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Impact of the Longevity Risk on Permanent Life Annuity in the Context of IFRS 17

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Abstract

Longevity risk – the risk that policyholders outlive expected mortality projections – poses a significant challenge to the financial sustainability of pension insurance. This paper investigates the valuation of permanent life annuities under IFRS 17, the accounting standard that fundamentally reshaped actuarial reporting in 2023. We propose a robust mortality model that integrates a selection factor to more accurately capture the idiosyncratic longevity of annuity holders. Furthermore, the study quantifies the Risk Adjustment (RA) for non-financial risks using the Cost of Capital (CoC) method, aligning with Solvency II valuation principles. Our results demonstrate how precise longevity modelling influences the Contractual Service Margin (CSM) and overall liability adequacy. These findings offer critical insights for insurers aiming to balance product stability with the rigorous transparency requirements of IFRS 17.

Keywords

Annuity, IFRS 17, Kannistö's Model, Longevity, General Measurement Model

I. Introduction

The EU insurance market is regulated by national and international directives, including Directive 2009/138/EC on insurance and reinsurance Solvency II (2022) Directive 2006/54/EC on equal treatment in employment Directive 2006/54/EC (2022), and IFRS 17 amendments issued by the IASB (2022), IFRS 17 Insurance Contracts (2019), effective for annual

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periods beginning January 1, 2023. As noted in Shukulipa (2023), post-Brexit regulatory changes in the UK may introduce discrepancies in longevity and insurance risk reporting under IFRS 17.

The main objective of IFRS 17 should be, in particular, to identify for-profit and non-profit insurance contracts and to monitor the direction of insurance contracts. Another point should be to spread the profits of insurance companies over several accounting periods. According to IFRS 4, it was not necessary to update the actuarial assumptions in the provisions that arise at the time of valuing the products at the time of their introduction, unless the contracts are onerous. These reasons led to the preparation of IFRS 17, which should ensure better comparability of information on insurance company profitability. According to IFRS 17, there is no reason to calculate the liability adequacy test because the technical provisions are calculated based on the most up-to-date assumptions.

IFRS 17 replaces technical provisions with future cash flows and introduces two key concepts: the contractual service margin and risk adjustment. Palmborg et al. (2021) align IFRS 17 with general accounting principles, proposing a computationally effective method for valuing insurance contract portfolios and demonstrating a profit-or-loss algorithm. Yousuf et al. (2021) provide a detailed analysis of the contractual service margin, concluding that the choice of coverage units significantly affects its final value. England et al. (2019) explain the risk margin under Solvency II in relation to the IFRS 17 risk adjustment, discussing cost-of-capital methods and risk measures applied to simulated liability distributions. Diffey et al. (2022) examine the impact of COVID-19 on reserve validation and data challenges under IFRS 17, while Sotona (2018) presents a mortality risk analysis and risk adjustment calculation for death insurance under IFRS 17. Araiza et al. (2021) implement a non-life insurance model, while Chan et al. (2021) simulate the simultaneous impact of IFRS 9 and IFRS 17 on Taiwanese life insurers, finding that both income and equity fluctuations will increase significantly, raising concerns about liability instability and insolvency risk. Owais and Dahiyat (2021) assess the readiness of Jordanian insurance companies for IFRS 17 adoption, concluding that they lack sufficient capability to define its scope, assess its impact on financial reports, and develop appropriate internal monitoring methods, urging both insurers and regulators to improve preparedness within a defined timeframe.

IFRS 17 Insurance Contracts (2019) establishes principles for the recognition, measurement, presentation, and disclosure of insurance contracts, enabling financial statement users to assess their effect on an entity's financial position, performance, and cash flows. Under IFRS 17, portfolios comprise contracts subject to similar risks and managed together, and must be divided into: (a) onerous contracts at initial recognition, (b) contracts with no significant possibility of becoming onerous, and (c) remaining contracts. Contracts issued more than one year apart cannot be grouped together. Recognition occurs at the earliest of: (a) the beginning of the coverage period, (b) the date of the first policyholder payment due, or (c) for onerous contracts, when the group becomes onerous.

The remainder of this work is organised as follows. Section II – Preliminaries provide basic information on our analysis of longevity models, permanent life pension annuities, the general measurement model, and its components. Section III – General Measurement Model of Permanent Life Annuity introduces our model for the implementation of the

IFRS 17 standard. Section IV – Conclusion concludes that incorporating longevity risk into pension valuation enhances both client security and insurer solvency, and that IFRS 17 brings significant changes not only to actuarial calculations but also to accounting procedures and financial statements.

II. Preliminaries

In this section, we offer basic information on dynamic mortality models with respect to longevity risk, lifetime pension models, and essential information on the general measurement model including a calculation of the risk adjustment for non-financial risk and its components.

Longevity models

Our model incorporates a dynamic longevity component forecasting mortality and survival probabilities by age and year, following the methodology of the Austrian Actuarial Association Kainhofer et al. (2006), itself inspired by the German Association of Actuaries Pasdika et al. (2005). Population mortality is first forecast, then adjusted by selection factors to obtain pensioner-specific mortality. Life insurers and pension funds typically require mortality projections up to age 110–120, with high-age mortality modelled separately from adult mortality. For adults, standard dynamic models include the Lee-Carter model Lee and Carter (1992), the Cairns-Blake-Dowd (CBD) model Cairns et al. (2006), and regression-based approaches Heathcote and Higgins (2004), with an overview provided in Villegas et al. (2018). For pension insurance, high-age mortality is the primary focus. Dynamic models for this range are scarce; most popular approaches specify a one-dimensional parametric function of age at a fixed point in time, calibrated on data up to around age 100 and informed by assumptions about the biodemographic limit Pitacco et al. (2009). The joint modelling of mortality across both age and time dimensions has been explored in only a limited number of studies Gavrilov and Gavrilova (1979); Gavrilova and Gavrilov (2011); Bongaarts (2005). Time dynamics can be introduced either by directly including a time variable or by allowing model parameters to evolve over time, with a general unifying formula derived in Zimmermann (2017).

