quotas.

To obtain the estimators for the prior cumulative quotas we can use the estimators for the cumulative factors of the chain-ladder method, as they can be converted into each other Schmidt & Zocher (2008, p.90) as follows:

$$\hat{\gamma}_k = \prod_{l=k+1}^{N-1} \frac{1}{\hat{f}_l}\ , \qquad k = 0, \dots, N-1\ . \qquad (A1)$$

To obtain the estimators for the prior expected ultimate losses the Cape Cod method, Schmidt & Zocher (2008, pp. 98-99) adds additional assumptions.

$(CC1)$ $\exists \boldsymbol{\pi} = (\pi_1, \pi_2, \dots, \pi_N);$

$(CC2)$ $\alpha_i = \kappa \times \pi_i\ , \quad i = 1,2, \dots, N.$

The vector $\boldsymbol{\pi}$ represents a measure of exposure for the accident year, in this study we consider the average number of policies in a year. The cape cod estimator for κ (Schmidt & Zocher (2008, p. 99) is:

$$\hat{\kappa}^{cc} = \frac{\sum_{j=1}^{N} C_{j,N-j}}{\sum_{j=1}^{N} (\hat{\gamma}_{N-j} \times \pi_j)}. \qquad (A2)$$

In a similar way to the chain-ladder method, we can calculate the predictor for the future cumulative claims and reserve as follows:

$$\hat{C}_{i,k} = C_{i,N-i} + (\hat{\gamma}_k - \hat{\gamma}_{N-i}) \times \hat{\kappa}^{cc} \pi_i\ , \qquad k = N-i+1, \dots, N-1, i = 2, \dots, N\ ; \quad (A3)$$

- Methods of Selection

It is a common actuarial practice, as well as a common practice within the company, to compute the chain-ladder estimates without considering all available observed data within the triangle. Such practices are called “methods of selecting claims development factors”, as described in Sahasrabuddhe (2008), and can be implemented within the chain-ladder method framework. Some of them, as well as their properties, are in Figure A1.

	Estimator			
Property	All-Year Average	Average of Recent Observations	Ex-Hi/Low Averages	Judgment
Unbiasedness	Yes	Yes	Yes	Unknown
Efficiency	Unknown	Unknown	Unknown	Unknown
Consistency	Yes	Not Applicable (Fixed sample size)	Yes	Unknown
Sufficiency	Yes	No	No	Unknown
Robustness / Resistance	Unknown	Unknown	Yes	Probably

Figure A1: Methods of Selection - Sahasrabuddhe (2008).

In our model, we considered two methods of selection, the 'Average of Recent Observations' and the 'Ex-Hi/Low Averages'. The first method of selection argues that, when estimating the development factors, we should only use the information of the most recent years in order to have a more unbiased prediction of the future. This is particularly helpful if we acknowledge that the individual development factors $\frac{C_{i,j}}{C_{i,j-1}}$ for recent years show significant differences compared to past years, for a given development period j. In our method, we will consider the recent observations as the past five years. The second method of selection defends that removing from each development period j, the year/s of the highest and/or lowest individual development factors from the estimation not only makes the estimation more unbiased, but also more robust to outliers.

To better understand the method, we should consider the equality deduced in Mack (1994).

$$\hat{f}_j = \frac{\sum_{i=1}^{N-j} C_{i,j}}{\sum_{i=1}^{N-j} C_{i,j-1}} = \sum_{i=1}^{N-j} \left(\frac{C_{i,j-1}}{\sum_{i=1}^{N-j} C_{i,j-1}} \times \frac{C_{i,j}}{C_{i,j-1}} \right), \qquad j = 1, \ldots, N-1. \tag{A4}$$

This demonstrates that the chain-ladder estimator for the development factors is a weighted average of the individual development factors, with weights equal to $\frac{C_{i,j-1}}{\sum_{i=1}^{N-j} C_{i,j-1}}$.

Essentially, these selection methods serve as criteria for excluding observations out of the weighted average calculation (additionally, excluded accident years must be removed when computing the weights). Figure A2 intuitively presents the exclusion criteria adopted. We exclude from each development year the highest and lowest development factors observed, except for the last 3 periods, as the number of observed factors is low. Also, we exclude all observations that are not from the past five years.

