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SPREAD RISK AND MATCHING ADJUSTMENT IN SOLVENCY II

Ljubljana, July 2022 MARIJA MITROVSKA

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LIST OF ABBREVIATIONS

BEL- Best Estimate Liabilities

CSM- Contractual service margin

CSPP- Corporate Sector Purchase Programme

CQS - Credit Quality Step

DD- Distance to default

DPT- Default point

ECAI- External Credit Assessment Institution

EEA- European Economic Area

EIOPA- European Insurance and Occupational Pensions Authority

EOF- Eligible own funds

EU – European Union

EUR – Euro

FS- Fundamental spread

IASB- International Accounting Standards Board

IFRS- International Financial Reporting Standard

LGD- Loss given default

LGT- Long-Term Guarantee

LTAS- Long-term average spread

MA- Matching Adjustment

MCR- Minimum Capital Requirement

MV- Market value

MVC- Market Value of Collateral

OAS- Option-adjusted spread

OECD- Organization for Economic Co-operation and Development

ORSA- Own Risk and Solvency Assessment

PD- Probability of default

Pgf- Probability generating function

PV- Present Value

RM-Risk Margin

RAVC- Risk Adjusted Value of Collateral

SII- Solvency II

SCR- Solvency Capital Requirement

SPV- Special Purposes Vehicles

VaR- Value-at-Risk

UK- United Kingdom

USA- United States of America

VA- Volatility Adjustment

INTRODUCTION

We live in a world full of risks and uncertainty. Individuals and entities face all sorts of risks on daily basis, such as risk of loss of life, health, assets, property etc. Unfortunately, sometimes these unforeseen events cannot be avoided. Insurance is a type of risk management that offers financial protection against these losses by financially compensating individuals and businesses. Insurance provides a mechanism which helps mitigate financial risk that occurs from unanticipated events while offering a financial cushion against suffered financial burdens. The insurance sector stimulates savings among individuals and promotes employment which significantly contributes to the general economic growth, providing stability and generating long-term financial resources. Insurance converts accumulated capital into productive investments. Insurance has a great importance, both as a safeguard to individuals and businesses and as an essential promotor of sustainable economic growth and stability. Stemming from this significance comes great responsibility and that is one of the main reasons why the insurance sector is heavily regulated and follows a strict set of rules.

The purpose of measuring the solvency of one undertaking is to measure its financial strength and the ability to meet its obligations. Regulation is becoming crucial in the daily operation of insurance businesses. In order to protect the stakeholders from the turbulent changes in their complex surroundings, regulators must intervene. In the 1970s the EU Solvency I Framework was first developed. It was based on the market and capabilities at the time of the development. However, it was regarded as not strict enough and lacking risk sensitivity. The key risks such as market, credit and operational risk were either not accounted for in the capital requirements or were not taken into consideration properly. The system was not easily comparable between companies or across territories. As the markets, technology and products rapidly developed, the need for an up-to-date regulatory regime was evident. Solvency II is a new Directive introduced by the European Union which aims towards harmonization of the EU insurance regulation (Directive 2009/138/EC, 2009). It entered into force on 01.01.2016, succeeding the previous simple factor-based Solvency I system. The new framework, Solvency II, considers the risk profile of every individual insurance company promoting transparency, comparability, and competitiveness. It is a tool for unifying the regulatory framework of the different member states of the EU (Buckham, Wahl & Rose, 2015a).

The need for implementing such regulation was amplified by the occurrence of the global financial crisis in 2007. Although banks were more severely hit, insurers suffered great losses as well. According to a report by EIOPA, the European Insurance and Occupational Pensions Authority, the crisis affected several insurers due to inappropriate investment decisions, the interdependency with banks or poor governance overall. The previous Solvency I framework could not ensure timely and efficient intervention by supervisors and did not generate optimal allocation of capital in terms of risk and return for shareholders. The crisis indicated the necessity for implementing a harmonized strategy for understanding

risks that accompany each actor involved in the process. It showed the need for a consistent supervisory approach that will incentivize good risk management and better harmonization across all European countries. EIOPA offers technical support and advice in the development of delegated acts and technical standards and overlooks proper implementation of the standards. However, it comes down to the local regulators to put the framework into practice.