Our implementation

Clearly, a long-term prediction of the evolution of mortality will always be accompanied by a great deal of subjectivity and uncertainty, and expert judgment has a strong role. We are only concerned with pension ages over 62 years old. The data used in our prediction of the Slovakian population were downloaded from the Human Mortality Database (2019). Data from 1992–2019 are used.

The following notation is used. The time is denoted t. The age is indicated by x. The force of mortality in a given age and time is denoted by $\mu(x,t)$, probability of death $q(x,t)$, and central death rate $m(x,t)$.

As both Pasdika et al. (2005) and Wilmoth et al. (2007) support a logistic type of models and the Human Mortality Database applies the Kannistö's model to smooth old age data, we decided to assume the Kannistö's specification with time-varying parameters in discrete one-year time steps for the force of mortality.

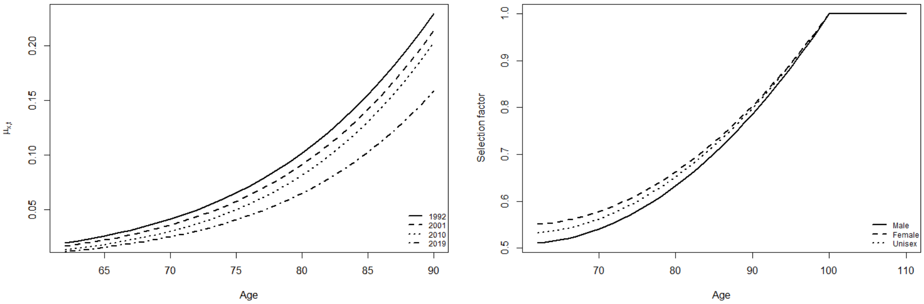
$$\mu(\eta_{x,t}) = \frac{1}{1 + \exp(-\eta_{x,t})} \tag{1}$$

where

$$\eta_{x,t} = a_t + b_t x. \tag{2}$$

The parameters a_t and b_t are fitted independently at each historical time for $t = 1992, 1993, \ldots, 2019$ using observations of age $x \in 62, 63, \ldots, 95$ years. The fitted curves of the force of mortality are for selected years shown in Figure 1 on the left.

Figure 1: Left – The fitted curves of the force of mortality are for selected years. Right – Selection factors (5) for men (solid line) and women (dashed line)



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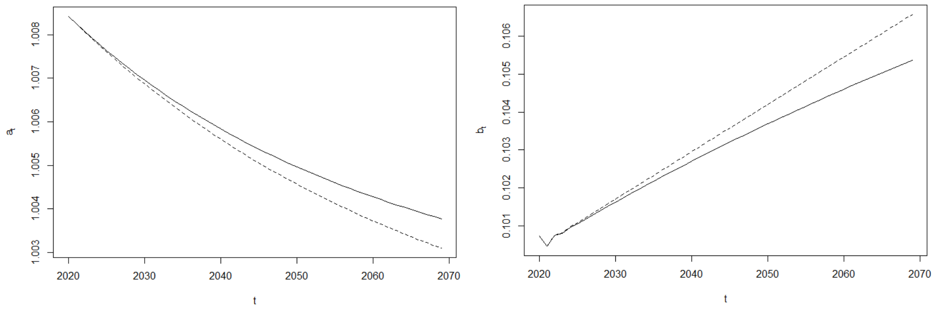
The time series of the parameter estimates are fitted independently with the constant ARIMA(1,1,0) models, and forecasts are made for future years. For the parameter a_t, the logarithmic transformation was applied prior to forecasting. As stated in Kainhofer et al. (2006), the linear trend of mortality decrease has been stable for decades now. "However, a perpetual extrapolation with a high constant trend leads to vanishing death probabilities and thus unreasonably high life expectancy in the far future. To avoid this problem, we thus propose a long-term trend reduction, which leads to a reasonable limiting life expectancy and a non-vanishing limiting death probability in the limit $t \longrightarrow \infty$".
The trend reduction factor is not based on data. We take over this adjustment and reduce the trend using

$$z_t = \frac{1}{1 + \left(\frac{t-1992}{t_{1/2}}\right)}, \tag{3}$$

where half-time $t_{1/2}$ is set to 100 years. This means that we assume that after $t_{1/2} = 100$ years, the trend is reduced by 50%. The reduction factor 3 is applied to the future linear trend for both parameters a_t and b_t. The resulting fitted force of mortality as a function of age is shown in Fig. 2.

Figure 2: Forecasts of parameters a_t and b_t with trend reduction (solid line) and without trend reduction (dashed line)



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The package R Mortality Laws was used to fit the Kannistö's model for each year observed, Pascariu (2019). The R package forecast was used to perform ARIMA forecasts Hyndman and Khandakar (2008). The estimate of the probability of death at one year $q_{x,t}$ at a discrete age x and a discrete time t is constructed as

$$q_{x,t} = 1 - \exp(-\mu_{x,t}). \tag{4}$$

We adopted the Cannistö stochastic mortality model for longevity risk modeling in IFRS 17 and pension annuity valuation because it:

1. captures both deterministic mortality improvements and stochastic period effects, essential for IFRS 17's probability-weighted cash flow requirements Haberman and Renshaw (2013);
2. models age-specific and cohort effects, reflecting heterogeneous aging patterns in pension populations while maintaining analytical tractability; and
3. generates realistic mortality scenarios for confidence interval estimation and tail risk assessment of long-duration annuity liabilities Cairns et al. (2011), aligning with IFRS 17 and Solvency II regulatory expectations.