Accident year	Development year 1	2	3	4	5	6	7	8	9	10	11	12	13	14
2010	1,52129	1,05125	1,02649	1,01014	1,00406	1,00261	1,00162	~~1,00454~~	0,99704	1,00130	1,00224	1,00119	1,00089	1,00077
2011	1,54391	1,05627	1,01102	1,01142	~~1,01259~~	1,00350	1,00174	~~0,99996~~	0,99907	1,00109	~~0,99994~~	1,00044	1,00027	
2012	1,45787	~~1,03231~~	1,01377	1,01146	1,00044	~~0,99966~~	1,00393	1,00142	1,00198	1,00155	1,00163	1,00188		
2013	1,50276	1,05948	1,02959	1,00767	1,00495	1,00484	0,99833	1,00128	~~1,00361~~	~~1,00353~~	~~1,00285~~			
2014	~~1,55587~~	~~1,07912~~	1,02099	1,01347	1,01199	1,00611	~~1,00864~~	1,00179	~~0,99373~~	~~0,98399~~				
2015	1,53279	1,05184	1,02228	~~1,01568~~	1,00774	1,00007	~~0,99800~~	1,00270	1,00048					
2016	~~1,44672~~	1,05609	1,02002	1,01349	0,99683	1,00302	1,00207	1,00375						
2017	1,55310	1,06571	~~1,03478~~	1,00985	1,00121	~~1,00619~~	1,00123							
2018	1,54930	1,06669	1,02467	1,01231	1,00884	1,00107								
2019	1,52561	1,07529	1,02026	~~1,00430~~	~~0,99171~~									
2020	1,53166	1,06053	~~1,00185~~	1,00619										
2021	1,54710	1,06989	1,01996											
2022	1,49294	1,05363												
2023	1,45408													

Figure A2: Individual Development Factors Run-Off Triangle – Made by ResQ

- Decision CL and BF

To choose between the two methods, we perform backtesting on the cash flows from the latest five years. We use the root mean square error (RMSE) and the mean absolute error (MAE) as criteria. The results are as follows.

	MAE	RMSE
Chain Ladder	73 848,17 €	184 501,96 €
Bornhuetter-Ferguson	127 558,98 €	241 205,43 €

Table A1: Backtesting Chain-Ladder and Bornhuetter Ferguson – Own elaboration.

The results for both measures indicate that the chain-ladder method registered the lowest prediction error. Based on this criterion we take it as our model for provision.

- Kaplan Meirer

We present here the formulation of the Kaplan-Meier estimator, developed by Kaplan & Meier (1958). To present the estimator in a clearer way I used the lecture notes from the Actuarial Topics class (Bergel, 2024).

The Kaplan-Meier estimator is used to model the distribution of the time until the occurrence of an event of interest, typically called "death," as the estimator is highly applicable to many problems in the fields of medical sciences. The Kaplan-Meier estimator's main difference from previous time models is that it allows for incomplete sample data (censored data) in the estimation of the distribution. The estimator produces an estimate of the survival function of the time until occurrence of the event, but a random variable's survival function directly describes the distribution.

In our case, the payment of the OR pension's lump sum is the event of interest, and so we need to estimate the distribution of the time until the payment, but first we need to define our sample.

Our sample will be all the historic OR pensions with accident date after 1 January 2000, as this is the date when Law No. 100/97 was enacted. It was the first law that explicitly defined the conditions for redemption. The already paid pensions are the complete data sample, while the active OR pensions in our portfolio are the incomplete data sample; because they have not been paid, they are right censored.

The time in the study should be the difference between a start point and an endpoint. For the start point, we have several options, such as the day following the discharged of the injured person or date of death, the day a process is categorized as a permanent disability process or the day of the accident, among others. The suggestion made in the company was that the day of the accident should be used, as it presents the best quality data.

The endpoint of the complete data is the date of the payment, as this is the event of interest, and for the incomplete data, it is the reference date 31 December 2024.

