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Solvency II and IFRS 17: A general overview how everything has changed

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This thesis considers the evolving regulatory landscape for the insurance sector, focusing on the almost simultaneous introduction of two key regulatory frameworks: Solvency II and IFRS 17.

Solvency II, implemented in the European Union on 1 January 2016, introduced a harmonized and risk-based prudential regime, with the primary objective of strengthening policyholder protection and financial stability. In parallel, IFRS 17, effective from 1 January 2023, is intended to be the first global accounting standard for insurance contracts, aiming to increase transparency and comparability of financial information.

The deep changes that these two frameworks have introduced in insurance companies are explored, requiring significant changes in terms of governance, risk management, information systems and reporting processes. The diverging primary purposes of the two regimes are highlighted: Solvency II focuses on prudential robustness and solvency, while IFRS 17 is oriented towards reporting of the economic performance of insurance contracts. The combined use of these two frameworks influence the decision-making in companies.

Going through the evolution of Solvency II with Minimum Capital Requirement and Solvency Capital Requirement, until the evaluation of technical provisions, with a focus on key concepts such as Risk Margin. Then, going through the measurement models of IFRS 17: General Measurement Model. Premium Allocation Approach and Variable Fee Approach.

Finally, the thesis includes a case study on Crédit Agricole Assurance, analyzing the Solvency and Financial Condition Report 2024 to illustrate the concrete application of the Solvency II principles and the implementations of the new accounting principle IFRS 17.

Santrauka

Šiame darbe nagrinėjama besikeičianti draudimo sektoriaus reguliavimo aplinka, daugiausia dėmesio skiriant beveik vienu metu įvestoms dviem pagrindinėms reguliavimo sistemoms: „Mokumas II“ ir „TFAS 17“.

„Mokumas II“, Europos Sąjungoje įgyvendintas 2016 m. sausio 1 d., įvedė suderintą ir rizika pagrįstą prudencinį režimą, kurio pagrindinis tikslas – stiprinti draudėjų apsaugą ir finansinį stabilumą. Tuo pačiu metu TFAS 17, įsigaliojantis nuo 2023 m. sausio 1 d., turėtų būti pirmasis pasaulinis draudimo sutarčių apskaitos standartas, kuriuo siekiama padidinti finansinės informacijos skaidrumą ir palyginamumą.

Nagrinėjami esminiai pokyčiai, kuriuos šios dvi sistemos įvedė draudimo bendrovėse, reikalaujantys reikšmingų pokyčių valdymo, rizikos valdymo, informacinių sistemų ir ataskaitų teikimo procesų srityse. Pabrėžiami skirtingi pagrindiniai dviejų režimų tikslai: „Mokumas II“ daugiausia dėmesio skiria prudenciniam patikimumui ir mokumui, o „TFAS 17“ – draudimo sutarčių ekonominio veiklos rezultatų ataskaitoms. Šių dviejų sistemų bendras naudojimas daro įtaką sprendimų priėmimui bendrovėse.

Apžvelgiama „Mokumo II“ evoliucija su minimaliu kapitalo reikalavimu ir mokumo kapitalo reikalavimu iki techninių atidėjinių vertinimo, daugiausia dėmesio skiriant pagrindinėms sąvokoms, tokioms kaip rizikos marža. Toliau aptariami TFAS 17 matavimo modeliai: bendrasis matavimo modelis, įmokų paskirstymo metodas ir kintamojo mokesčio metodas.

Galiausiai, darbe pateikiamas „Crédit Agricole Assurance“ atvejo tyrimas, kuriame analizuojama 2024 m. mokumo ir finansinės būklės ataskaita, siekiant iliustruoti konkretų „Mokumo II“ principų taikymą ir naujojo apskaitos principo TFAS 17 įgyvendinimą.

Solvency II & IFRS 17: A general overview of how everything has changed

1. The Evolving Regulatory Landscape for the Insurance Industry

In the contemporary economic fabric, the insurance industry plays a unique role, acting as a linchpin for risk management and at the same time acting as a long-term institutional investor. This dual nature, in turn, implies the need for sound regulatory and accounting structures, aimed at safeguarding policyholders and preserving financial stability. The operating landscape of insurance companies has evolved, in recent decades, towards an increasing complexity of financial markets and progressive globalization: these dynamics have made the adoption of homogeneous standards at the international level indispensable.

In this context, previous regimes have shown significant shortcomings. The prudential framework known as Solvency I (or, in some cases, "Solvency 0"), while setting minimum capital requirements, lacked adequate sensitivity to firm-specific risk, did not fully address the full range of risks (for example, financial risk was underestimated) and was based on simplified metrics, such as premiums and claims.

In parallel, on the accounting front, IFRS 4, introduced in 2004 as an intermediate standard, allowed firms to continue to use a plurality of local accounting practices ("grandfathering"), hindering the comparability of financial statements across jurisdictions and firms.

In order to overcome these limitations, two landmark regulatory frameworks have been developed: Solvency II and IFRS 17. Solvency II, implemented in the European Union as of 1 January 2016, has replaced 14 previous insurance directives, introducing a harmonized, comprehensive and risk-based prudential regime. Its primary objective is to strengthen the protection of policyholders and beneficiaries, while ensuring the financial stability of the sector, through stringent quantitative and qualitative requirements, applied in a proportionate manner.

At the same time, the International Accounting Standards Board (IASB) defined IFRS 17 Insurance Contracts, which came into force on 1 January 2023. This principle represents the first truly global

accounting standard for insurance contracts, intended to replace the fragmentation inherited from IFRS 4.9. The key objective of IFRS 17 is to increase the transparency, usefulness and comparability of financial information relating to insurance contracts, for the benefit of all users of financial statements (investors, analysts, regulators).

The almost simultaneous introduction of these two regulatory frameworks, both extremely complex and with a high impact on business operations, has triggered a real paradigm shift for the European and global insurance industry. Solvency II has been defined as a "comprehensive paradigm of enterprise risk management", requiring profound changes in governance, risk management, information systems and reporting processes. Similarly, the implementation of IFRS 17 has proven to be a particularly burdensome process in terms of financial and human resources, requiring significant investments in new systems, greater data granularity, the development of new actuarial and accounting methodologies, and close collaboration between previously more autonomous corporate functions (actuarial, finance, IT, risk management).

Temporal simultaneity and conceptual overlaps, for example in discounted cash flow-based liability valuation principles, have forced companies to address these challenges not sequentially, but by considering their interactions from the outset, generating unprecedented implementation pressure and requiring an integrated strategic vision. This dual regulatory challenge is therefore not limited to mere compliance but requires a fundamental operational transformation and a holistic review of risk management, capital allocation, information systems, actuarial processes, financial reporting and overall business strategy.

The operational arena for insurance companies operating within the European Union, or for multinational groups with significant operations in the EU, is configured as a need to simultaneously navigate the intricate dynamics of Solvency II and IFRS 17. This simultaneity produces an essential tension, which originates from the divergent purposes underlying the two regulatory frameworks. Solvency II focuses primarily on prudential robustness, on the calculation of the capital required to ensure the company's payment capacity and on the protection of policyholders over time. IFRS 17, on the other hand, aims to provide clear and comparable financial reporting on the economic performance resulting from insurance contracts, addressing investors and other market stakeholders first and foremost.

Although both regimes share some basic principles, such as the risk-based approach and the valuation of liabilities at market-consistent or current values value, significant differences emerge in specific valuation methodologies, in the levels of contract aggregation required, in the recognition of profits and in reporting and disclosure requirements.

It is essential for insurance companies to fully understand these dynamics, differences, and potential collaborations. Decisions made in one area can have direct effects on the other, affecting strategic planning, operational effectiveness, capital management, investment decisions, new product development, and communication with regulators and the public. This thesis therefore aims to examine this intricate relationship in depth.

The interaction between two complex frameworks, with different yet overlapping primary objectives, generates a situation where companies may prefer one regulatory approach over the other (arbitrage), or face non-ideal choices in order to harmonize systems and processes developed for distinct purposes. A key management issue arising from this duality is the “critical constraint”: which of the two regimes – Solvency II with its capital requirements, or IFRS 17 with its impact on profits and equity – will define key strategic decisions, such as the ability to pay dividends or the distribution of capital. Differences in profit recognition, for example the introduction of the

Contractual Service Margin (CSM) in IFRS 17, which defers profit over time versus the faster recognition in equity in Solvency II, and possible discrepancies arising from Solvency II-oriented hedging strategies. Management needs careful consideration, as optimizing for one framework may disadvantage the other.

2.1 The regulatory framework: From Solvency 0 to Solvency II

Solvency 0 was the first regulatory apparatus that began the European harmonization process since 1970 years through the patrimonial requirements (minimal margin solvency) and defined by directive 73/239/EEC (non-life) and 79/267/EEC (life) - whereas it is necessary that insurance undertakings should possess, over and above technical reserves of sufficient amount to meet their underwriting liabilities, a supplementary reserve, to be known as the solvency margin, and represented by free assets, in order to provide against business fluctuations[1].

Insurance companies took into consideration only premiums or claims for non life insurance, or capital and reserves for life insurance.

After that the regulations evolved in Solvency I, it updated the previous regulations, but did not show a radical change of basic principles. This was accomplished through two directives in 2002 (13/2002/EC and 83/2002/EC).

In depth:

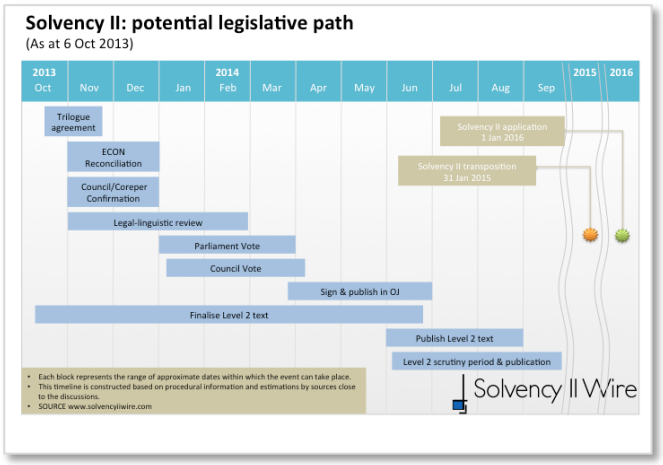
- Non-life insurance: the amount of the solvency margin is calculated as a fraction of the damage premiums or the average claims load[2]
- Life insurance: the amount of the solvency margin is calculated as a share of the mathematical reserves.