Selection factor

Facultative pension programs typically exhibit strong selection effects, as annuitants have different mortality than the general population. Due to the absence of publicly available Slovakian market data, we adopt the selection factors from Kainhofer et al. (2006), derived from pooled data of over 20 German insurance companies by Gen Re and Munich Re. These factors are defined across different age intervals, such as

$$s_x = \begin{cases} f_1 & \text{for } x \le c_1 \\ f_1 - (f_2 - f_1) \times \dfrac{x - c_1}{c_2 - c_1} & \text{for } c_1 \le x \le c_2 \\ f_2 + (1 - f_2) \times \dfrac{(x - c_2)^2}{(c_3 - c_2)^2} & \text{for } c_2 \le x \le c_3 \\ 1 & \text{for } x \ge c_3 \end{cases} \tag{5}$$

where f_1, f_2 are constants and c_1, c_2, c_3 are breaks of the age intervals shown in Tab. 1. Function (5) is plotted in Fig. 1 on the right.
The resulting prediction of the shift between the death probability estimates $q_{x,2019}$ and $q_{x,2069}$ is shown in Figure 3.

Permanent Life Annuity

We offer the determination of the amount of the permanent monthly immediate annuity in the same sense as in Špirková et al. (2023). This means that the insurer will pay these annuities until the death of the insured life. If the policyholder dies before the date of the insurer's obligation to perform the pension insurance contract, the amount of the single premium paid under the terms of this contract will be reduced by the amount of the insurer's eligible expenses related to the payment of the premium amount in cash. Following the death of the beneficiary, survivors are not entitled to any benefit or other financial compensation. This means that the product includes a permanent monthly annuity and does not include an increase in pension or survivors' benefits.

Figure 3: The resulting forecast of the shift between the estimates of the probability of death $q_{x,2019}$ and $q_{x,2069}$

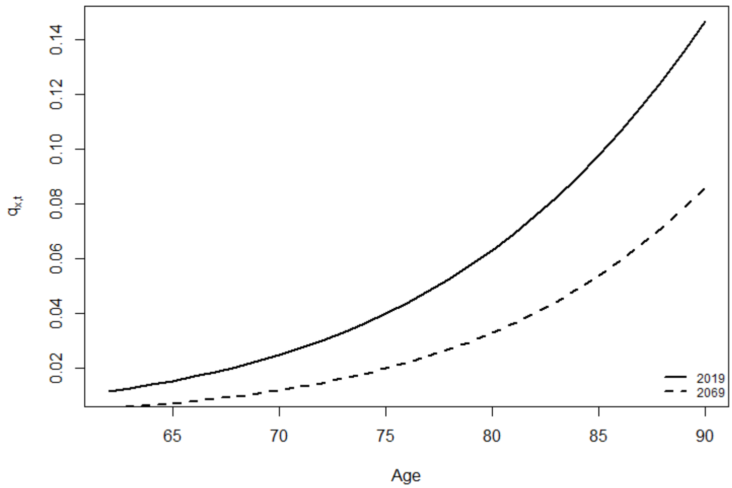

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Table 1: Constants used in function (5)

Sex	f_1	c_1	f_2	c_2	c_3
Males	0.8	40	0.51	60	100
Females	0.8	40	0.55	60	100

Source: Kainhofer et al. (2006)

First, we give the basic notation as follows.

- S – accumulated sum, single premium in monetary units (m.u.), we use the euro throughout the text,
- $P(z)$ – discounting factor using a basic risk-free spot rate curve $R(z)$ (as a % p.a.) with volatility adjustment as of January 31, 2022, EIOPA (2022),

$$P(z) = \left(1 + \frac{R(z)}{100\%}\right)^{-z}, \tag{6}$$

- x – retirement age, in years,
- ω – maximum age to which a person can live to see (with respect to used life tables: $\omega = 110$ years,
- α_1 – initial costs as a % of the first yearly annuity,
- α_2 – initial costs as an absolute amount (in m.u.) independent of an accumulated sum,
- β – administrative costs as % p.m. from technical provisions on the immediate geometrically increasing annuity, respectively.

The values used in our model are: $\alpha_1 = 20\%$, $\alpha_2 = 200$ euros, and $\beta = 0.1\%$.

We give a formula for the calculation of the monthly pension annuity of this product in the form Špirková et al. (2023)

$$MP_x = \frac{S \times \left(1 - A^{1}_{x:\overline{1/12}|}\right) - \alpha_2}{12 \times \left(a_x^{(12)} + \frac{\alpha_1}{100\%} + \frac{\beta}{100\%} \times \sum_{t=1}^{12\times(\omega-x+1)} {}_{\frac{t}{12}|}a_x^{(12)}\right)} \tag{7}$$

where

- S – an accumulated sum that represents a single premium of the product;
- $A^{1}_{x:\overline{1/12}|}$ – an expected present value of the benefit in the amount of 1 mu in the case of the beneficiary's death during the first month of retirement;

$$A^{1}_{x:\overline{1/12}|} = {}_{\frac{1}{12}}q_x \times P\left(\frac{1}{12}\right); \tag{8}$$

* $a_x^{(12)}$ – the expected present value of immediate benefits of the whole life in the amount of $\frac{1}{12}$ m.u., 12× per year, under the condition that the client is alive;

$$a_x^{(12)} = \sum_{t=1}^{12\times(\omega-x+1)} \frac{1}{12} \times {}_{\frac{t}{12}}p_x \times P\left(\frac{t}{12}\right); \tag{9}$$

* ${}_{\frac{t}{12}|}a_x^{(12)}$ – the expected present value of the deferred annuities for $t = 1, 2, \ldots, 12 \times (\omega - x + 1)$, that is,

$${}_{\frac{t}{12}|}a_x^{(12)} = \frac{1}{12} \times \sum_{r=t}^{12\times(\omega-x+1)} {}_{\frac{r+1}{12}}p_x \times P\left(\frac{r+1}{12}\right). \tag{10}$$