With this in mind, we can formulate the Kaplan-Meier estimator following Bergel (2024). Defining:

- m is the number of deaths observed.
- $t_1 < t_2 < t_3 < \cdots < t_k$, $k \leq m$, are the ordered times (measured in days) at which deaths are observed, and $t_0 = 0$ and $t_{k+1} = +\infty$. t_j^- is the time right before t_j and before a death occurs $j = 1,2, \dots, k$;
- d_j is the number of deaths at time t_j, $d_j \geq 1, j = 1,2, \dots, k$;
- n_j is the number of observations at risk (not paid and uncensored) at t_j^-, $j = 1,2, \dots, k;$
- c_j is the number of observations censored in the interval $]t_j, t_{j+1}[$, $j = 1,2, \dots, k;$
- $n_j = n_{j-1} - c_j - d_{j-1}, n_0 = m, n_{k+1} = 0, j = 1,2, \dots, k;$
- If censor and death events occur at the same time t_j, then we assume that the death events occur before the censor, meaning these censored observations are included in n_j.

The random variables of the time until payment are defined as T_i, and the Kaplan-Meier model assumes they are independent and identically distributed. The observed values are $\min(T_i, L_i)$, where L_i is the time from the date of the accident until the reference date. In the case T_i is higher than L_i, we know that the observation is censored; in the case T_i is smaller than L_i we know the exact time until payment of the pension, and these observations are $t_j, j = 1,2, \dots, k$.

The Kaplan-Meier estimator at times $t_1 < t_2 < t_3 < \cdots < t_k$ is:

$$\hat{S}_T(t_j) = \hat{P}(T_i > t_j) = \prod_{e=1}^{j} \frac{n_e - d_e}{n_e}, \ j = 1,2, \dots, k, \tag{A5}$$

$$S_T(0) = 1, S_T(t_{k+1}) = 0. \tag{A6}$$

The Kaplan-Meier estimator only produces estimates at the points t_j, $j = 1,2, \dots, k$. For our model, we are interested in a survival function with daily frequency. To achieve that we assume that between each interval $]t_j, t_{j+1}[, j = 0,2, \dots, k$ the function follows a linear trend.

$$\hat{S}_T(t) = \hat{S}_T(t_{j+1}) \left(\frac{t - t_j}{t_{j+1} - t_j} \right) + \hat{S}_T(t_j) \left(1 - \frac{t - t_j}{t_{j+1} - t_j} \right), t \in]t_j, t_{j+1}[, j = 0,1, \dots, k. \tag{A7}$$

Additionally, we observed differences in behaviour when using different samples. Rather than considering a single distribution for all observations, we ended up estimating three distinct payment patterns. The first and second patterns used IPP and death pensions as samples, respectively, for which the company either had no co-insurance contract or was the leader of a co-insurance contract. The third pattern used all pensions with a co-insurance contract where the company was not the leader. Consequently, new survival functions must be defined: $S_{T_1}(0)$, $S_{T_2}(0)$ and $S_{T_3}(0)$, estimated using the Kaplan-Meier estimator with the before mentioned samples. The survival function for a particular pension i will be:

$$S_i(t) = \begin{cases} S_{T_1}(t), & if\ pension\ i\ is\ an\ IPP\ with\ no\ co-insurance\ contract \\ S_{T_2}(t), & if\ pension\ i\ is\ a\ death\ pension\ without\ co-insurance\ contract \\ S_{T_3}(t), & if\ pension\ i\ is\ not\ leader\ in\ a\ co-insurance\ contract \end{cases} \quad (A8)$$

We can model the timing of the lump sum cash flow under certain assumptions:

- The year is divided into 12 months all with the duration of 30 days.
- If a payment happens within a month, we discount the cash flow considering it is paid at the end of the month.