The Solvency II framework is built on three pillars:

-Pillar I - Quantitative requirements which consist of rules for calculation of capital requirements, valuation of assets and liabilities (technical provisions) and identifying eligible own funds for covering the requirements.

-Pillar II - Qualitative requirements and supervisory review – this includes the Own Risk and Solvency Assessment, that each insurer should perform in order to identify the individual risks to which the insurer is exposed to identify its risk management processes and calculate its ability to meet the prescribed capital requirements.

-Pillar III - Reporting, disclosure, and market discipline – obliges insurance companies to publish reports and disclosures to both supervisors and the public guaranteeing transparency and market discipline while promoting competition.

The focus of this thesis is on the first pillar, the quantitative aspect, dealing with valuation methodologies of assets and liabilities based on market consistent principles, calculating the capital requirements SCR (Solvency Capital Requirement) and MCR (Minimum Capital Requirement) and securing enough eligible own funds to cover these requirements. For these purposes, insurance companies use either the standard model prescribed by the regulators or an internal model that is developed by the insurance undertaking itself or a third party.

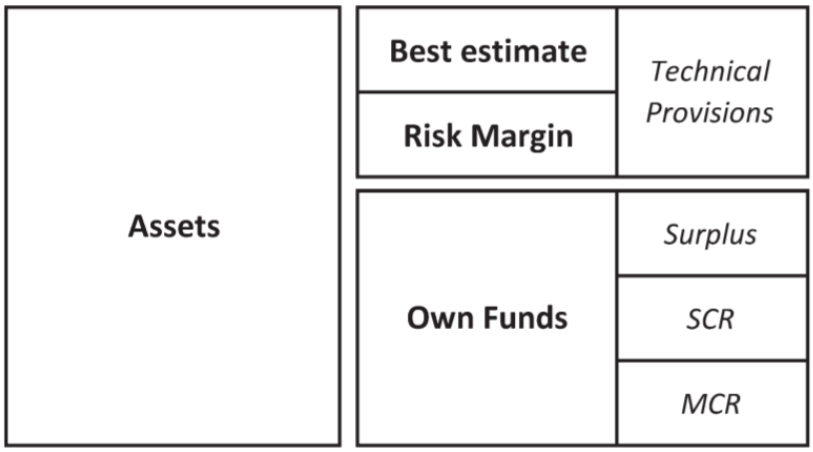
The implementation of the new Solvency II framework is believed to stimulate long-term investments and economic growth. The capital requirements are designed in a way that incentivize insurers to match the duration of their assets and liabilities resulting in increasing the insurers' appetite for investing in long-term assets. Insurers are free to invest as long as they respect the "prudent person principle" and the capital requirements are dependent on the actual risk the investments pose. The standard formula for calculating market risk is relatively detailed to differentiate among the different asset classes and their risk profiles, resulting in promotion of good risk management and support of the prudential robustness of the framework overall. Among scholars that are investigating the effectiveness of the framework are Clipici (2012); Tarantino (2012); Swain & Swallow (2015); Doff (2016); Laas & Siegel (2017) and Rae et al (2018).

1 INVESTMENTS AND CAPITAL REQUIREMENTS

Solvency II aims to provide a regulatory framework that better matches the real risks an insurance company faces. According to Solvency II, the balance sheet of the insurer is a key

tool for the management and regulators to assess the solvency of the insurance company and make decisions. The Solvency II balance sheet reflects the market values of the assets and liabilities from deep and liquid markets (Buckham, Wahl & Rose, 2015b; de Weert, 2015). The balance sheet of an insurer mostly consists of high-quality government and corporate bonds on the asset side and the technical provisions on the liabilities side. While market prices exist for most of the assets, there are no available market prices for the majority of insurance obligations. Technical provisions are the estimated amount to fulfil the insurance obligations towards the policyholders and beneficiaries. The technical provisions are usually the largest item on the balance sheet, thus making them crucial for formulating the solvency balance sheet. The category consists of two components: the best estimate and the risk margin. Both components are built on projection models and rely on numerous assumptions and actuarial judgement. The third section of the balance sheet, commonly known as capital, is called Own Funds under Solvency II. As a starting point for calculating the available own funds, the value of the assets less the value of the liabilities is taken. The category Own Funds is a buffer covering the risk assets will not be sufficient to finance the liabilities of the insurer. The Own Funds are actually composed of basic own funds and ancillary own funds. Basic own funds amount to assets minus liabilities plus sub-ordinated liabilities and ancillary funds is supplementary capital, subordinate to all policyholders and beneficiaries and all non-subordinated creditors. Insurance companies must manage their own funds to make sure that they have enough capital of sufficient quality to cover the SCR and the MCR.