Therefore, the total sum of the provisions is as follows

$$\sum_{t=1}^{12\times(\omega-x+1)} {}_{\frac{t}{12}|}a_x^{(12)}.$$

The best estimate of future cash flows

According to the standard, insurance companies will have to regularly update their assumptions. These updated assumptions will already be included in future cash flow estimates at the beginning of subsequent insurance contract measurement. The insurance company shall include in the valuation of a group of insurance contracts all future cash flows within the contract boundary of each contract in the group. Future cash flows can also be estimated at a higher level of segmentation, and then fulfilment cash flows are assigned to individual groups of insurance contracts. The present value of future cash flows using the risk-free interest rate is given by

$$PVFCF_t = \sum_{s=t}^{T} FCF_s \times D(t, s) \tag{11}$$

where

$$D(t, s) = \left(\prod_{u=t}^{s-1}\left(1 + \frac{R_f(u, u+1)}{100\%}\right)\right)^{-1}$$

* FCF_s – Future Cash Flows in the month s,
* R_f – forward risk-free rate curve from u to $u + 1$ expressed from the EIOPA risk-free spot curve with volatility adjustment as of January 31, 2022, EIOPA (2022), (as a % p.m.),
* $T = 12 \times N, N$ – a number of insurance periods (months).

Using the risk-free interest rate, we applied a simplification because an insurance premium for illiquidity should be added. IFRS 17 introduces a new asset-side item of insurance acquisition cash flows for groups of insurance contracts, provided that a systematic and rational method is used, but only in specific cases.

* acquisition costs paid before initial recognition of a group of contracts to which they belong to,
* acquisition costs paid for insurance contracts that are expected to arise from renewals of the insurance contracts.

An insurance company should use a systematic and rational method even if it does not generate acquisition cash flows but reports them as costs as part of the PAA method. Similarly, acquisition costs that have measured the liability using another IFRS will be generated. Acquisition costs may also be recognised before the group of insurance contracts to which they relate is valued.

Risk adjustment for non-financial risk

The IFRS 17 standard introduces new values that insurance companies will have to report. They are risk adjustment and contractual service margin. The adjustment for risk for nonfinancial risk represents uncertainty in cash flows resulting from insurance contracts. Uncertainty resulting from financial and operational risks is not included in it. Risk adjustment includes risks such as longevity risk, mortality risk, lapse risk, and risk of expenses and inflation. England et al. (2019) give the explanation of the risk margin according to Solvency II in relation to the risk premium according to IFRS 17. The risk adjustment can be calculated, for example, by the Value-at-risk, Cost of Capital (CoC) methods, the conditional value-at-risk method, or as an adjustment to assumptions. The Cost of Capital method is a well-known and transparent method within Solvency II (2022). Insurance companies use this method to calculate the risk margin. We apply this method to a portfolio of insurance contracts for a lump sum lifetime pension that includes a longevity risk. We use the shocks that Solvency II determines for selected risks to express the amount of capital required in our modelling. The risks that have an impact on pension insurance are especially longevity risk, and the risk of the costs of this life insurance. The correlation coefficients between these risks are shown in Table 2. The longevity risk correlates with the cost risk. In IFRS 17, the exact calculation technique for RA is not given, but an insurance company that uses a technique to calculate RA other than using the confidence level must disclose the calculation technique used and the confidence interval corresponding to the results of this technique. Solvency II shock scenarios must be interpolated assuming some distribution around the best estimate parameter to determine the risk adjustment at a confidence level other than 99.5%. The parameters listed in Solvency II are calibrated to the "average European insurance company", and therefore it is possible that certain shock scenarios overestimate or underestimate the risk of the insurance company. We have worked with the shock scenario values that Solvency II offers with a confidence level of 99.5%, that is, a 20% decrease in mortality and a 10% increase in expenses, with a further 1% increase in inflation. Based on these shock scenarios, we have expressed the value of additional capital using solvency capital requirements.

Table 2: Correlation matrix

Correlation matrix		
i \ j	mortality	expense
mortality	1	0.25
expense	0.25	1

Source: The author's work according to Solvency II (2022)

The capital requirement for life insurance expresses the minimum value of the own resources that the insurance company must have. We calculate *SCR* for individual risks as the difference in the present value of cash flows in the basic model and in the model with increased risk of longevity or costs with inflation. The value of *SCR* for reduced mortality is derived from the difference between the present value of the remaining net cash flows of the base model and the present value of the net cash flows of the model with reduced mortality,

$$SCR_t^m = PVFCF_t - PVFCF_t^m \tag{12}$$

where

* SCR_t^m – Solvency Capital Requirement – mortality, the value of additional capital in the shock scenario with decreased mortality in the month t,
* $PVFCF_t^m$ – Present value of Future Cash Flows – mortality, the present value of future cash flows after the application of the mortality shock in the month t,
* $PVFCF_t$ – Present value of future cash flows in the month t;

$$SCR_t^e = PVFCF_t - PVFCF_t^e, \tag{13}$$

where

* SCR_t^e – Solvency Capital Requirement – life expenses with inflation, the value of additional capital in the shock scenario with increased expenses with inflation in the month t,
* $PVFCF_t^e$ – Present value of Future Cash Flows – life expenses with inflation, the present value of future cash flows after the application of the expenses shock in the month t,
* $PVFCF_t$ – Present value of future cash flows in the month t.

The value of the total solvency capital requirement in year t expressed by the mortality shock and the expenses shock is determined by the formula in Solvency II

$$SCR_t = \sqrt{SCR_{m,t}^2 + SCR_{e,t}^2 + 2 \times \rho \times SCR_{m,t} \times SCR_{e,t}}, \tag{14}$$

where

* $\rho = 0.25$ – the correlation parameter for the life insurance risk model presented in Table 2.