We are only interested in estimating future payment times for censored observations, as these are the only active pensions in the portfolio. However, as time has passed between the accident date and the reference date, we must calculate the conditional probability of survival. Suppose that for pension i it has passed ρ_i days since the accident date, we need to estimate the survival function of the future time $T_i^F = T_i - \rho_i | T_i > \rho_i$.

$$\widehat{S^F}_i(t) = \hat{P}(T_i^F > t) = \hat{P}(T_i > t + \rho_i | T_i > \rho_i) = \frac{\hat{P}(T_i > t + \rho_i \wedge T_i > \rho_i)}{\hat{P}(T_i > \rho_i)} = \quad (A9)$$

$$\frac{\hat{P}(T_i > t + \rho_i)}{\hat{P}(T_i > \rho_i)}, t > 0.$$

At the company, I was asked to avoid patterns of cash flows that extended much further than was currently practiced by the technical department. To address this, we defined a threshold ω, such that $\hat{S}_i(\omega) = 0$. The cases where $\rho_i > \omega$ are treated as outliers and we assume that they will be paid in the next month with probability 1, with the payment being discounted at the end of that month. The threshold ω was taken as the estimated 95% percentile of the distribution of T_i.

To calculate the probability of the monthly payment pattern, we divide the future time into 30-day intervals. In line with what has been done in the report, t which is the moment in time is measured in years.

$$pat_{i,t} = \widehat{S^F}_i\big(30 \times (t-1)\big) - \widehat{S^F}_i\big(30 \times 12 \times (t)\big), t = \frac{1}{12}, \frac{2}{12}, \ldots. \quad (A10)$$

APPENDIX 2

Equations A11 to A13 represent the provisions for the average pensioner resulting from a death pension from accident year n and under the scope of Solvency II or IFRS 17. They are the provisions for the spouse, children, and ascendants respectively.

$$Prov.kind.spouse_{n,scope} = \qquad (A11)$$
$$\overline{plb}^{d}_{spouse,1} \times \Big(\overline{gp}_{M,n} \times Prov.NOR_{scope}\big(\overline{Pens}^{d}_{spouse,M,n}; \overline{age}_{n,M}; F; spouse\big) + \overline{gp}_{F,n} \times Prov.NOR_{scope}\big(\overline{Pens}^{d}_{spouse,F,n}; \overline{age}_{n,F}; M; spouse\big)\Big)$$

$$Prov.kind.children_{n,scope} = \qquad (A12)$$
$$\sum_{m=1}^{4} \overline{plb}^{d}_{children,m} \times m \times \Big(\overline{gp}_{M,n}\Big(0.5 \times Prov.NOR_{scope}\big(\overline{Pens}^{d}_{children,M,n}; \overline{age.child}; M; children\big) + 0.5 \times Prov.NOR_{scope}\big(\overline{Pens}^{d}_{children,M,n}; \overline{age.child}; F; children\big)\Big) + \overline{gp}_{F,n}\Big(0.5 \times Prov.NOR_{scope}\big(\overline{Pens}^{d}_{children,F,n}; \overline{age.child}; M; children\big) + 0.5 \times Prov.NOR_{scope}\big(\overline{Pens}^{d}_{children,F,n}; \overline{age.child}; F; children\big)\Big)\Big)$$

$$Prov.kind.asc_{n,scope} = \qquad (A13)$$
$$\sum_{m=1}^{2} \overline{plb}^{d}_{ascendant,m} \times m \times 0.5 \times \Big(\overline{gp}_{M,n}\Big(Prov.NOR_{scope}\big(\overline{Pens}^{d}_{ascendant,M,n}; \overline{age}_{n,M} + \overline{diff.acs}; M; asc\big) + Prov.NOR_{scope}\big(\overline{Pens}^{d}_{ascendant,M,n}; \overline{age}_{n,M} + \overline{diff.acs}; F; asc\big)\Big) + \overline{gp}_{F,n}\Big(Prov.NOR_{scope}\big(\overline{Pens}^{d}_{ascendant,F,n}; \overline{age}_{n,F} + \overline{diff.acs}; M; asc\big) + Prov.NOR_{scope}\big(\overline{Pens}^{d}_{ascendant,F,n}; \overline{age}_{n,F} + \overline{diff.acs}; F; asc\big)\Big)\Big)$$

APPENDIX 3

The following results were adapted from Dickson D, Hardy M, Waters H (2019). Considering that ${}_tp_{x,sex}$ is the probability that a person of gender sex aged x will live t years, and ${}_tq_{x,sex}$ is the probability that a person of gender sex aged x will die t years.