With the advent of Solvency II in 2009, which reformed the entire system of prudential supervision and a general evolution of the regulatory framework, bringing the following benefits and effects:

- A general cross-sectoral liberalization and convergence;
- Increased sectoral competition
- Greater instability in financial markets

[1] https://liu.diva-portal.org/smash/get/diva2:1247062/FULLTEXT02.pdf
[2] https://www.europarl.europa.eu/RegData/etudes/note/join/2001/304260/IPOL-ECON_NT(2001)304260_EN.pdf

- Growing expectations expected from stakeholders to optimize invested capital
- Improvements in techniques and models used for risk analysis



[3]

2.2 Regulatory framework: Solvency II – Directive 138/2009

The main objective of insurance and reinsurance regulation and supervision is the adequate protection of policy holders and beneficiaries. The term beneficiary is intended to cover any natural or legal person who is entitled to a right under an insurance contract. Financial stability and fair and stable markets are other objectives of insurance and reinsurance regulation and supervision which should also be taken into account but should not undermine the main objective[4].

As reported before, Solvency II is Risk based Approach and to explain the reason:

In line with the latest in risk management, in the context of the International Association of Insurance Supervisors, the International Accounting Standards Board and the International Actuarial Association and with recent developments in other financial sectors an economic ***risk-based approach*** *should be adopted which provides incentives for insurance and reinsurance undertakings* ***to properly measure and manage their risks.*** *Harmonization should be increased by providing specific rules for the valuation of assets and liabilities, including technical provisions* [5].

It means that **the more risks** an insurance company takes, **the more capital** it needs.

[3] https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.solvencyiiwire.com%2Fsolvency-ii-news-solvency-ii-delays-timelines-quick-fixes%2F&psig=AOvVaw3uH-VV_H542MNk3q2aoBys&ust=1747758746360000&source=images&cd=vfe&opi=89978449&ved=0CBcQjhxqFwoTCLCcuev6r40DFQAAAAAdAAAAABAE
[4] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0138
[5] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0138

Solvency II is the harmonized prudential regulatory framework for insurance and reinsurance undertakings in the European Union, which entered into force on 1 January 2016. Its key objective is to ensure an adequate level of protection for policyholders and beneficiaries, while promoting the stability of the financial system. This objective is pursued through a holistic and risk-based approach, which considers the overall solvency of the undertaking.

The Solvency II structure is based on three fundamental pillars (Three Pillars' approach):

- **Pillar I:** Quantitative Requirements. This pillar establishes the capital requirements that companies must meet. The core is the determination of the capital needed to cover the risks assumed.
- **Pillar II:** Qualitative Requirements and Supervision. This pillar focuses on the qualitative aspects of corporate management and the Supervisory Review Process (SRP). It includes stringent requirements on corporate governance, risk management *and* internal control functions. A central element of Pillar II is the Own Risk and Solvency Assessment (ORSA). ORSA is a process conducted regularly by the undertaking (at least annually), aimed at assessing the adequacy of its overall solvency in relation to its specific risk profile, approved risk tolerance. It is not just a calculation exercise, but a strategic management tool that must be integrated into the decision-making process. Recent revisions of the Solvency II framework have placed further emphasis on ORSA, requiring the inclusion of macroeconomic analyses and stress scenarios related to climate change.
- **Pillar III:** Disclosure and Information. This pillar defines the reporting requirements to supervisory authorities and public disclosure. The aim is to increase market transparency and facilitate market discipline, allowing stakeholders to better understand the financial position and risk profile of the company.[3] The main reporting documents include the Solvency and Financial Condition Report (SFCR), intended for the public, the Regular Supervisory Report (RSR), for internal use of authority and the Quantitative Reporting Templates (QRTs).

The Solvency II regulatory framework is structured according to the *Lamfalussy Process*, which is divided into four levels:

- **Level 1: Frameworks Directive – Omnibus II**
    - *A directive is a legal act of the European Union that requires member states to achieve particular goals without dictating how the member states achieve those goals. A directive's goals have to be made the goals of one or more new or changed national laws by the member states before this legislation applies to individuals residing in the member states. Directives normally leave member states with a certain amount of leeway as for the exact rules to be adopted. Directives can be adopted by means of a variety of legislative procedures depending on their subject matter. The text of a draft directive (if subject to the co-decision process, as contentious matters usually are) is prepared by the Commission after consultation with its own and national experts. The draft is presented to the Parliament and the Council—composed of relevant ministers of member governments, initially for evaluation and comment and then subsequently for approval or rejection* [6].
- **Level 2: Implementing measures – Delegated Acts**
    - Regulation 2015/35/EU, adopted by Commission and in force for all EU members.
- **Level 2.5: Technical Standard**
    - **Regulatory Technical Standard**
    - **Implementing Technical Standard**
- **Level 3: Guidelines**
    - Supporting EU members and National Authorities to comply or explain mechanism decided[7]

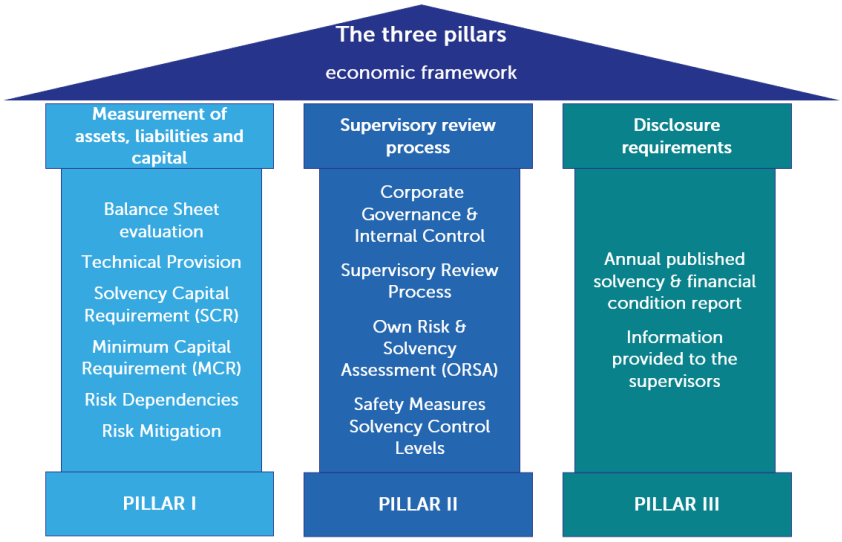
The key principles that inform the entire regime are the risk-based approach, the market-consistent assessment, the principle of proportionality[8] (the requirements must be proportionate with the nature, scale and complexity of the risks of the undertaking) and a strengthening of the supervision of cross-border insurance groups. It is important to note that Solvency II is a dynamic framework, subject to periodic reviews aimed at refining its effectiveness, increasing proportionality, improving risk

[6] https://en.wikipedia.org/wiki/Directive_%28European_Union%29
[7] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0138
[8] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:02009L0138-20250117

sensitivity and integrating new emerging risks, such as those related to sustainability and macroprudential risks[9].

The very structure of Solvency II, in particular the emphasis on ORSA in Pillar 2 and detailed disclosure in Pillar 3, actively pushes insurance undertakings towards a more integrated, forward-looking and transparent approach to risk management. It is not simply a matter of calculating a capital requirement (Pillar 1), but of embedding risk awareness ("risk awareness culture") into the very fabric of governance and strategic decisions. ORSA, in particular, requires undertakings to independently assess their solvency needs in relation to their specific risk profile and strategy, while the transparency required by Pillar 3 aims to strengthen market discipline. This approach marks a clear departure from previous solvency regimes, which were more static and less sensitive to company-specific risk.

Below is a graphic representation:



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[9] https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:32009L0138

[10] https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.finalyse.com%2Fsolvency-ii&psig=AOvVaw3pKSV592J_f1rupBK70Ycw&ust=1748448007131000&source=images&cd=vfe&opi=89978449&ved=0CBcQjhxqFwoTCMCCq8iCxI0DFQAAAAAdAAAAABAE

The principles of the regulation concern the provision of a risk sensitive requirement, which is based on a prospective calculation and a limit below which the amount of financial resources must not fall.[11]

The capital requirement for solvency purposes corresponds to the capital that must be paid by companies to honor their obligations towards customers with a probability of 99.5% and must ensure coverage of risks for both the Life and Non-life branches and also the market, systemic (which does not depend on strategic choices) and credit risk.

It is essential to understand the actual solvency and an adequate analysis of the financial situation - assets of insurance companies are required to comply with economic principles and the optimal use of information available in financial markets; this verification occurs through the evaluation of the balance sheet. In fact, Solvency II promotes, for a completer and more detailed picture of companies, principles of:

- Materiality and proportionality
- On the prevalence of substance over form
- On harmonization and convergence of supervisory practices

Analyzing the financial economic sheet, assets are valued at the values at which they can be exchanged in an arm's length transaction, while liabilities are valued at the values at which they can be transferred.