Of the total capital amount, we define 6 as the capital rate cost. It should be emphasised that the insurance company can choose a percentage other than 6. It can be chosen based on an internal assessment of the cost of capital. We express the cost of capital:

$$CoC_t = SCR_t \times \frac{i^{CoC}}{12 \times 100\%} \tag{15}$$

where

* i^{CoC} – the annual cost of capital rate.

We will subsequently express the risk adjustment as the present value of the cost of capital by formula

$$RA_t = \sum_{j=t}^{T} \frac{CoC_j}{\prod_{u=t}^{j-1}\left(1 + \frac{R_f(u, u+1)}{100\%}\right)} \tag{16}$$

When calculating risk adjustment, we chose the Cost of Capital method and confidence level VaR (Value at Risk) of 99.50%, as stated in the Solvency II Directive for simplicity. This method is suitable according to IFRS 17 also under Palmborg et al. (2021). The VaR percentile represents the probability that the actual result for the selected time period will be less than the VaR value and therefore equal to the target confidence level. The risk adjustment is defined as the difference between the VaR and the best estimate, which represents the present value of future cash flows as part of the fulfilment cash flows.

Contractual Service Margin

The contractual service margin *CSM* represents unearned profit from insurance contracts, recognised through technical provisions for future services. It is carried on the balance sheet and gradually released to the income statement as revenue over the coverage period, and must be fully written off upon contract termination.
Since *CSM* cannot be negative, unprofitable contracts instead recognise a loss component *LC* directly in the profit and loss statement. However, the insurer must monitor the potential return to profitability, as this would reinstate *CSM* reporting and require tracking of specific loss components.
The *CSM* at initial recognition equals the positive difference:

* Financial income from insurance contracts and
* financial expenses from insurance contracts, discount, and risk adjustment.

To calculate *CSM*, it is necessary to determine the previous two components, namely, the present value of future cash flows and the risk adjustment. The value of money in time is expressed in the present value of future cash flows by discounting. The longevity risk and the risk resulting from the uncertainty of these cash flows are expressed in the risk adjustment. We expressed the value *CSM* at time $t = 1$ in the GMM model as follows.

$$CSM_1 = PVFCF_1 - RA_1 \tag{17}$$

The release of *CSM* must be implemented by the insurance company based on the identification of the coverage units *CU*. These coverage units can be expressed in different ways. We chose the calculation based on the assured sum, which covers the risk of insurance contracts. Coverage units are expressed as the product of the number of policies in force (*NoP*) and the annuity amount payable (*AAP*). Another way of calculating can be, for example, through the insurance premium or the insurance period.

$$CU_t = NoP_t \times AAP_t \tag{18}$$

The amortisation factor (*Af*) represents the percentage by which *CSM* is released until the entire amount is released at the end of the insurance period. We express it as follows.

$$Af_t = \frac{CU_t}{\sum_{t=1}^{12\times N} PVCU_t} \tag{19}$$

In subsequent periods, *CSM* is expressed according to the value of its release, as follows.

$$CSM_t = CSM_{t-1} \times \left(1 - Af_t\right) \tag{20}$$

where

* CSM_{t-1} – Contractual Service Margin in the previous period,
* Af_t – Amortization factor in the current period.

The difference between actuarial neutrality and individual retirement incentives has a direct impact on the Contractual Service Margin (CSM) and risk adjustment under IFRS 17. This is because socio-economic variations in “incentive-neutrality” create significant uncertainty regarding the fulfilment of cash flows for longevity-linked annuity contracts, Christl and Kucsera (2019).

III. General Measurement Model of Permanent Life Annuity

The IFRS 17 standard requires the use of the GMM method for long-term insurance contracts. The GMM method can also be used in the case of reinsurance contracts, as stated in more detail by Zelinová et al. (2022). To estimate the permanent life annuity for a 62-year-old person, we used the GMM method, which is suitable for this. The number of insurance contracts was 2,000; therefore, we could better show the impact of longevity risk on the new values that need to be reported and then compile the financial statements.

The risk adjustment is a value created at the beginning of insurance contracts and is released throughout the insurance period. Figure 4 shows the development of *RA* throughout the insurance period, exactly 49 years or 588 months. The risk adjustment decreases as the risk of insurance contracts decreases. As mentioned above, we have included the longevity risk and the risk of expense and inflation in *RA*. Figure 5 illustrates the release of risk adjustment.

Figure 4: Risk Adjustment

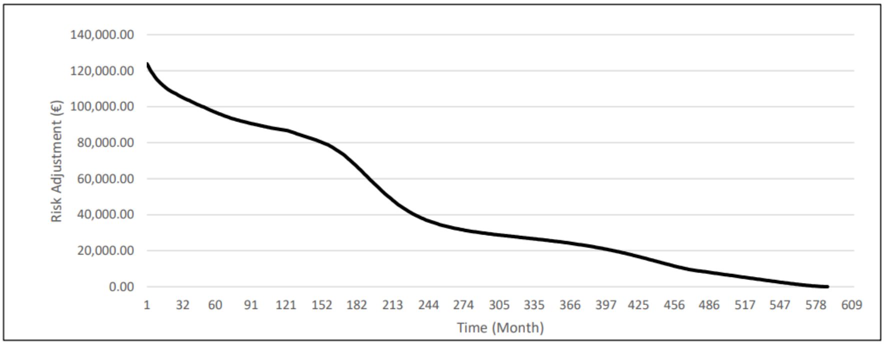

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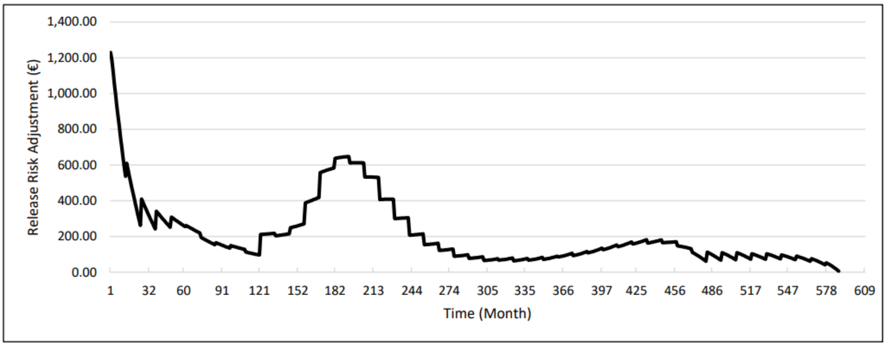
Figure 5: Release of Risk Adjustment