$$p_{x,sex} = 1 - q_{x,sex}, \qquad (A14)$$

$$ {}_tp_{x,sex} = \prod_{i=0}^{t-1} p_{x+i,sex}, \qquad (A15)$$

$$ {}_tp_x = \prod_{i=0}^{m-1} p_{x+i,sex} \prod_{i=m}^{t-1} p_{x+i,sex} \xRightarrow[i=t-1\to j=t-1-m]{\substack{j=i-m \\ i=m\to j=0}} \prod_{j=0}^{t-m-1} p_{x+m+j,sex} \times \prod_{i=0}^{m-1} p_{x+i,sex} = \qquad (A16)$$

$${}_mp_{x,sex} \times {}_{t-m}p_{x+m,sex} \Leftrightarrow {}_{t-m}p_{x+m,sex} = \frac{{}_tp_{x,sex}}{{}_mp_{x,sex}}.$$

Considering the Uniform Distribution of Deaths (UDD) approach, also found in Dickson, Hardy & Waters (2019):

Let $t \in [0,1]$,

$(UDD)\ {}_tq_{x,sex} = t \times q_{x,sex}$.

Noticing that t can be defined as $(t - \lfloor t \rfloor) + \lfloor t \rfloor$, it is evident that $(t - \lfloor t \rfloor) \in [0,1[$. Applying this remark to equations A14 to A16 above, we can estimate the required survival probabilities.

$$ {}_tp_{x,sex} = {}_{(t-\lfloor t \rfloor)}p_{x+\lfloor t \rfloor,sex} \times {}_{\lfloor t \rfloor}p_{x,sex} = (1 - {}_{(t-\lfloor t \rfloor)}q_{x+\lfloor t \rfloor,sex}) \times {}_{\lfloor t \rfloor}p_{x,sex} \qquad (A17)$$

$$\overset{UDD}{\Longleftrightarrow} {}_tp_{x,sex} = \left(1 - \left((t - \lfloor t \rfloor)\right) \times q_{x,sex}\right) \times {}_{\lfloor t \rfloor}p_{x,sex}$$

$$ {}_tp_{0,sex} = {}_xp_{0,sex} \times {}_{t-x}p_{x,sex} \Leftrightarrow {}_{t-x}p_{x,sex} = \frac{{}_tp_{0,sex}}{{}_xp_{0,sex}} \qquad (A18)$$

These results allow us to calculate all ${}_tp_{x,sex}$ in a monthly basis. Considering the values of ${}_tq_{x,sex}$ in table A3 from Appendix 5, equations X1 to X3 calculate ${}_tp_{x,sex}$ for integers x and t.

Equations A14 to A18 and the UDD approach allow for the calculation of ${}_tp_{x,sex}$ where x and t are multiples of $1/12$. If we consider the year is divided equally into 12 months and $t = \left\{\frac{1}{12}, \frac{2}{12}, \frac{3}{12}, \dots\right\}$, then ${}_tp_{x,sex}$ will be the probabilities of the pensioner aged x and with gender sex to survive past possible months.

APPENDIX 4

Table A2 presents the t-year spot curves for the Solvency II and IFRS 17 regime. EIOPA (2024) released this curve on 4 December of 2024. The IFRS 17 spot curve was produced internally with a bottom-up approach (IFRS Foundation, 2022).