Figure 1: Simplified Solvency II Balance Sheet



Source: Giuliani & Palma (2018).

1.1 Valuation of assets and liabilities under Solvency II

The biggest portion of assets on the insurer's balance sheet consists of top-quality, income-paying government and corporate bonds which are held to maturity. Generally, the insurer's investment strategy is predominantly influenced by the duration and predictability of its

obligations. Life insurance companies' liabilities tend to have a much longer duration than their non-life insurance counterparts. In order to match their liabilities, life insurers invest in long-term, interest-bearing assets. On the other hand, property and casualty insurers practice a more conservative asset allocation strategy investing mainly in fixed income assets taking into account the liabilities' durations, due to the unpredictable nature of the business and the constant need of liquidity.

As previously stated, the largest category on the liabilities side are the technical provisions. They represent the required amount for the (re)insurer to be able to meet its obligations and settle all (re)insurance obligations towards the policyholders. In some cases, these obligations may lie in the distant future, such as in the case of life and pension insurance. Under Solvency II technical provisions are calculated as the sum of the best estimate and the risk margin.

The best estimate is the probability weighted average of all future cash flows considering the time value of money. For discounting the relevant risk-free term structure is used. When calculating the best estimate, the used cash-flow projection covers all cash-in and out-flows necessary for settling the insurance and reinsurance obligations. To calculate the best estimate, relevant and up-to-date information and realistic assumptions should be used, while applying appropriate actuarial and statistical methods.

The risk margin ensures that the value of technical provisions is equal to the amount that insurers and reinsurers would have to require in order to acquire and fulfill the insurance and reinsurance obligations over their lifetime. According to EIOPA, there are four simplified methods for calculating the Risk Margin (European Parliament, 2015**)**:

-Calculate the SCR for each future year but approximate each SCR module.

-Project the overall SCR relative to the Best Estimate.

-Calibrate the Risk Margin based on the duration of the insurance liabilities.

-Approximate the Risk Margin as a percentage of the Best Estimate.

The four methods are not equivalent and there might be differences in the results of the Risk Margin depending on the chosen methodology. (Re)Insurance undertakings should value the best estimate and the risk margin separately. In that case, the risk margin is calibrated by determining the cost of providing eligible own funds equal to SCR necessary for the insurance and reinsurance obligations of the entity.

In the matter of recognition and valuation of assets and liabilities the Solvency II standards are relying heavily on the international accounting principles. According to these international standards, every insurance and reinsurance undertaking should use the market consistent valuation method (mark-to-market) or fair value. That is the price which an

independent party would pay or receive for obtaining or selling the assets or liabilities under regular market conditions.