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Remark 1. The significant hump on the Release Risk Adjustment value curve is caused by the hump on the risk-free spot rate curve with volatility adjustment as of January 31, 2022, EIOPA (2022).

The goal of the standard is the immediate identification of onerous contracts, and the impossibility of creating a negative *CSM* is one of the tools to achieve this goal. Figure 7 shows the development of *CSM* throughout the insurance period. The release of *CSM* and the amortisation factor are shown in Figure 6. The amount for the release of *CSM* represents the profit attributed to the insurance contracts in the respective month. The release of *CSM* is performed according to the amortisation factor, which is expressed on the basis of coverage units in that month.

Figure 6: Release Contractual Service Margin

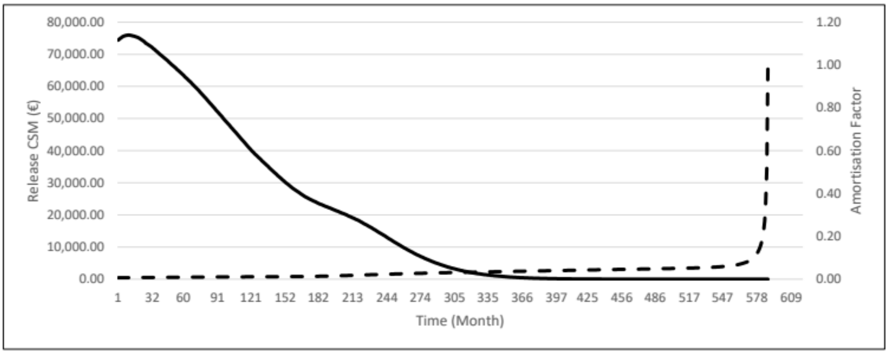

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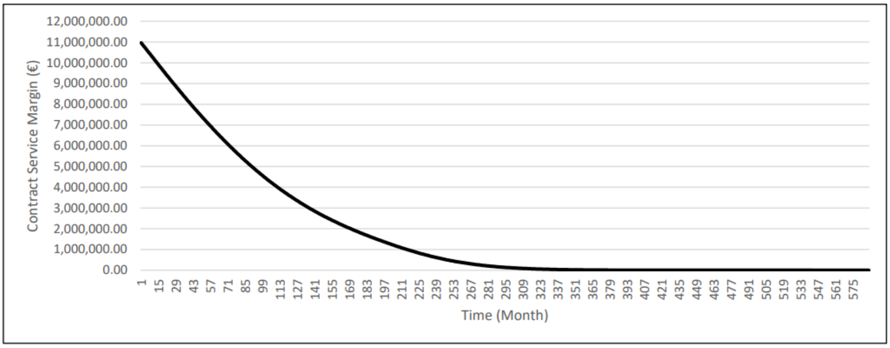
Figure 7: Contractual Service Margin at the End of Period



Source: Own processing

These insights are vital for insurers seeking to navigate the complexities of longevity risk while complying with the rigorous standards of IFRS 17. Furthermore, the findings reflect the growing influence of artificial intelligence and digitalization in shaping modern business and management research Dvouletý et al. (2025), offering a pathway for more automated and precise actuarial reporting.

In Tables 3 and 4 we give the main financial statements at the end of the first month. The balance sheet and income statement are given according to the requirements of IFRS 17. The income statement is divided into the insurance service result and the income and expenses of the insurance finance. The new values added there are Release of Risk Adjustment and Release of Contractual Service Margin. New values have also been added to the balance sheet. Insurance acquisition cash flows on the asset side and on the liability side. Present Value of Future Cash Flows, Risk adjustment and Contractual Service Margin. Both tables show values with and without the selection factor.

Table 3: Income statement in euros. SF – selection factor

Income statement	First month with SF	First month without SF
Insurance Service Result	75,609	155,532
Insurance revenue	144,152	231,670
Contractual Service Margin Release	74,381	151,513
Risk Adjustment Release	1,229	4,019
Expected Claims	55,579	63,175
Expected Expenses	12,963	12,963
Insurance Service Expense	−68,542	−76,138
Claims incurred	−55,579	−63,175
Fulfilment expenses incurred	−12,963	−12,963
Insurance Finance Income and Expenses	37,326	25,396
Interest accretion on PVFCF	37,326	25,396
Profit and Loss	112,936	180,928
Effect of discount rate changes on insurance liability	0	0
Total Comprehensive Income	112,936	180,928

Source: Own processing

Table 4: Balance sheet in euros. SF – selection factor

Balance Sheet	Initial recognition	End of the first month mortality with SF	End of the first month mortality without SF
Cash income		19,494,421	19,486,825
Total assets		19,494,421	19,486,825
PV FCF at inception	11,162,110		
RA at inception	123,851		
CSM at inception	11,038,259		
PV FCF		8,294,985	5,618,465
RA		122,622	316,650
CSM		10,963,878	13,370,781
Total liability		19,381,485	19,305,897
Equity		112,96	180,928
Total liability+Equity		19,494,421	19,486,825