DISCOUNT RATES (31/12/2024)			DISCOUNT RATES (31/12/2024)			DISCOUNT RATES (31/12/2024)		
YEAR	IFRS 17	EIOPA VA	YEAR	IFRS 17	EIOPA VA	YEAR	IFRS 17	EIOPA VA
0	2,73%	2,47%	51	3,38%	2,83%	102	3,34%	3,06%
1	2,73%	2,47%	52	3,38%	2,84%	103	3,34%	3,06%
2	2,63%	2,32%	53	3,38%	2,84%	104	3,34%	3,07%
3	2,67%	2,32%	54	3,38%	2,85%	105	3,34%	3,07%
4	2,75%	2,35%	55	3,37%	2,86%	106	3,34%	3,07%
5	2,81%	2,37%	56	3,37%	2,87%	107	3,34%	3,07%
6	2,88%	2,40%	57	3,37%	2,88%	108	3,34%	3,07%
7	2,95%	2,43%	58	3,37%	2,88%	109	3,34%	3,08%
8	3,02%	2,45%	59	3,37%	2,89%	110	3,34%	3,08%
9	3,08%	2,47%	60	3,37%	2,90%	111	3,34%	3,08%
10	3,14%	2,50%	61	3,37%	2,90%	112	3,34%	3,08%
11	3,20%	2,52%	62	3,37%	2,91%	113	3,34%	3,08%
12	3,26%	2,54%	63	3,36%	2,91%	114	3,34%	3,09%
13	3,31%	2,56%	64	3,36%	2,92%	115	3,34%	3,09%
14	3,36%	2,56%	65	3,36%	2,93%	116	3,34%	3,09%
15	3,38%	2,56%	66	3,36%	2,93%	117	3,34%	3,09%
16	3,40%	2,55%	67	3,36%	2,94%	118	3,34%	3,09%
17	3,42%	2,53%	68	3,36%	2,94%	119	3,34%	3,10%
18	3,43%	2,51%	69	3,36%	2,95%	120	3,34%	3,10%
19	3,43%	2,50%	70	3,36%	2,95%	121	3,34%	3,10%
20	3,44%	2,49%	71	3,36%	2,96%	122	3,34%	3,10%
21	3,44%	2,49%	72	3,36%	2,96%	123	3,34%	3,10%
22	3,44%	2,49%	73	3,36%	2,97%	124	3,34%	3,10%
23	3,44%	2,49%	74	3,36%	2,97%	125	3,34%	3,11%
24	3,44%	2,50%	75	3,35%	2,98%	126	3,34%	3,11%
25	3,44%	2,51%	76	3,35%	2,98%	127	3,34%	3,11%
26	3,44%	2,52%	77	3,35%	2,98%	128	3,34%	3,11%
27	3,43%	2,54%	78	3,35%	2,99%	129	3,34%	3,11%
28	3,43%	2,55%	79	3,35%	2,99%	130	3,34%	3,11%
29	3,43%	2,56%	80	3,35%	3,00%	131	3,34%	3,11%
30	3,43%	2,58%	81	3,35%	3,00%	132	3,34%	3,12%
31	3,42%	2,59%	82	3,35%	3,00%	133	3,34%	3,12%
32	3,42%	2,61%	83	3,35%	3,01%	134	3,34%	3,12%
33	3,42%	2,62%	84	3,35%	3,01%	135	3,34%	3,12%
34	3,42%	2,63%	85	3,35%	3,01%	136	3,34%	3,12%
35	3,41%	2,65%	86	3,35%	3,02%	137	3,34%	3,12%
36	3,41%	2,66%	87	3,35%	3,02%	138	3,34%	3,12%
37	3,41%	2,68%	88	3,35%	3,02%	139	3,34%	3,13%
38	3,41%	2,69%	89	3,35%	3,03%	140	3,34%	3,13%
39	3,40%	2,70%	90	3,35%	3,03%	141	3,34%	3,13%
40	3,40%	2,71%	91	3,34%	3,03%	142	3,34%	3,13%
41	3,40%	2,73%	92	3,34%	3,04%	143	3,34%	3,13%
42	3,40%	2,74%	93	3,34%	3,04%	144	3,34%	3,13%
43	3,39%	2,75%	94	3,34%	3,04%	145	3,34%	3,13%
44	3,39%	2,76%	95	3,34%	3,04%	146	3,34%	3,13%
45	3,39%	2,77%	96	3,34%	3,05%	147	3,34%	3,13%
46	3,39%	2,78%	97	3,34%	3,05%	148	3,34%	3,14%
47	3,39%	2,79%	98	3,34%	3,05%	149	3,34%	3,14%
48	3,38%	2,80%	99	3,34%	3,05%	150	3,34%	3,14%
49	3,38%	2,81%	100	3,34%	3,06%			
50	3,38%	2,82%	101	3,34%	3,06%			

Table A2: Solvency II and IFRS 17 t-year spot curves - EIOPA and Lusitania Seguros.