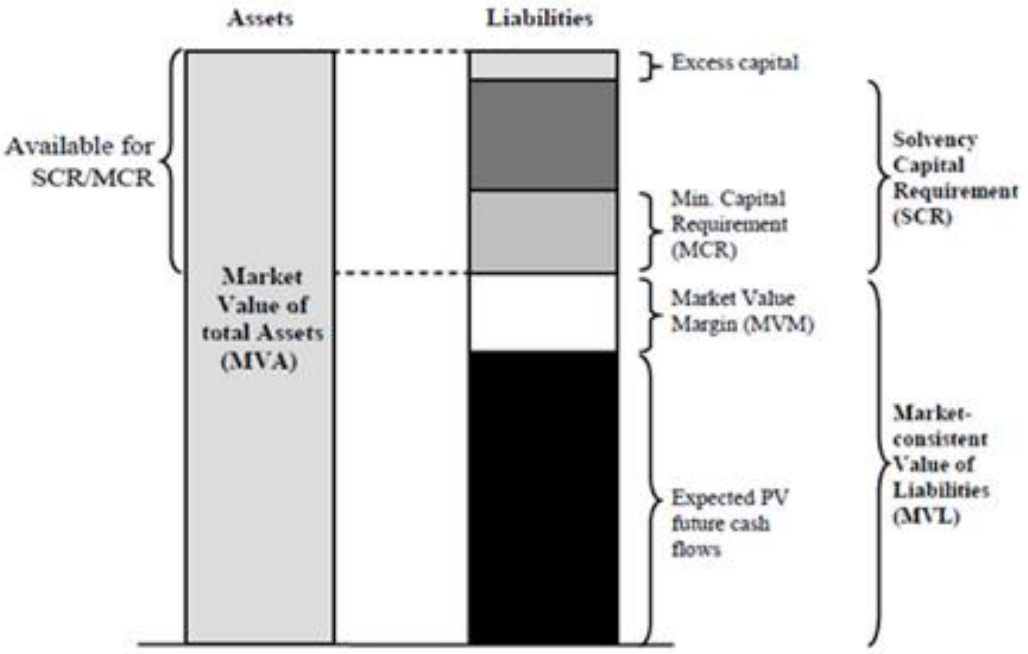
Financial economic sheet:

- Assets (Market Value of total Assets)
- Liabilities:
    - Solvency Capital Requirement (SCR)
        - Min. Capital Requirement

[11] https://www.casact.org/sites/default/files/2021-05/6I_Geneva.pdf

- Excess capital

- Market-consistent Value of Liabilities
  - Market Value Margin (MVM)
  - Expected PV future cash flows



[12]

The Solvency Capital Requirement (SCR) is the amount of capital an insurance or reinsurance company needs to hold in the European Union to withstand the potential for losses, specifically to meet a 99.5% confidence level over a one-year period[13].

The goal is to prevent the 0.5% probability of failure, as one in 200 insurance companies is at risk of failure.

Minimum Capital Requirement: In addition to the SCR capital a Minimum capital requirement (MCR) must be calculated which represents the threshold below which the national supervisor (regulator) would intervene. The MCR is intended to correspond to an 85% probability of adequacy over a one-year period and is bounded between 25% and 45% of the SCR. [14,15]

[12] https://www.insureware.com/cat/8/12/98-solvency-ii
[13] https://www.aemagroupe.fr/wp-content/uploads/2023/05/AEMA-GROUPE-SOLVENCY-AND-FINANCIAL-CONDITION-REPORT-2022-SFCR.pdf
[14] http://hdl.handle.net/10400.5/12809
[15] https://en.wikipedia.org/wiki/Solvency_II#:~:text=In%20addition%20to%20the%20SCR,and%2045%25%20of%20the%20SCR

2.3 Technical Reserves

The Technical Provisions are the amount given under a certain measurement to adequately meet the obligations related to an insurance contract or a portfolio.

DEF Art. 76/2: The value of technical provisions shall correspond to the current amount insurance and reinsurance undertakings would have to pay if they were to transfer their insurance and reinsurance obligations immediately to another insurance or reinsurance undertaking [16].

For the calculation Art76/3/4: The calculation of technical provisions shall make use of and be consistent with information provided by the financial markets and generally available data on underwriting risks (market consistency). 4. Technical provisions shall be calculated in a prudent, reliable and objective manner [17].

Art. 77:

1. The value of technical provisions shall be equal to the sum of a best estimate and a risk margin as set out in paragraphs 2 and 3.

2. The best estimate shall correspond to the probability-weighted average of future cash-flows, taking account of the time value of money (expected present value of future cash-flows), using the relevant risk-free interest rate term structure.

The calculation of the best estimate shall be based upon up-to-date and credible information and realistic assumptions and be performed using adequate, applicable and relevant actuarial and statistical methods.

The cash-flow projection used in the calculation of the best estimate shall take account of all the cash in- and out-flows required to settle the insurance and reinsurance obligations over the lifetime thereof.

The best estimate shall be calculated gross, without deduction of the amounts recoverable from reinsurance contracts and special purpose vehicles. Those amounts shall be calculated separately, in accordance with Article 81.

3. The risk margin shall be such as to ensure that the value of the technical provisions is equivalent to the amount that insurance and reinsurance undertakings would be expected to require in order to take over and meet the insurance and reinsurance obligations. [18]

They have two different definitions, in the case of Non-life Insurance or Life Insurance. In the first case they can be divided into:

- Unearned premium provision
- Claims provision

[16] *https://www.eiopa.europa.eu/rulebook/solvency-ii/article-2159_en*
[17] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0138
[18] https://www.eiopa.europa.eu/rulebook/solvency-ii/article-2160_en

In the second case instead:

- Mathematical Provision

Regarding the measurement of these technical reserves there are different approaches for Solvency II and IFRS 17. Now we will look at the first case, which is in line with theoretical framework.

Solvency II uses:

- Replacing Portfolio Technique
- The Present value of future expected cash flows with a risk adjustment[19]

2.4 The Present value of future expected cash flows with a risk adjustment

The best estimate is the probability-weighted average of future cash flows, considering the present value of future cash flows, using the risk-free interest rate term structure[20]. The formula is:

$$\boldsymbol{BE\ (F)\ =\ \sum_{t=1}^{T}\ \frac{E(Ft)}{(1+i_t)^t}}$$

Where:

- BE($\tilde{F}$) is the best estimate of future cash flows
- $E(F_t)$ is the expected value of cash flows at time t
- i_t is the risk-free interest rate at maturity t
- T is the time horizon

The risk-free rate is the expected interest from a completely risk-free investment for a specific time. Investors expect a predictable return from a risk-free investment over a given period. In the real version, it is calculated by taking the yield of a Treasury bond with same duration as the investment and subtracting the current inflation rate. Risk margin is intended to ensure that the value of the technical provisions is equivalent to the amount that insurance and reinsurance companies would expect to require to meet the obligations. The latter is calculated using the cost of capital approach. The cost of capital rate is set at 6%[21].

The CoC's conceptual foundations approach and the specific 6% calibration were influenced by the Swiss Solvency Test (SST). And it has been explained as a calculation of the cost of capital for a solid and financial stable company (specifically BBB rating).

The Risk Margin formula is:

$$\boldsymbol{RM = CoC \cdot \sum_{t \geq 0}^{T} \frac{SCR_t}{1 + r(t+1)^{t+1}}}$$

Where:

- RM is the Risk Margin
- CoC is the cost of capital
- SCR_t is the Solvency Capital Requirement at time t to support the insurance and reinsurance obligations over their lifetime, at the end of each future year t. The summation covers all until the obligations are fully run-off
- The term $(1+r(t+1))^{t+1}$ represents the discount-factor applied to the cost of holding capital in year t.

[21] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0138

How it is possible to see, the formula is directly and linearly proportional to the CoC rate. If the other components remain constant, any change in the CoC rate results proportionally change in the RM. This is crucial to understanding why the level of CoC rate is determinant for RM's magnitude. The structure of Risk Margin Formula is highly sensitive to the duration of liabilities because it determines the number of SCR_t included in the summation, which influences the development of future capital requirements. In a situation of long-tailed business, where SCR_t may decline slowly, will inevitably result in a higher sum of SCR_t value. Then, seeing the formula, the RM is sensitive to the level of risk-free rate interest rate. However, in a situation of low interest (see years ago), the discount factors are larger, this amplifies the value of CoC. The rate can be a significant multiplier and the RM can be volatile for long-duration business.

A direct consequence of RM volatility in insurance business is the impact can be on the pricing of new products. In fact, this can lead to a potentially uneconomic or uncompetitive situation for the insurer to write.

With Solvency II 2020 Review[22], a new formula for the Risk Margin was discussed that seen the change for the CoC, from 6% to 4.75% and the introduction of lamba λ ($0 <= \lambda <= 1$), time-dependent exponential damping factor. The goal is to hold into time-dependent risks, reducing RM, in particular for the long-term liabilities e decreasing the sensitivity to changes in interest rates over time.

With the first approach of RM there is implicit a lambda λ value = 1, with the new approach it will be $0 <= \lambda <= 1$.

[22] https://www.eiopa.europa.eu/document/download/f155bdf8-1f24-4252-8192-fc8239b63fb6_en?filename=Background%20impact%20assessment-updated%20in%20June%202021.pdf

The European Commission has indicated a floor of the lambda value of λ = 0.5, as it is possible to see in the new approach:

$$\boldsymbol{RM = CoC \cdot \sum_{t\geq 0}^{T} \frac{SCR_t \times max(\lambda^t, 0, 5)}{[1 + r(t+1)^{t+1}]}}$$

For this approach, the lambda parameter will apply for each future SCR.

Another approach for the calculation of Risk Margin simplified it is introduced: estimation all future SCRs "at once" and multiplied for $\lambda^{\frac{Duration}{2}}$.

What should be the value of the duration to have a floor = 0.5?

$$\lambda^{\frac{Duration}{2}} = 0.5$$

$$\ln(\lambda)^{\frac{Duration}{2}} = \ln(0.5)$$

$$\text{Duration} = \left[\frac{\ln(0.5)}{\ln(\lambda)}\right]$$

Using the assumption of λ = 0.975, advised by EIOPA, the result is:

Duration = 54 years

An insurance portfolio with this long duration is difficult to find, for this reason in this case there is not a technical floor as in the first approach.

In my opinion with Solvency 2020 Review, the goal must have a less volatility for technical provisions and a reduce of sensitivity from interest rate, with a positive impact: lower TP, lower CoC, it means more Eligible Own Funds.

The overall value of TP (technical provision or technical reserve RT) is given by:

$$\mathbf{RT(\tilde{F}) = BE(\tilde{F}) + RM(\tilde{F}) = \sum_{t=1}^{T} \frac{E(Ft)}{(1+i_t)^t} + RM(\tilde{F})}$$

As we have seen above, the key components of measurement for Solvency II are given by **three fundamental elements**:

- **Cash Flow and calculation of future cash flow**
- **Risk-free interest rate**
- **Risk Margin**

The term structure of risk-free interest rates is used to discount expected cash flows, but adjustments have been introduced by the Omnibus II directive to mitigate **procyclicality –** the tendency of risk measurement, in determining capital requirements, to amplify market cycles. Capital requirements tend to spike during economic downturns and stay relatively low during expansions, which can destabilize the financial system. And these measures are:

- **Volatility Adjustment –** an addition to the risk-free rate interest rate term structure (it is a curve) to adjust the value of technical provisions. It is computed monthly by EIOPA, following the second level of regulation and it is made by *currency volatility adjustment = 65% * correct currency spread* (computed by a part of spread on a reference portfolio – generic investment of EU insurance companies). The VA is low in normal market conditions and higher in stressed market ones.
- **Matching Adjustment** is applied to a specific life insurance portfolio
- **Transitional Measurement** is applied to avoid TP, for a specific insurance portfolio, rises too much in the passage from SI to SII.