Source: Own processing

The balance sheet and also the income statement are the main part of the financial statements of insurance companies. In the balance sheet under IFRS 17, there is no longer an item of technical provisions or deferred acquisition costs. The comparison of the income statement shows that profitability is significantly lower when taking into account the selection factor reflecting the economic impact of longevity risk. This reduction is mainly driven by a lower release of the contractual service margin and lower insurance revenue, which indicates that profits are spread over a longer period due to extended policyholder lifetimes. Although expected claims are slightly lower in the short term, this does not reduce overall costs, as payments are spread over a longer horizon. The balance sheet confirms this effect, as the present value of future cash flows is substantially higher under the selection factor, indicating increased liabilities due to longer survival. At the same time, the contractual service margin is lower, meaning that less profit is available upfront and more is recognized gradually over time. This leads to a decrease in equity, demonstrating an immediate negative impact of longevity risk on the insurer's financial position. Overall, longevity risk manifests as higher liabilities, delayed profit recognition, and decrease current profitability and equity. If longevity is not properly modeled, the insurer is effectively underestimating the cost of survival, which would lead to overstated profits and capital.

IV. Conclusion

The impact of longevity risk is substantial at first in longevity models, where strong selection factors were used to correct the fit of the mortality of the annuitants. This mortality based on Kannistö's model was consequently used to calculate insurance premiums and estimate insurance claims. Our results lead us to the constant that the mortality based on the dynamic longevity model is set in the correct way, but for the insurance companies it can lead to a higher premium for annuitants. Long-term risk was also included in the calculation of the risk adjustment for non-financial risk, which is mandatory to calculate and report according to the principles of IFRS 17. Using the Cost of Capital method, we came to the conclusion that the Value at Risk expressed in the 99.5% quantile can lead to high-risk adjustment values. We worked with the assumption that the standard Solvency II formula corresponds to the risk profile of the insurance company. We consider the Cost of Capital method suitable for calculating the risk adjustment, but the decision on the percentile amount is up to the actuary, who knows well the relevant risks of the portfolio for which he plans to value the risk adjustment. If longevity risk is included in the valuation of the pension, it will provide greater security for clients and solvency for the insurance company. The IFRS 17 standard brings significant changes not only to actuarial calculations but also to the accounting procedures and statements themselves. Future demographic changes are expected to have a significant impact on longevity risk under IFRS 17. Increasing life expectancy and aging populations may lead to longer payout periods for annuity and pension-type insurance products. As a result, insurers may face higher fulfillment cash flows and greater uncertainty in estimating future liabilities. Accurate modeling of mortality improvements therefore becomes essential for reliable measurement of insurance contract liabilities. Consequently, insurers must regularly update demographic assumptions to ensure that longevity trends are appropriately reflected in IFRS 17 valuations.

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References

Araiza, I., Carlos, A., Godin, F., Mailhot, M. (2021). Tweedie double GLM loss triangles with dependence within and across business lines, *Eur. Actuar. J.*, 11(2), 619–653. https://doi.org/10.1007/s13385-021-00267-0.

Bongaarts, J. (2005). Long-range trends in adult mortality: Models and projection methods. *Demography*, Springer, 42(1), 23–49. https://doi.org/10.1353/dem.2005.0003.

Cairns, A. J. G., Blake, D., Dowd, K. (2006). Pricing Death: Frameworks for the Valuation and Securitization of Mortality Risk. *ASTIN Bulletin: The Journal of the IAA*, 36(1), 79–120. https://doi:10.1017/S0515036100014410.

Cairns, A. J. G., Blake, D., Dowd, K., Coughlan, G. D., Epstein, D., Khalaf-Allah, M. (2011). Mortality density forecast: An analysis of six stochastic mortality models. *Insurance: Mathematics and Economics*, 48(3), 355–367. https://doi.org/10.1016/j.insmatheco.2010.12.005.

Denton, F. T., Spencer, B. G. (1999). How old is old? Revising the definition based on life table criteria. *Mathematical Population Studies*, Taylor & Francis, 7(2), 147–159. https://doi.org/10.1080/08898489909525452.

Diffey, W., Hobern, L., Lauder, A., Cleugh, M., Wu, M., Mukherjee, S., Dan, A., Dharamshi, P., Atwal, R., Vijay, A., Dolan, F., Grewal, A. (2022). Your reserves may be best estimate, but are they valid? *British Actuarial Journal*, 27(3), 1–40. https://doi.org/10.1017/S1357321721000179.

Directive 2006/54/EC of the European Parliament and of the Council of 5 July 2006 on the implementation of the principle of equal opportunities and equal treatment of men and women in matters of employment and occupation. (2022). *Official Journal of the European Union*. Taylor & Francis. https://eurlex.europa.eu/legalcontent/EN/TXT/PDF/?uri=CELEX:32006L0054&from=ENň.

Dvouletý, O., Jirásek, M., Giglio, C., Liguori, E. (2025). Artificial intelligence, digitalization, and new technologies in shaping business and management research. *Cogent Business & Management*, 12(1), 2580126. https://doi.org/10.1080/23311975.2025.2580126.

Christl, M., Kucsera, D. (2019). Actuarial Neutrality and Financial Incentives for Early Retirement in the Austrian Pension System. *DANUBE: Law, Economics and Social Issues Review*, 10(1), 1–22. https://doi.org/10.2478/danb-2019-0001.

Directive 2009/138/EC of the European Parliament and of the Council of 25 November 2009 on the acquisition and pursuit of the insurance and reinsurance business (Solvency II).

(2009). *Official Journal of the European Union*. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0138&from=SK.

EIOPA. (2022). Risk-free rate structure with volatility adjustment. https://www.eiopa.europa.eu/tools-and-data/risk-free-interest-rate-term-structures_en

England, P. D., Verrall, R. J., Wüthrich, M. V. (2019). On the lifetime and one-year views of reserve risk, with application to IFRS 17 and Solvency II risk margins. *Insurance: Mathematics and Economics*, 85, 74–88. https://doi.org/10.1016/j.insmatheco.2018.12.002.