APPENDIX 5

MORTALITY RATE - qx (2021-2023)					
AGE	GENDER		AGE	GENDER	
	MALE	FEMALE		MALE	FEMALE
0	0,0027	0,0025	51	0,0043	0,0019
1	0,0002	0,0002	52	0,0048	0,0020
2	0,0003	0,0002	53	0,0057	0,0021
3	0,0002	0,0002	54	0,0060	0,0023
4	0,0002	0,0001	55	0,0070	0,0024
5	0,0001	0,0001	56	0,0070	0,0027
6	0,0001	0,0001	57	0,0079	0,0029
7	0,0001	0,0002	58	0,0083	0,0033
8	0,0001	0,0001	59	0,0092	0,0036
9	0,0001	0,0001	60	0,0098	0,0040
10	0,0001	0,0001	61	0,0102	0,0043
11	0,0001	0,0001	62	0,0113	0,0045
12	0,0001	0,0001	63	0,0125	0,0050
13	0,0002	0,0001	64	0,0127	0,0054
14	0,0001	0,0001	65	0,0142	0,0056
15	0,0003	0,0001	66	0,0150	0,0064
16	0,0002	0,0001	67	0,0160	0,0069
17	0,0003	0,0002	68	0,0175	0,0075
18	0,0005	0,0003	69	0,0185	0,0085
19	0,0005	0,0002	70	0,0198	0,0094
20	0,0005	0,0002	71	0,0201	0,0095
21	0,0005	0,0002	72	0,0223	0,0108
22	0,0004	0,0003	73	0,0244	0,0121
23	0,0005	0,0002	74	0,0267	0,0141
24	0,0006	0,0002	75	0,0300	0,0165
25	0,0005	0,0002	76	0,0315	0,0180
26	0,0006	0,0002	77	0,0363	0,0213
27	0,0006	0,0003	78	0,0423	0,0250
28	0,0006	0,0001	79	0,0461	0,0293
29	0,0005	0,0003	80	0,0509	0,0332
30	0,0006	0,0004	81	0,0575	0,0384
31	0,0007	0,0004	82	0,0650	0,0443
32	0,0007	0,0004	83	0,0793	0,0552
33	0,0008	0,0005	84	0,0982	0,0695
34	0,0008	0,0004	85	0,1245	0,0895
35	0,0008	0,0004	86	0,1469	0,1077
36	0,0008	0,0006	87	0,1712	0,1280
37	0,0012	0,0006	88	0,1957	0,1492
38	0,0012	0,0006	89	0,2217	0,1723
39	0,0011	0,0006	90	0,2523	0,2000
40	0,0013	0,0007	91	0,2810	0,2269
41	0,0013	0,0008	92	0,3117	0,2560
42	0,0016	0,0008	93	0,3442	0,2875
43	0,0016	0,0009	94	0,3784	0,3212
44	0,0020	0,0011	95	0,4142	0,3569
45	0,0022	0,0011	96	0,4514	0,3947
46	0,0023	0,0011	97	0,4897	0,4341
47	0,0027	0,0013	98	0,5290	0,4751
48	0,0031	0,0014	99	0,5689	0,5172
49	0,0035	0,0015	100	0,6091	0,5602
50	0,0040	0,0017			

Table A3: Mortality Table INE 2021-2023 – INE, 2024.