The above-mentioned components are used to discount future cash flows and this also brings the management of own funds into the scope of Solvency II.

Own funds are defined as the capital resources of the insurance company and allow to absorb losses, thus maintaining solvency. The Solvency Directive establishes that total own funds are formed by the sum of Basic Own Funds (BOF) and Ancillary Own Funds[23].

Basic Own Funds:

(1) the excess of assets over liabilities, valued in accordance with Article 75 and Section 2;

(2) subordinated liabilities.

The excess amount referred to in point (1) shall be reduced by the amount of own shares held by the insurance or reinsurance undertaking [24].

Ancillary Own Funds:

Ancillary own funds shall consist of items other than basic own funds which can be called up to absorb losses. They are not basic own-fund items:

(a) unpaid share capital or initial fund that has not been called up;

(b) letters of credit and guarantees;

(c) any other legally binding commitments received by insurance and reinsurance undertakings.

The amount ascribed to each ancillary own-fund item shall reflect the loss-absorbency of the item and shall be based upon prudent and realistic assumptions. Where an ancillary own-fund item has a fixed nominal value, the amount of that item shall be equal to its nominal value, where it appropriately reflects its loss-absorbency [25].

A key feature of Solvency II is the classification (tiering) of funds into three levels: Tier 1, Tier 2 and Tier 3.

Own-fund items shall be classified into three tiers. The classification of those items shall depend upon whether they are basic own fund or ancillary own-fund items and the extent to which they possess the following characteristics:[26]

(a) the item is available, or can be called up on demand, to fully absorb losses on a going-concern basis, as well as in the case of winding-up (permanent availability);

(b) in the case of winding-up, the total amount of the item is available to absorb losses and the repayment of the item is refused to its holder until all other obligations, including insurance and reinsurance obligations towards policy holders and beneficiaries of insurance and reinsurance contracts, have been met (subordination).

2. When assessing the extent to which own-fund items possess the characteristics set out in points (a) and (b) of paragraph 1, currently and in the future, due consideration shall be given to the duration of the item, in particular whether the item is dated or not. Where an own-fund item is dated, the

[23] https://www.eiopa.europa.eu/rulebook/solvency-ii/article-2175_en
[24] https://www.eiopa.europa.eu/rulebook/solvency-ii/article-2176_en
[25] https://www.eiopa.europa.eu/rulebook/solvency-ii/article-2178_en
[26] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0138

relative duration of the item as compared to the duration of the insurance and reinsurance obligations of the undertaking shall be considered (sufficient duration) [27].

[27] https://www.eiopa.europa.eu/rulebook/solvency-ii/article-2181_en

3.Solvency II: Risk Measures, Capital Requirements and Calculation Models

Risk measurement is essential for sound insurance management. Before moving into the specifics, it is useful to recall the distinction between stock variables and flow variables.

3.1 Stock and Flow variables

A stock variable is measured at a specific point in time and represents a quantity that exists at that time (e.g. assets, liabilities, equity).
It accumulates over time through inflows and/or decreases due to outflows and these values can be modified by the flows themselves.

A flow variable is measured over a time interval and changes a stock variable over that interval (e.g. revenues, costs, profit, change in basic equity - ΔBOF).

For example:

- $\Delta\widetilde{A}_1 = \widetilde{A}_1 - A_0$ (variation of activities)
- $\Delta\widetilde{L}_1 = \widetilde{L}_1 - L_0$ (change in liabilities)
- $\Delta\widetilde{E}_1 = \widetilde{E}_1 - E_0$ (change in equity)

A = Asset

L = Liabilities

E = Equity

While *past and present accounting variables* are certain numbers, *future accounting variables* are random variables. Risk is intrinsically connected to the uncertainty of the future outcome of these.

3.2 Concept of Risk Measure

The risk measure is a mapping from a set of random variables to real numbers. A property of the risk measure is subadditivity: $R(X+Y) \leq R(X)+R(Y)$. This property expresses that the risk of an aggregate portfolio should not be greater than the sum of the risks of its individual components. Explaining how diversification is a benefit.

3.3 Value at Risk (VaR)

Value at Risk (VaR) is the loss in an adverse scenario ("worst case scenario") with a given confidence level over a predetermined time horizon.
In this case, SCR is calibrated on a VaR based on Basic Own Funds, over a time horizon of one year and with a confidence level of 99.5%.

For a positive stock variable (e.g. BOF, Assets) X_t , the VaR with confidence level $1-\alpha = 99.5\%$ over horizon t is:

$$VaR_{1-\alpha}(X_t) = X_0 - P_{\alpha}(X_t)$$

where X_0 is the current value and $P_{\alpha}(X_t)$ is the α-percentile, the 0.5^{th} percentile, of the distribution of X_t.

$X_0 - P_{\alpha}(X_t)$ represents the potential loss from the current value. Specifically for assets, a decrease in value is a loss.

For a negative stock variable (e.g. Technical Liabilities, TP) or a negative flow variable (e.g. Claims), the VaR is:

$$VaR_{1-\alpha}(X_t) = P_{1-\alpha}(X_t) - X_0$$

While $P_{1-\alpha}(X_t) - X_0$ represents the increase in liabilities. This increase is the loss.

3.4 VaR in Case of Normal Distribution

If the random variable is normally distributed, the percentile can be calculated from the expected value and the standard deviation. For a positive flow variable, the VaR is:

$$\text{VaR}_{1-\alpha}(\Delta X) = N^{-1}(1-\alpha)\,\sigma(\Delta X) - E(\Delta X)$$

Where $N^{-1}(1-\alpha)$ is the quantile of the standard normal distribution. For some common confidence levels:

1. $\text{VaR}_{99.5\%}(X) = 2.57 \cdot \sigma(X) - E(X)$ (SCR)
2. $\text{VaR}_{85\%}(X) = 1.04 \cdot \sigma(X) - E(X)$ (MCR)

4.Solvency Capital Requirement (SCR) and Minimum Capital Requirement (MCR)

The Capital requirements are designed to ensure that insurance companies maintain a sufficient level of financial resources to cover their obligations to policyholders even in the worst scenarios.

4.1 Solvency Capital Requirement (SCR)

4.1.1 Definition and Principles

Article 101.3 of the Solvency II Directive defines the Solvency Capital Requirement (SCR) as:

It shall correspond to the Value-at-Risk of the basic own funds of an insurance or reinsurance undertaking subject to a confidence level of 99.5% over a one-year period.[28]

Continuing Article 101.3, SCR should cover at least these risks:

- Non-Life Underwriting Risk
- Life Underwriting Risk
- Health Underwriting Risk
- Market Risk
- Credit Risk
- Operational Risk

SCR can be calculated using the standard formula or an approved internal model.

It must be calculated at least once a year or at each change in risk compared to the last calculated SCR.

In fact, following art. 138 of the Solvency Directive, companies must immediately notify the supervisory authority if SCR is not respected in the following three months. Within two months of non-compliance with the SCR, a recovery plan must be submitted and everything must be re-established within six months with two potential actions: increase of eligible own funds or by

[28] https://www.eiopa.europa.eu/rulebook/solvency-ii/article-2188_en

reducing risks. The supervisory authority may extend it up to seven years in exceptional adverse situations.

For this reason, it is important to constantly monitor the **Solvency Ratio** (Eligible Own Funds/SCR) to decide which strategy to implement.

The Solvency Ratio has to be higher than 100%, but in some cases it can happen it goes down. In those cases, it is crucial to raise again and there are two possible routes: Eligible Own Funds or SCR.

- **Eligible Own Funds:** Increase eligible own funds, in particular issue new equity, new subordinated debt or new ancillary own funds.
- **Solvency Capital Requirement:** first of all, decrease the risk, specifically decrease market risk or underwriting risk or otherwise improve diversification.

No insurance or reinsurance company will have an SCR equal to 100%, since the probability of bankruptcy within the year is 0.5%. In fact, the requirement is kept well above the minimum value.

The expected default is less than one in 200 cases per year.

4.2 Minimum Capital Requirement (MCR)

4.2.1 Definition and Purpose

The Minimum Capital Requirement (MCR) is defined by art. 129: *it shall correspond to an amount of eligible basic own funds below which policy holders and beneficiaries are exposed to an unacceptable level of risk were insurance and reinsurance undertakings allowed to continue their operation.*[29] *And the linear function referred to calculate the Minimum Capital Requirement shall be calibrated to the Value-at-Risk of the basic own funds of an insurance or reinsurance undertaking subject to a confidence level of 85% over a one-year period.* [30]

Its value must be in absolute floor for Non-life and Life insurances and it has respect this range and never fall below 25% and not exceed 45% of the undertaking's Solvency Capital Requirement.

4.2.2 Calculating the MCR

The MCR (Art. 129 [31]) must be calculated every three months in a clear and simple way.

An example formula for calculating MCR:

$$MCR_{NL} = \sum_j \max(\alpha_j \cdot TP_j ; \beta_j \cdot P_j)$$

where TP_j (technical provisions) and P_j (premium) of branch j, and α_j, β_j are coefficients.

In case of non-compliance with the MCR (or imminent risk), the company must immediately inform the supervisory authority. Within one month, a short-term financial plan must be submitted to restore compliance within three months. Authorization is withdrawn if the company does not comply with the MCR and the recovery plan is inadequate or not complied with.

[29] https://www.eiopa.europa.eu/rulebook/solvency-ii-single-rulebook/article-2216_en
[30] https://www.eiopa.europa.eu/rulebook/solvency-ii-single-rulebook/article-2216_en
[31] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0138

4.3 The Standard Formula

The Solvency Capital Requirement can be calculated using the standard formula or internal model.

4.3.1 Alternative Approaches for Calculating SCR

There are several approaches:

- **Standard Formula:** taking into account a risk map, aggregation approach, modules and aggregation parameters set by regulation.
- **Standard Formula with Enterprise Specific Parameters (USP):** Similar to the standard formula, but some parameters in the risk modules may be enterprise specific, subject to regulatory approval.
- **Partial Internal Model:** Combination of standard formula (or USP) for some modules and internal model for others, subject to regulatory approval.
- **Complete Internal Model:** Risk map, aggregation approach, modules and parameters developed internally by the company, subject to regulatory approval.