Gavrilov, L. A., Gavrilova, N. S. (1979). Historical perspective on the kinetics of human mortality. *Proc. Acad. Sci. USSR* [Doklady Akademii Nauk SSSR], 245(4), 1017–1020.

Gavrilova, N. S., Gavrilov, L. A. (2011). Ageing and longevity: Mortality laws and mortality forecasts for ageing populations. *Demografie*, 53(2), 109–128.

Haberman, S., Renshaw, A. (2013). Modelling and projecting mortality improvement rates using a cohort perspective. *Insurance: Mathematics and Economics*, 53(1), 150–168. https://doi.org/10.1016/j.insmatheco.2013.04.006.

Heathcote, Ch., Higgins, T. (2004). Regression modelling of mortality surfaces and the deceleration of mortality. *Mathematical Population Studies*, Taylor & Francis, 11(2), 73–91. https://doi.org/10.1080/08898480490478229.

Human Mortality Database. (2019). University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany) https://www.mortality.org.

Hyndman, R. J., Khandakar, Y. (2008). Automatic time series forecasting: the R forecast package. *Journal of Statistical Software*. 26(3), 1–22. http://www.jstatsoft.org/article/view/v027i03.

Chan, L. F.-S., Peng, J.-L., Tsai, Ch.-H. (2021). The Impact of IFRS 9 and IFRS 17 on the Regulation and Management of the Taiwan Life Insurance Industry: A Preliminary Analysis. *NTU Management Review*, 31(2), 29–62. https://doi.org/10.6226/NTUMR.202108_31(2).0002.

International Accounting Standards Board. (2022). https://www.ifrs.org/groups/international-accounting-standards-board

IFRS Foundation: Amendments to IFRS 17 Insurance Contracts. (2019). https://www.ifrs.org/projects/completed-projects/2020/amendments-to-ifrs-17

Kainhofer, R., Predota, M., Schmock, U. (2006). The new Austrian annuity valuation table AVÖ 2005R. https://kainhofer.com/wpcontent/uploads/2010/03/KainhoferPredotaSchmock_AVOe2005R.pdf.

Lee, R. D., Carter, L. R. (1992). Modeling and forecasting US mortality. *Journal of the American statistical association*, Taylor & Francis Group, 87(419), 659–671. https://doi.org/10.2307/2290201.

Owais, W. O., Dahiyat, A. A. (2021). Readiness and Challenges for Applying IFRS 17 (Insurance Contracts): The Case of Jordanian Insurance Companies. *Journal of Asian Finance, Economics, and Business*, 8(3), 277–286. https://doi.org/10.13106/jafeb.2021.vol8.no3.0277.

Palmborg, L., Lindholm, M., Lindskog, F. (2021). Financial position and performance in IFRS 17. *Scandinavian Actuarial Journal*, 3, 171–197. doi/full/10.1080/03461238.2020.1823464.

Pascariu, M. D. (2019). Mortality Laws: Parametric Mortality Models, Life Tables and HMD.

Package R version 1.8.0. https://CRAN.R-project.org/package=MortalityLaws.

Pasdika, U., Wolff, J., Re, G., Life, M. (2005). Coping with Longevity: The new German annuity valuation table DAV 2004 R. *The Living to 100 and Beyond Symposium*, Orlando, Florida, 1–48.

Pitacco, E., Denuit, M., Haberman, S., Olivieri, A. (2009). *Modeling longevity dynamics for pensions and annuity business*. Oxford University Press.

Sotona, P. (2018). Mortality risk assessment under IFRS 17. *Applications of Mathematics and Statistics in Economics 2018*, Kutná Hora, 281–289.

Shukulipa, L. (2023). Political and Economic Aspects of Brexit Impact on Accounting Legislation in the UK – New Directions in Standards (GAAP UK and IFRS). *DANUBE: Law, Economics and Social Issues Review*, 14(1), 1–25. https://doi.org/10.2478/danb-2023-0001.

Špirková, J., Kollár, I., Szűcs, G., Zimmermann, P. (2023). Selected Payout Products of the Old-Age Pension Saving Scheme. *Springer Nature*. https://doi.org/10.1007/978-3-031-23849-9.

Villegas A. M., Kaishev, V. K., Millossovich, P. (2018). An R Package for Stochastic Mortality Modeling. *Journal of Statistical Software*, 84(3), 1–38. https://doi.org/10.18637/jss.v084.i03.

Wilmoth, J. R., Andreev, K., Jdanov, D., Glei, D. A., Boe, C. Bubenheim, M., Philipov, D., Shkolnikov, V., Vachon, P. (2007). Methods protocol for the human mortality database [version 31/05/2007]. *University of California, Berkeley, and Max Planck Institute for Demographic Research*, Rostock. http://mortality.org.

Yousuf, W., Stansfield, J., Malde, K., Mirin, N., Walton, R., Thorpe, B., Thorpe, J., Iftode, C., Tan, L., Dyble, R., Pelsser, A., Ghosh, A., Qin, W., Berry, T., Er. C. (2021). The IFRS 17 contractual service margin: A life insurance perspective. *British Actuarial Journal*, 26, E2. https://doi.org/10.1080/08898480.2017.1330013.

Zelinová, S., Blahušiaková, M., Šoltésová, T. (2022). Proposal for the Measurement of Reinsurance Contracts Under IFRS 17. *Journal of Economics*, 3, 284–304. https://doi.org/10.31577/ekoncas.2022.03.04.

Zimmermann, P. (2017). Modeling mortality at old age with time-varying parameters. *Mathematical Population Studies*, Taylor & Francis, 24(3), 172–180. https://doi.org/10.1080/08898480.2017.1330013.