Appendix 6

INFLATION - YEAR TO YEAR (PORTUGAL)			
DATE	INFLATION	DATE	INFLATION
31/12/2024	3,0%	31/12/1986	11,6%
31/12/2023	1,4%	31/12/1985	16,9%
31/12/2022	9,6%	31/12/1984	21,3%
31/12/2021	2,7%	31/12/1983	32,3%
31/12/2020	-0,2%	31/12/1982	18,2%
31/12/2019	0,4%	31/12/1981	23,7%
31/12/2018	0,7%	31/12/1980	13,0%
31/12/2017	1,5%	31/12/1979	20,9%
31/12/2016	0,9%	31/12/1978	23,1%
31/12/2015	0,4%	31/12/1977	23,5%
31/12/2014	-0,4%	31/12/1976	21,5%
31/12/2013	0,2%	31/12/1975	19,5%
31/12/2012	1,9%	31/12/1974	24,3%
31/12/2011	3,6%	31/12/1973	18,1%
31/12/2010	2,5%	31/12/1972	8,1%
31/12/2009	0,0%	31/12/1971	16,0%
31/12/2008	0,8%	31/12/1970	2,8%
31/12/2007	2,7%	31/12/1969	8,8%
31/12/2006	2,5%	31/12/1968	6,2%
31/12/2005	2,6%	31/12/1967	6,3%
31/12/2004	2,5%	31/12/1966	5,0%
31/12/2003	2,4%	31/12/1965	6,0%
31/12/2002	4,0%	31/12/1964	4,0%
31/12/2001	3,8%	31/12/1963	1,4%
31/12/2000	3,9%	31/12/1962	2,5%
31/12/1999	2,0%	31/12/1961	0,7%
31/12/1998	3,2%	31/12/1960	0,5%
31/12/1997	2,5%	31/12/1959	3,2%
31/12/1996	3,2%	31/12/1958	1,1%
31/12/1995	3,5%	31/12/1957	1,7%
31/12/1994	4,3%	31/12/1956	2,4%
31/12/1993	6,7%	31/12/1955	2,2%
31/12/1992	8,9%	31/12/1954	-1,1%
31/12/1991	9,9%	31/12/1953	-0,7%
31/12/1990	13,9%	31/12/1952	0,8%
31/12/1989	11,6%	31/12/1951	0,5%
31/12/1988	11,7%	31/12/1950	-1,4%
31/12/1987	9,1%	31/12/1949	2,8%

Table A4: Inflation Year-Year (Portugal) – Bank of Portugal, (2024).

HEALTH INFLATION - YEAR TO YEAR (PORTUGAL)			
DATE	INFLATION	DATE	INFLATION
31/12/2024	3,2%	31/12/1986	11,6%
31/12/2023	4,5%	31/12/1985	16,9%
31/12/2022	-2,3%	31/12/1984	21,3%
31/12/2021	0,6%	31/12/1983	32,3%
31/12/2020	2,9%	31/12/1982	18,2%
31/12/2019	0,6%	31/12/1981	23,7%
31/12/2018	1,0%	31/12/1980	13,0%
31/12/2017	1,0%	31/12/1979	20,9%
31/12/2016	-0,8%	31/12/1978	23,1%
31/12/2015	0,3%	31/12/1977	23,5%
31/12/2014	0,3%	31/12/1976	21,5%
31/12/2013	3,0%	31/12/1975	19,5%
31/12/2012	-1,8%	31/12/1974	24,3%
31/12/2011	3,6%	31/12/1973	18,1%
31/12/2010	2,5%	31/12/1972	8,1%
31/12/2009	0,0%	31/12/1971	16,0%
31/12/2008	0,8%	31/12/1970	2,8%
31/12/2007	2,7%	31/12/1969	8,8%
31/12/2006	2,5%	31/12/1968	6,2%
31/12/2005	2,6%	31/12/1967	6,3%
31/12/2004	2,5%	31/12/1966	5,0%
31/12/2003	2,4%	31/12/1965	6,0%
31/12/2002	4,0%	31/12/1964	4,0%
31/12/2001	3,8%	31/12/1963	1,4%
31/12/2000	3,9%	31/12/1962	2,5%
31/12/1999	2,0%	31/12/1961	0,7%
31/12/1998	3,2%	31/12/1960	0,5%
31/12/1997	2,5%	31/12/1959	3,2%
31/12/1996	3,2%	31/12/1958	1,1%
31/12/1995	3,5%	31/12/1957	1,7%
31/12/1994	4,3%	31/12/1956	2,4%
31/12/1993	6,7%	31/12/1955	2,2%
31/12/1992	8,9%	31/12/1954	-1,1%
31/12/1991	9,9%	31/12/1953	-0,7%
31/12/1990	13,9%	31/12/1952	0,8%
31/12/1989	11,6%	31/12/1951	0,5%
31/12/1988	11,7%	31/12/1950	-1,4%
31/12/1987	9,1%	31/12/1949	2,8%

Table A5: Health Inflation Year-Year (Portugal) – Bank of Portugal, (2024).