4.3.2. Structure of the Standard Formula

Standard formula for SCR is composed by modules. The Total SCR is given by the sum of the Basic SCR (BSCR) and the SCR for Operational Risk, net of some adjustments.

BasicSCR is an aggregation of risk modules:

- **Life Underwriting Risk** (SCRLife)
- **Non-Life Underwriting Risk** (SCRNon-life)
- **Health Underwriting Risk** (SCRHealth)
- **Market Risk** (SCRMarket)

- **Counterparty Default Risk** (SCRDefault)
- **Risk for Intangibles** (SCRIntangible)

Each of these core modules is further divided into submodules. The SCR for each submodule is calculated separately, and then aggregated to obtain the module SCR, taking into account diversification effects. Finally, the core module SCRs are aggregated to calculate the BasicSCR, again taking diversification into account.

4.3.3 SCR Submodules

The SCR submodules are calculated using two main approaches:

1. **Scenario-Based Approach:** Mainly used for life underwriting risks, market risks and non-life catastrophe risks.

   A specific stress scenario is defined for the risk sub-module. The asset and liability values in this stressed scenario are recalculated to determine the new value of basic own funds (BOF_S). The loss in the stressed scenario (ΔBOF) is the difference between the current BOF and the BOF_S: $\Delta BOF = BOF - BOF_S$.

   SCR for the sub-module is therefore: $SCR = MAX[\Delta BOF|Stress; 0]$.

   For some sub-modules (e.g. interest rate risk, lapse risk), multiple stress scenarios are considered and the one generating the highest loss is chosen.

2. **Factor-Based Approach:** Used for operational risk, premium and non-life risks, MCR. In some cases, a simple linear function is used (e.g. MCR, Operational SCR), in others a more complex function (e.g. premium and non-life risks).

   This approach is simpler but less precise than the scenario-based approach and is used when simplicity is a requirement or a scenario-based approach is too complex.

4.3.4 Aggregation of SCRs in the Standard Formula

The aggregation of the SCRs of the various modules to obtain the BasicSCR (and similarly to aggregate the sub-modules within a module) is based on a formula similar to that of the standard deviation of a portfolio, using a correlation matrix ($Corr_{ij}$):

Basic SCR = $\sqrt{\sum_{i,j} Corr_{i,j} \times SCR_i \times SCR_j}$ + SCRIntangible

Correlation coefficients represent correlations between *worst-case scenarios.*

i \ j	Market	Default	Life	Health	Non-life
Market	1	0,25	0,25	0,25	0,25
Default	0,25	1	0,25	0,25	0,5
Life	0,25	0,25	1	0,25	0
Health	0,25	0,25	0,25	1	0
Non-life	0,25	0,5	0	0	1

[32]

4.3.5 From Basic SCR (BSCR) to Total SCR

Solvency Capital Requirement is obtained from:

BasicSCR + SCR Operational – Adjustment

Adjustment refers to the ability to absorb the loss of:

- technical provisions: Future Discretionary Benefits (FDBs) are future benefits that the company can decide whether or not to distribute to policyholders, typical of "with-profit" life contracts. They are considered as liabilities in the calculation of the best estimate. However, in a stress scenario that generates losses, the company could reduce or cancel such benefits, demonstrating a capacity to absorb losses. The latter, in the event of a reduction, can be subtracted from the BasicSCR.

[32] https://www.irishstatutebook.ie/eli/2015/si/485/made/en/print

- Deferred Taxes: these are liabilities and therefore represent a future tax debt relating to profits already accounted for in the financial statement. In a worst-case scenario , *by reducing* profits, taxes will also be reduced. Therefore, we have an absorption of losses. As with TP, these can also be subtracted from the BasicSCR.

4.3.6 Operational Risk

Operational risk is *the risk of loss resulting from inadequacy or failure of internal processes, people or systems, or from external events."*

Operational SCR in the standard formula is factor-based and is a function of the premiums and technical liabilities (for non-life and traditional life branches) and expenses (for unit-linked life products).

The typical formula is:

$SCR_{Operational} = \min(0.3 \cdot BSCR; Op) + 0.25 \cdot Exp_{ul}$

where $Op = \max(Op_{premiums}; Op_{provisions})$.

4.3.7 Life Underwriting Risks

Life underwriting risk refers to the loss or adverse change in the value of insurance liabilities resulting from uncertainties relating to life contracts [33].

[33] https://register.eiopa.europa.eu/CEIOPS-Archive/Documents/Advices/CEIOPS-L2-Final-Advice-on-Standard-Formula-Health-underwriting-risk.pdf

4.3.8 Life Underwriting Risk Sub-modules

This module includes seven submodules:

1. **Mortality risk:** Unexpected increase in mortality rates. Consequence: Increase in the value of liabilities.
2. **Longevity risk:** Unexpected decrease in mortality rates (increase in life expectancy). Consequence: Increase in the value of liabilities.
3. **Disability/morbidity risk:** Changes in rates of disability, disease.
4. **Life expense risk:** Changes in expenses incurred for managing contracts.
5. **Review risk:** Fluctuations in the review rates applied to annuities.
6. **Lapse risk:** Changes in the surrender, expiration, renewal and termination rates of policies.
7. **Life Catastrophe Risk:** Significant uncertainty in pricing and reserving assumptions related to extreme or irregular events.

For some of these submodules, the standard formula defines specific stress scenarios.

- **Mortality:** Instant permanent 15% increase in mortality rates.
- **Longevity:** Instant permanent 20% decrease in mortality rates.
- **Spending:** 10% increase in eligible expenditure and 1 percentage point increase in the inflation rate of expenditure.
- **Catastrophe:** Instantaneous increase of 0.15 percentage points in mortality rates for the next 12 months.

4.3.9 Mortality and Longevity Risk

- **Mortality risk** is prevalent in products such as term life insurance.
- **Longevity risk** is crucial for life annuities, often used in pension products.

4.3.10 Lapse Risk

Lapse risk is the loss that occurs due to a change in the surrender, termination, renewal rates of policies. The insurance company can classify the portfolio based on the *Lapse value:* Surrender Value - Best Estimate.

- If the lapse value is positive, an increase in redemption rates generates a loss.
- If the lapse value is negative, a decrease in redemption rates generates a loss.

This risk can be high for investment products, especially with-profit. For unit-linked contracts, the redemption value is usually linked to the value of the underlying fund. The best estimate is often lower than the redemption value due to expected future margins, leading to a lapse positive value.

For with-profit contracts, the situation is more complex. Possible redemption penalties can reduce the lapse value, even making it negative. Furthermore, if current interest rates are very low (near zero or negative) and contracts have guaranteed minimum returns, the present value of future cash flows (the best estimate component) may be significantly higher than the (unpenalized) surrender value, leading to a lapse markedly negative value.

lapse risk considers the greater of:

- Permanent 50% increase in call option rates (for contracts with lapse positive value).
- Permanent 50% decrease in call option rates (for contracts with lapse negative value).

- Instant termination of 70% of non-retail policies and 40% of retail policies (mass lapse).

4.3.11 Health Risk Module

Health insurance contracts can have different characteristics, such as damage contracts or life contracts. For this reason, their SCR is a combination of requirements for two sub-modules:

1. **SLT Health** - Similar to Life Techniques
2. **Non-SLT Health -** Similar to Non-Life Techniques

The Non-SLT Health submodules are similar to the non-life submodules, while the SLT Health submodules are similar to the life submodules . There is also a submodule for catastrophe health risk.

4.3.12 Damage Underwriting Risks

The property and casualty underwriting risk module reflects the risk arising from property and casualty insurance obligations.

Main Submodules

There are two main submodules:

1. **Non-life premium and reserve risk:** risk of loss or adverse change in the value of insurance liabilities, resulting from fluctuations in the timing, frequency and severity of insured events (premium risk) and in the timing and amount of claims settlement (reserve risk). The SCR measurement for this risk is factor-based approach [34].
2. **Catastrophe risk:** Risk of loss or adverse change in the value of insurance liabilities resulting from uncertainty in pricing and reserving assumptions related to extreme or exceptional events. The measurement of the SCR for this risk is scenario- based approach.

[34] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0138

4.3.13 SCR for Premium Risk and Damage Reserves

SCR for premium risk and damage reserves (SCRnl) is calculated as:

$SCR_{nl} = 3 * \sigma_{nl} * V_{nl}$

where σ_{nl} is the standard deviation for the premium and non-life reserve risk and V_{nl} is the volume measure for that risk.

The coefficient of 3 (instead of 2.58 that would be obtained with a normal distribution and 99.5% confidence) reflects the asymmetry of the distribution of liabilities, typically assumed to be lognormal in Solvency II.

The aggregate standard deviation (σnl) is obtained by aggregating the standard deviations of each business segment (σ_s), taking into account the correlations between segments ($CorrS_{s,t}$) and the volumes (V_s,V_t):

$$\sigma_{nl} = \frac{1}{V_{nl}} \times \sqrt{\sum_{s,t} CorrS_{s,t} \times \sigma_s \cdot V_t \times \sigma_t \times V_t}$$

The standard deviation for each segment (σ_s) in turn aggregates the standard deviation of the premium risk (σ(prem,s)) and that of the reserve risk (σ(res,s)) for that segment, using the respective volumes V (prem,s) and V(res,s):

$$\sigma_s = \frac{\sqrt{\sigma^2_{prem.s} \times V^2_{prem,s} + \sigma_{prem,s} \times V_{prem,s} \times \sigma_{res,s} \times V_{res,s} + \sigma^2_{res,s} \times V^2_{res,s}}}{V_{prem,s} + V_{res,s}}$$

The volume measure by segment (Vs) is the sum of the volume measures for premium risk and reserve risk for that segment. The overall volume measure (V_{nl}) is the sum of the volume measures for each

segment. The volume measure for premium risk is linked to premiums (current and future), while the volume measure for reserve risk is linked to the best estimate of the claims reserves.

4.3.14 Catastrophic Damage Risk

SCR for catastrophic damage risk is measured with scenario-based approach.

The sub-modules considered include:

- Risk of natural disaster (wind, earthquake, flood, hail, subsidence)
- property reinsurance
- Man-made catastrophe risk (auto insurance, marine, aeronautical, fire, civil liability, credit and suretyship)
- Other catastrophic risks damage

The aggregation of these submodules follows a specific formula, for example:

$SCR_{nlCAT} = (SCR_{natCAT} + SCR_{nppropCAT})2 + SCR^{2}_{manCAT} + SCR^{2}_{CATother}$.

Within natural and man-made catastrophe risk, the respective submodules are often aggregated via root sum of squares: SCR = $\sqrt{\sum_i SCR_i^2}$ [35].

4.3.15 Undertaking-Specific Parameters (Undertaking-Specific Parameters - USP)

Undertakings may, subject to supervisory approval, replace a subset of the parameters of the standard formula with undertaking-specific parameters (USPs) in the calculation of the life, non-life and health underwriting risk modules. These parameters must be calibrated on the basis of the undertaking's

[35] https://actuary.eu/documents/CEIOPS_CAT-TF-Report.pdf

internal data or data directly relevant to its operations, using standardised methods. The most relevant parameters that may be replaced are the standard deviations for premium and reserve risk.

4.3.16 Market Risks and Counterparty Risk

This section focuses on market risks other than interest rate risk and counterparty default risk.

4.3.17 Market Risk

SCRMarket includes several sub-modules that reflect the sensitivity of the value of assets, liabilities and financial instruments to changes in market conditions.

Market Risk Sub-modules

- **Interest rate risk:** Sensitivity to changes in the term structure of interest rates or their volatility;
- **Equity Risk:** Sensitivity to changes in the level or volatility of stock prices;
- **Property Risk:** Sensitivity to changes in the level or volatility of property prices;
- **Spread risk:** Sensitivity to changes in the level or volatility of credit spreads relative to the term structure of risk-free rates;
- **Currency Risk**: Sensitivity to changes in the level or volatility of exchange rates.
- **Market concentration risk:** Additional risks arising from a lack of diversification in the asset portfolio or from large exposures to the default risk of a single issuer.

Exposure to market risks varies depending on the type of assets and liabilities. For example, bonds are exposed to interest rate and spread risk, stocks to equity risk. Life technical liabilities are exposed to interest rate risk, and for with-profit products, the loss-absorbing capacity adjustment mitigates market risks on the assets covering such products.

4.3.17 Equity Risk

There are two basic approaches to measuring VaR on an equity portfolio:

- **Normal VaR:** Based on the assumption of normal distribution of returns. VaR 99.5%(r)=2.57 · σ(r)−E(r), where σ(r) is the annual volatility and E(r) the expected return. It usually underestimates the real VaR due to the heavier tails of the empirical distributions of stock returns (" fat tails ").
- **Empirical VaR:** Based on historical series of returns, taking the desired percentile (e.g. 0.5 percentile for 99.5% VaR). It can be more precise but its estimate over long horizons (annual) can be distorted if overlapping historical series are used.

The calibration process of the standard formula parameters was conducted by EIOPA by considering representative indices (e.g. MSCI), calculating normal and empirical VaRs over long historical periods, and then submitting these analyses to the European Commission for the final definition of the regulatory parameters.

In the standard formula, stocks are classified into:

- **Type 1 Equities:** Listed on EEA or OECD regulated markets. Stress is an instantaneous decrease in value of 39% (plus a symmetric adjustment) for general investments, or 22% for strategic investments.
- **Type 2 Equities:** Listed on non-EEA/OECD exchanges, unlisted, commodities and other alternative investments. Stress is a 49% instantaneous decline (plus symmetric adjustment) for general investments, or 22% for strategic.

SCRs for Type 1 and Type 2 are aggregated with a correlation coefficient of 0.75.

The symmetric adjustment: $\frac{1}{2} \times \left(\frac{CI-AI}{AI} - 8\%\right)$ where CI is the current level of equity index and AI is the weighted average of the daily levels of the equity index over the last 36 months.

It is a countercyclical measure that modifies the basic stress parameters (39% and 49%) by increasing them in bull markets and decreasing them in bear markets, within a range of +/-10%. It is calculated monthly by EIOPA on the basis of a formula that compares the current level of the stock index with its moving average of the last 36 months.

$$SCR_{Equity} = \sqrt{SCR_{T1}^2 + 2 * 0{,}75 * (SCR_{T2} + SCR_{Qinf} + SCR_{QinfC}) + (SCR_{T2} + SCR_{Qinf} + SCR_{QinfC})^2}$$

For the calculation of SCR_{Equity}, it is adopted a correlation factor of 75% between Type 1 and Type 2.

Nowadays, the World is changing through the application the **duties** or **inflation**.

For instance, the SCR_{Equity} is often calculated by applying a shock into the equity current market value. A simplified model could be:

$$SCR_{Equity} = MV_{Equity} * Shock_{Equity}$$

- MV_{Equity}: current market value insurance's investments
- $Shock_{Equity:}$ predefined shock value

Tariffs can impact in negative way the $MV_{Equity.}$ In this case a company has to face the increase in costs caused by duties, consequently the profitability can decline. This leads to lower earnings and a drop of stock prices. However, for the Shock factors, we can have an increment of market volatility.

Assume tariffs cause a β decrease in the market value of a portion α of an insurer's equity portfolio due to reduced corporate profitability.

- Market Value: $MV_{Equity,0}$
- Market Value affected by duties: $MV_{Equity,1} = MV_{Equity,0} * (1-\alpha * \beta)$

The SCR_{Equity} changes from:

- $SCR_{Equity} = MV_{Equity,0} * Shock_{Equity}$

to

- $SCR_{Equity,1} = (MV_{Equity,0} * (1-\alpha * \beta)) * Shock_{Equity}$

If $MV_{Equity,1} < MV_{Equity,0}$, the SCR_{Equity} should be lower. However, the risk in the economic environment has increased. Standard formula shocks are typically calculated to a specific VaR. If tariffs increase the volatility (σ) of equity returns, the calibrated $Shock_{Equity}$ could increase, potentially offsetting or even exceeding the decrease resulting from a lower MV_{Equity}.

Considering the inflation in SCR_{Equity}:

- Market Value: $MV_{Equity,0}$
- Market Value affected by inflation: $MV_{Equity,1} = MV_{Equity,0} * (1+ \Pi)$

Where Π is the inflation rate

$SCR_{Equity,1} = MV_{Equity,1} * stress_{Equity} \approx [MV_{Equity,0} * (1+ \Pi)] * stress_{Equity}$

$SCR_{Equity,1} = SCR_{Equity,0} * (1+ \Pi)$

This simplified condition shows how SCR_{Equity} grows proportionally to the inflation. To satisfy SCR, insurance companies have to hold more capital in an inflation environment.

4.3.18 Spread Risk

Spread risk is the sensitivity to changes in credit spreads. The main asset classes exposed are government, corporate and structured bonds, and credit derivatives.

$$\mathbf{SCR_{Spread} = SCR_{Bonds} + SCR_{Securitisation} + SCR_{Cd}}$$

where

- $\mathbf{SCR_{Bonds}} = (a + b * (dur - Minus_{dur}))$

- a and b are multiplicative factors defined in the Delegated Regulation
- $Minus_{dur}$ – the lower element of the duration class where the security falls into
- dur – duration

- **$SCR_{Securitisation:}$** the same calculation above, but the only differences are the value of multiplicative factors; a and b value represent Senior and non-Senior securitizations;
- **SCR_{Cd}** – for credit derivates; it is a function where underlying the Cd in the credit spread.

For corporate bonds, the SCR spread is obtained with a ΔBOF approach, stressing the price of each bond with a non-linear coefficient that depends on its duration and its credit quality step (CQS), a standardized rating measure. The stress coefficient table is provided by the regulation. The SCR spread is the sum of the SCRs of each bond (without diversification effects at this level).

The formula for the market value of a bond is: $V(F)= \sum_{t=0}^{T} \frac{F_{Nt}}{(1+i_t+ sprd_t)^t}$

For government bonds issued by EU member states and denominated in their domestic currency, and for those issued by the ECB, the standard formula assigns a stress factor of 0%. This is a significant distortion, especially for insurers with large investments in low-rated government bonds.

In case a change on tariffs, even the Spread Risk will result affected by a loss. Because the tariffs can weaken financial positions and increase credit spreads. It is enough to see the formula above to understand why it is crucial the spread. A higher spread value, it brings a low market value of the bond.

In the end, this will affect the SCR_{Spread} and the overall SCR.

4.3.19 Market Concentration Risk

This sub-module covers additional risks due to poor portfolio diversification or large exposures to a single issuer. For government issuers (with 0% spread stress), the concentration stress factor is also 0%. For other issuers, the concentration SCR is calculated by identifying the total exposure to each individual issuer (Ei). The excess exposure (XS_i) is then calculated with respect to a relative threshold (CT_i, percentage of total assets, dependent on the issuer's CQS): $XS_i = Max(0; Ei - CT_i \square Assets)$.

SCR of total concentration is $SCR\ Mkt_{Conc} = \sqrt{\sum_i (Conc_i^2)}$.

4.3.20 Currency Risk

It is the sensitivity to changes in exchange rates. All assets and liabilities denominated in currencies other than the local currency are exposed. It is measured with a ΔBOF approach, considering for each foreign currency the greater loss between a 25% appreciation scenario and a 25% depreciation scenario of the foreign currency against the local currency. The total capital requirement is the sum of the requirements for each foreign currency.

For example, even in this case the tariffs can influence trade balances and if supposing an insurance company has assets or liabilities in foreign currencies, the currency risk can increase impacting the capital need for $SCR_{Currency.}$

4.3.21 Property Risk

It is the sensitivity to changes in real estate prices. It is measured with a ΔBOF approach considering a stress factor of 25% on the value of real estate investments.

4.3.22 Counterparty Default Risk

This module reflects the possible losses due to unexpected default or deterioration in the creditworthiness of counterparties and debtors in the following 12 months. It covers risk mitigation contracts (reinsurance, securitizations, derivatives), receivables from intermediaries and other credit exposures not covered by spread risk.

A distinction is made between:

- Type 1 Exposures: For which a CQS is expected (e.g. reinsurance contracts, cash at banks).
- Type 2 Exposures: For which a CQS is not expected (e.g. receivables from intermediaries, receivables from insured people).

For **Type 1 exposures**, SCR depends on the Loss Given Default (LGD) and the probability of default (p). A simplified model with N identical and independent exposures, each with a certain probability of default p and LGD, would have total losses PT with a binomial distribution: $E(PT)= N \cdot p \cdot LGD$ and $\sigma(PT)= N \cdot p \cdot (1-p) \cdot LGD$. For large N, this approximates to a normal and $VaR99.5\%(PT) \approx 2.58 \cdot \sigma(PT)$. The standard formula uses a similar approximation, but considers non-identical and correlated exposures. It requires the calculation of pe LGD according to regulatory parameters, the calculation of the standard deviation of the loss distribution (σ_{loss}), and then the SCR is $3 \cdot \sigma loss$ (for $\sigma_{loss} \leq 7\%$), $5 \cdot \sigma_{loss}$ (for $7\% < \sigma_{loss} \leq 20\%$), or the total LGD (for $\sigma_{loss} > 20\%$).

For **Type 2 exposures,** the SCR depends only on the LGD. It is the sum of 90% of the LGD of receivables from intermediaries that are more than three months past due and 15% of the LGD of all other Type 2 exposures.

5.Internal Models

Internal models represent an alternative to the standard formula for calculating the SCR.

5.1 Definition and Types

In full internal models, the risk mapping, aggregation approach and parameters are developed and estimated internally by the insurance company, subject to approval by the supervisory authority.

In partial internal models, some modules or submodules are developed internally, while others follow the standard formula; they also require approval.

5.2 Internal Model Requirements - Approval

An internal model must reflect the insurer's risk profile more appropriately than the standard formula. Several requirements must be met (Art. 120-125 Directive):

- **Use test:** The internal model must be widely used and play an important role in the enterprise's governance system.
- **Statistical Quality Standards:** Robust statistical methodologies for risk quantification.
- **Calibration standard:** The model must be calibrated to produce an SCR consistent with Solvency II principles (1-year VaR 99.5%).
- **Validation standards:** Robust processes for validating model appropriateness and accuracy.
- **Documentation Standard:** Detailed documentation of the design, operational details, theory, assumptions, and mathematical and empirical basis of the model.

5.3 Approval Procedures

Supervisory authorities decide on the request for approval within six months of receiving the complete application. A pre -application procedure usually precedes the formal application. Major

changes to the internal model always require new approval. Once an internal model has been approved, the undertaking cannot return to the standard formula except in justified circumstances and with approval. If the model ceases to meet the requirements, the authority may require a return to the standard formula.

6.IFRS 17: Global Standard for Accounting for Insurance Contracts

IFRS 17, issued by the IASB and effective from 1 January 2023, represents a milestone in international accounting harmonization for the insurance sector.

Its primary objective is to provide those who will use the financial statements (investors, analysts, creditors, regulators) with relevant and faithfully representative information on the insurance contracts issued, allowing them to evaluate the impact of such contracts on the financial position, economic performance and cash flows of the company.
A fundamental corollary is the increase in the comparability of insurance financial statements at a global level, overcoming the significant divergences allowed by the previous standard IFRS 4.

The measurement philosophy underlying IFRS 17 is based on the concept of current value (current value): estimates of insurance liabilities shall be updated at each balance sheet date to reflect the most recent information available. The standard recognizes that insurance contracts combine characteristics of both a financial instrument and a service contract.

IFRS 17 introduces three main measurement models:

- **General Measurement Model** - GMM, also known as Building Block Approach (BBA): This is the default model, applicable unless the conditions for the other two models are met. The insurance liability (or asset) is measured as the sum of three blocks:
    - Fulfilment Cash Flows - FCF: They represent the present value of the estimates of future cash flows (incoming premiums, claims and outgoing expenses) that fall within the boundaries of the contract (*contract boundary*). Such estimates must be unbiased , probability-weighted and based on all available reasonable and supportable information. Cash flows must be discounted using current discount rates that reflect the characteristics of the flows (timing, currency, liquidity) and the associated financial risks. A Risk Adjustment (RA) for non-financial risk is added to the discounted FCF.
    - **Risk Adjustment - RA** : This is an explicit margin that represents the compensation required by the entity for the uncertainty relating to the amount and timing of future cash flows arising from non-financial risk (insurance risk, expense risk, lapse risk,

etc.). This is in contrast to the margins of prudence often implicit in valuations under previous accounting principles. IFRS 17 does not prescribe a specific method for calculating RA (unlike the Risk Margin in Solvency II), but requires the entity to use an approach that reflects its degree of risk aversion and to provide information on the associated level of confidence (for example, through methods based on Value- at -Risk (VaR), Cost of Capital (CoC)).

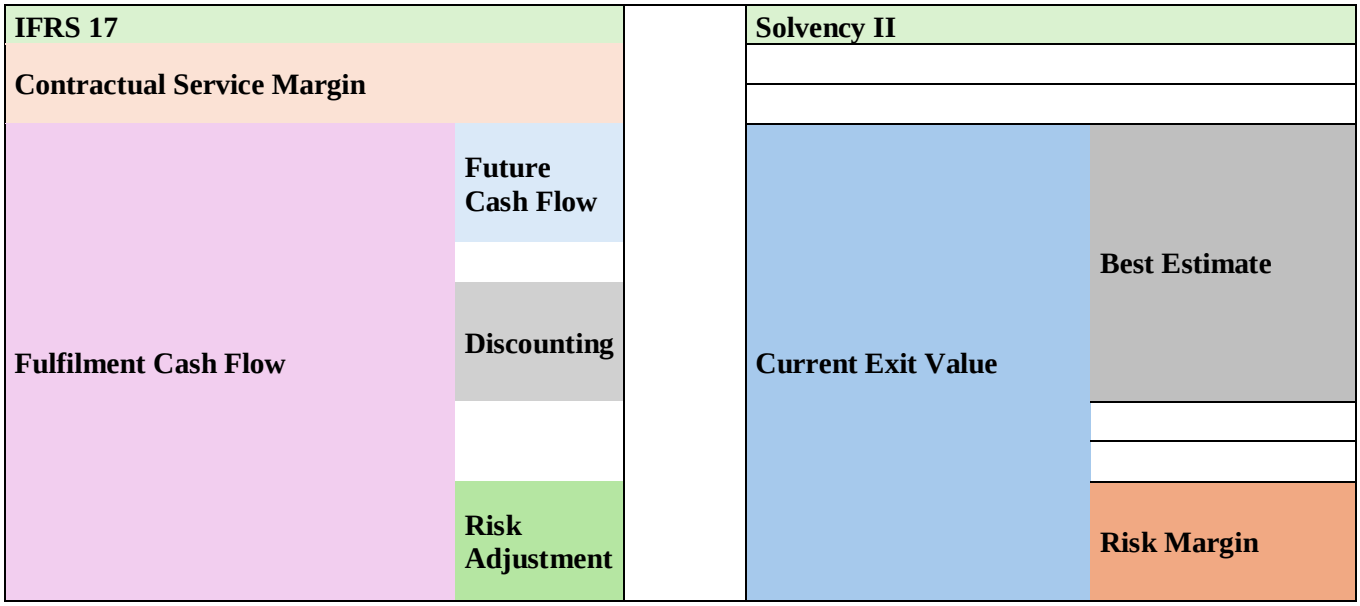
- **Contractual Service Margin - CSM:** This is one of the most significant innovations of IFRS 17. It represents the unearned profit on a group of insurance contracts. It is calculated on initial recognition of the group of contracts in such a way as to cancel out any gain arising from the initial measurement. The CSM is then systematically released to the income statement over the period of coverage of the contract, reflecting the provision of the insurance service by the company (typically on a "coverage unit " basis). The CSM cannot be negative; if initial or subsequent estimates indicate an expected loss for a group of contracts (onerous contracts), that loss is recognised immediately in the income statement. The CSM is subsequently updated to reflect the effect of changes in estimates of future cash flows relating to future services and for accretion of interest at "locked in" rates at the initial recognition date.

- **Premium Allocation Approach** - PAA: It is an optional simplified model, applicable mainly to short-term contracts (generally with a coverage period equal to or less than one year) or when this approach provides a reasonable approximation of the GMM. According to the PAA, the liability for remaining coverage (LRC) is initially measured on the basis of premiums received less acquisition costs, and subsequently released to revenue based on the passage of time and risk profile. The liability for incurred claims (Liability for Claims - LIC) is calculated similarly to GMM (FCF without CSM).

- **Variable Fee Approach** - VFA: It is a modification of the GMM specifically designed for insurance contracts with direct participation elements (direct participation features), such as unit-linked policies or certain *with-profit contracts* . In these contracts, the entity agrees to pay the insured an amount based on the fair value of an identified set of underlying items (e.g. mutual funds). The key difference from the GMM is in the updating of the CSM: under the VFA, the CSM is adjusted to reflect the entity's share of the changes in the fair value of the underlying items.

7.Solvency II vs IFRS 17

The two principles are very close in approach, even if the purpose is different; in fact, as you can see from the table below:



IFRS 17 was created with the purpose of creating the financial statement for information purposes for stakeholders and corporate strategies. In fact, it focuses on the value, given by the Balance Sheet and on the performance, values explained by the income statement. Instead, **Solvency II** serves to prudently regulate the operator of the companies, so that they are always solvent.

Going into detail they have two different types of approach:

- **IFRS 17: Principle-based approach**
    - Discount rate, which must be consistent with market prices and reflects the characteristics of the liability cash flows. There are two approaches that can be used:
        - **Bottom-up approach:** risk-free rate structure plus adjustment
        - **Top-down approach:** yield curve of the assets backing liabilities minus adjustment not related to insurance cash flows.
    - **Risk Adjustment** is the compensation required to tolerate uncertainty.

- **Solvency II: rule- based approach**
    - **discounting structure** is given by three typologies which we talked about above: Risk-Free rate term structure + volatility Adjustment or Matching Adjustment or Transitional Measures.
    - **Risk Margin:** Cost of Capital Approach

discounting for each individual portfolio. structure and also differs from SII in this respect.

As explained above, the absolute novelty of IFRS 17 is **Contractual Service Margin – CSM:** it represents the unearned profit on a group of insurance contracts and is then systematically released to the income statement over the period of coverage of the contract.

8.CASE STUDY CREDIT AGRICOLE

By examining the Solvency and Financial Condition Report 2024 of Credit Agricole Assicurazioni, we will see how the principles and requirements of the Solvency II regime find a concrete application and we will analyze the implementations of the new accounting principle IFRS 17.

Crédit Agricole Assicurazioni (CAA) SpA, is wholly owned by Crédit Agricole Assurance and operates in the damage sector in Italy, offering products such as auto, home, property and personal protection.

In 2024, gross premiums earned reached 150,492 euros.

Starting from the structure of the three pillars mentioned in the thesis and cited within the SFCR, they are structured as follows for CAA.

Pillar I: Quantitative Requirements

- **Valuation of assets and liabilities for the purposes of Solvency II:**
    - CAA's SFCR specifies that the Solvency II balance sheet is drawn up on 31 December and the general valuation principle is market value.
    - The company, operating in the Italian market, adopts Italian accounting principles as a basis and makes the appropriate changes in case it needs to align with the Solvency II *fair value requirements.*

Account	Amount (in thousands of euros)
	Solvency II Value as at 31 December 2024
Goodwill	0
Deferred acquisition costs	0
Intangible assets	0
Deferred tax assets	0
Property and tangible assets for own use	1,37
Investments (other than assets held for unit-linked and index-linked contracts)	162,734
Participations	16
Shares	0
Bonds	118,64
Investment funds	44,078
Derivatives	0
Insurance receivables and receivables from intermediaries	5,349
Amounts recoverable from reinsurance contracts	66,331
Reinsurance receivables	7,347
Receivables (trade, non-insurance)	23,077
Cash and cash equivalents	3,463
Other assets not previously reported	544
Total assets	270,215

- **Technical Reserves:**

    - CAA calculates the RT from the sum of Best Estimate and Risk Margin with the values explained in the BE and RM paragraph. As reported by the SFCT the company does not use Matching Adjustment or Transitional Measurement .

    - As we can see below, we have a summary of the technical reserves divided by business lines (LoB).

Summary of the Company's Solvency II Technical Reserves

(In thousands of euros) 2024

	Motor third party liability insurance	Health insurance and Income protection insurance	Fire and other damage to property insurance	Other Lines of Business	Total
Gross BEL (Best Estimate Liability)	68,184	13,47	33,595	40,365	155,615
Ceded BEL	38,421	2,029	8,181	17,699	66,33
Net BEL	29,763	11,441	25,414	22,366	89,285
Risk Margin	1,416	1,417	929	1,561	5,323
Total net technical reserves	31,179	12,858	26,343	24,227	94,608

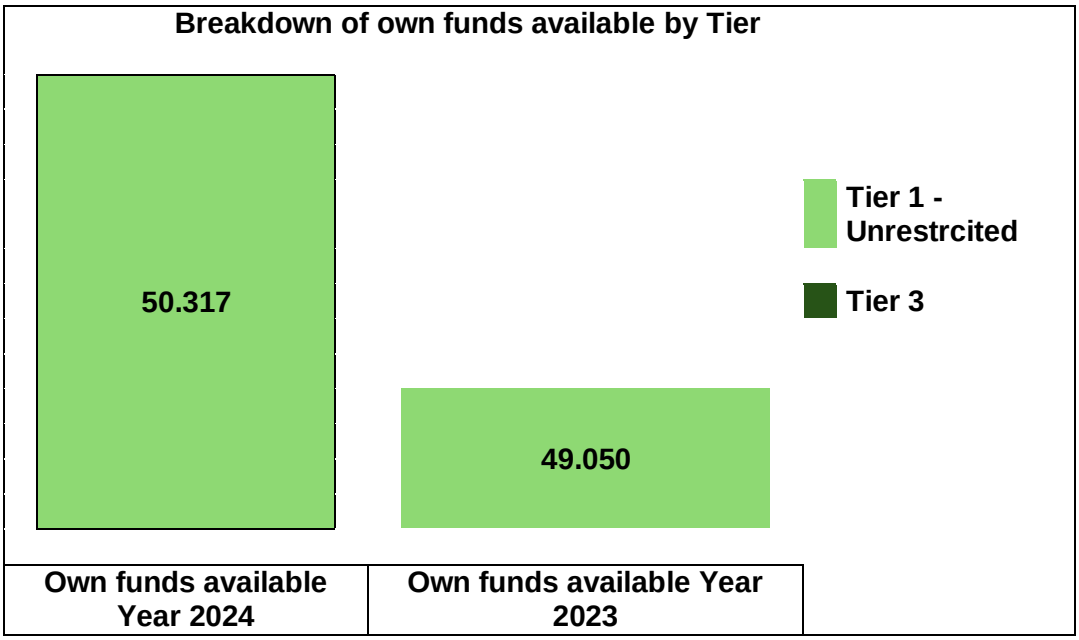
	Solvency II Value
Technical reserves – non-life (excluding health)	146,05
Technical reserves – health (similar to non-life insurance)	14,887
Total gross technical reserves	160,937

The difference in gross technical reserves arising from the comparison between the value resulting from Italian accounting principles and Solvency II principles (amounting to -37,197 thousand euros) is substantially explained by the different calculation methodology. In particular, the difference is composed as follows:

premium reserves (-27,179 thousand euros); claims reserves (-15,339 thousand euros); Risk Margin (+5,322 thousand euros) calculated for Solvency II purposes only.

- **Own Funds:**

    - Own Funds, as of December 2024, amounted to €50,317 and are entirely classified as Tier 1 and no Tier 3. Eligible Own Funds grew +1.267 euros between 2023 and 2024. The imagine below shows EOF for 2024 and 2023.



- **Solvency Capital Requirement (SCR) and Minimum Capital Requirement (MCR)**
    - To calculate its SCR, CAA uses the standard formula together with Undertaking-Specific Parameters - USP, authorized by IVASS.
        - SCR: the coefficient is 167% for an amount of 30,178 euros
        - MCR: the coefficient is 370.5% for an amount of 13,580 euros

The major risk faced by CAA is non-life underwriting followed by health underwriting risk.

The components inside the image for the contribution of the modules of risk for SCR:

Chart for 31/12/2024 (left side):

Non-life underwriting risk: 48%

Health underwriting risk: 24%

Market risk: 14%

Operational risk: 10%

Counterparty risk: 3%

Pillar II: Qualitative Requirements and Supervision

- **Governance System:**
    - Crédit Agricole Assicurazioni has a “traditional” governance system with a Board of Directors, Board of Auditors and Shareholders’ Meeting.

- The Board of Directors defines the strategy and monitors, as it is responsible for compliance with Solvency II requirements. The four key functions: Actuarial, Compliance, Internal Audit and Risk Management, support the Board of Directors.

- **Risk Management System and ORSA:**
  - SFCR report, ORSA process and stress scenarios considered such as the increase in the Loss Ratio due to the MTPL product due to an increase in major claims in the period 2024-2026.

- **Pillar III: Information and Transparency**
  - Within the SFRC, Quantitative Reporting Templates are reported and there are SII, own funds and balance sheet.

In conclusion, the analysis of the SFCR 2024 of Crédit Agricole Assicurazioni offers us a valuable practical point of view in the application of Solvency II.

The thesis explores the deep transformation that the European and global insurance industry is undergoing, which is primarily driven by the nearly simultaneous introduction of two complex and widespread regulatory frameworks: Solvency II and IFRS 17. As discussed, insurance companies today must navigate the intricate dynamics of these two regimes in a complex operating environment.

Solvency II, fully operational since 2016, has established a risk-based prudential framework, with the primary objective of protecting policyholders and ensuring the financial stability of the sector. IFRS 17, effective from 2023, has introduced the first truly global accounting standard for insurance contracts, aiming to increase the transparency, usefulness and comparability of financial information for all stakeholders.

The case study of Crédit Agricole Assicurazioni (CAA) gave a concrete illustration of how these regulatory principles are applied in everyday practice.

The analysis of CAA's Solvency and Financial Condition Report (SFCR) 2024 highlighted the meticulous application of the three pillars of Solvency II. For Pillar 1, we observe the valuation of assets and liabilities at market values consistent with Solvency II principles, the calculation of Technical Provisions as the sum of Best Estimate and Risk Margin (without the use of Matching Adjustment or Transitional Measures in the specific case of CAA) and the classification of own funds, which for CAA are entirely Tier 1. The company uses the standard formula with Company Specific Parameters (USP) for the calculation of the Solvency Capital Requirement (SCR), highlighting how the non-life underwriting risk represents the predominant component. As for Pillar 2, CAA demonstrates a structured governance system, with the four key functions (Actuarial, Compliance, Internal Audit and Risk Management) supporting the corporate bodies, and an ORSA (Own Risk and Solvency Assessment) process that includes the analysis of significant stress scenarios. Finally, Pillar 3 is realized in the publication of Quantitative Reporting Templates (QRTs) and other required information. The fact that CAA, like other companies in the sector, is simultaneously managing the implementation of the new accounting principle IFRS 17, as mentioned in its SFCR, highlights the real manifestation of the double regulatory challenge discussed in this thesis.

The analysis has consistently highlighted that, despite sharing some fundamental principles such as the risk-based approach and the measurement of liabilities at current or market values, significant differences persist. These concern specific valuation methodologies (for example, Risk Margin in Solvency II versus Risk Adjustment in IFRS 17), discount rates, contract aggregation levels, profit recognition (with the introduction of Contractual Service Margin in IFRS 17) and disclosure requirements.

This regulatory duality requires insurance companies to take an integrated strategic view. Decisions taken in one area can have direct repercussions on the other, influencing capital management, new product development, operational efficiency, communication with regulators and the market. The

crucial managerial question of which of the two regimes – Solvency II with its capital requirements or IFRS 17 with its impact on profits and equity – will act as market-driven on strategic decisions, such as the ability to distribute dividends or capital allocation policy, remains a central concern. Differences in profit recognition, for example the introduction of the Contractual Service Margin (CSM) in IFRS 17 that defers profits over time versus the faster recognition in equity in Solvency II, need careful managerial consideration, as optimising for one framework may penalise the other.

In conclusion, the introduction of Solvency II and IFRS 17 represents a fundamental operational and strategic transformation for the insurance industry. The journey through these new landscapes, exemplified by companies such as Crédit Agricole Assicurazioni, requires continuous adaptation, careful consideration of the interactions between the two regimes and a holistic approach to risk and financial management. Successfully navigating this dual challenge will be critical for insurance companies aiming for prudential soundness, transparent financial reporting and sustainable long-term value creation in an increasingly complex regulatory environment.

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