In 2017, the International Accounting Standards Board (IASB) published a new International Financial Reporting Standard: IFRS 17 Insurance Contracts (2017). The Standard improves comparability among insurance companies. It introduces principles for recognition, measurement, presentation and disclosure of insurance contracts. The standard focuses on how to value insurance contracts and when to recognize profits and losses. The implementation of the new standard with its principles largely affects the financial statements of insurance companies. Insurance companies have to start using the new IFRS 17 by the beginning of 2023 with earlier application permitted if the entity applies IFRS 9 as well. The standard suggests a hybrid of market valuation and book value accounting. An entity applies IFRS 17 to (re)insurance contracts it issues, reinsurance contracts it holds and investment contracts with discretionary participation features it issues if the entity issues insurance contracts as well. The key principle of the standard is that the insurance company recognizes as insurance contracts those contracts under which the insurer accepts significant insurance risk from another party (the policyholder) by agreeing to reimburse the policyholder if a specified uncertain event (insured event) occurs and adversely affects the policyholder. Some contracts meet the definition of an insurance contract, but their primary purpose is the provision of services for a fixed fee. Such contracts are in the scope of the standard, but an insurer can choose to apply IFRS 15-Revenue from Contracts with Customers to them. The entity should separate the specified embedded derivatives, distinct investment components and distinct performance obligations from insurance contracts. Additionally, it divides the contracts into groups, portfolios of insurance contracts subject to similar risks that it will recognize and measure together. Including contracts issued more than one year apart in the same group is not allowed. The entity recognizes a group of insurance contracts it issues from the earliest of the following: the beginning of the coverage of the group of contracts; the date when the first payment from a policyholder is due or when the group becomes onerous (for a group of onerous contracts). An insurance contract is considered onerous at initial recognition if the total of the fulfilment cash flows, previously recognized acquisition cash flows and any cash flow from the contract at that date is a net outflow. The insurer measures a group of insurance contracts as the total of a risk adjusted present value of future cash flows (the fulfilment cash flows) incorporating all available information about the fulfilment cash flows in a way that is consistent with the observable market information and the contractual service margin CSM. The CSM represents the unearned profit the entity will recognize while providing services under the insurance contracts in the group. The fulfilment cash flows are the expected value of the present value of the future cash outflows less the present value of the future cash inflows that arise while the entity is fulfilling insurance contracts, including a risk adjustment for non-financial risk. The estimates of future cash flows should be current, explicit, unbiased and include all available information without undue cost and effort about the amount, timing and uncertainty of those future cash flows. In the case of change of the terms of an insurance contract, the

entity derecognizes the original contract and recognizes the modified contract as a new one if there is a substantive modification. The entity will derecognize the insurance contract when it is terminated or if the conditions of a substantive modification of an insurance contract are met. The (re)insurer recognizes the profit from a group of insurance contracts over the period it provides insurance contract services. If a group of contracts becomes loss-making, the entity recognizes the loss immediately. The entity presents separately insurance revenue, insurance service expenses and insurance finance income and expenses. Income or expenses from reinsurance contracts held are separated from the income or expenses from insurance contracts issued. The entity is obliged to disclose qualitative and quantitative information about the recognized amounts in the financial statements that arise from insurance contracts, the significant judgements, and change in those judgements made when applying IFRS 17 and the nature and extent of the risks arising from insurance contracts. The information enables users of financial statements to assess the effect that contracts have on the financial position, financial performance and cash flows of an entity.

1.2 Structure of the Market module

The European Commission has asked CEOPS to design a fully consulted advice on implementing measures on Solvency II. In the document Calibration of Market Risk Module (2010), CEOPS gives clear directives on how to introduce the measures concerning the market module. Solvency II's starting point is the economic valuation of the whole balance sheet of the insurer. According to the framework's valuation methodology, assets and liabilities should be valued using quoted market prices in active markets for the same assets and liabilities, on the assumption of going concern (or in other words that the company is financially stable, can fulfil its obligations and will continue to do so in the foreseeable future). The items on the balance sheet are valued at their fair value, giving a realistic estimate of the financial situation of the insurer. Solvency II specifically prohibits some valuation methodologies such as: historical cost, amortised cost or depreciated cost. The market consistent valuation technique relies on financial instruments traded on deep and liquid markets where cash flows are used to create replicating portfolios or observed market prices can be used as inputs to models. If using quoted market prices in active markets for the same assets or liabilities is not possible, insurance and reinsurance entities will use the quoted market prices for similar assets and liabilities with an adjustment that reflects any differences. The adjustment applies for specific factors such as: the condition or location of the asset or liability, the extent to which the inputs are related to items that are comparable to the asset or liability and the market's volume or level of activity where the inputs are observed.

When it is not possible to use the fair value method, a mark-to-model approach is considered. This is a common strategy in incomplete markets where at the moment of valuation the financial instruments do not have observable market prices. The mark-to-model method contrasts the mark-to-market approach where the market prices are used in pricing of the

items. It uses valuation based on financial models which are heavily based on assumptions which makes the asset riskier. If companies opt to use a model different than the mark-to market approach, they have to disclose justifiable reasons why they have chosen to use other strategies together with the chosen method and the valuation uncertainty related to the chosen method. When assessing the risk, the insurance undertakings should include both the risk of the specific valuation technique used to obtain the fair value and the risk that the inputs of that valuation technique bear.

The need for implementing the mark-to-market model comes from having a better assessment of the financial stability and riskiness of the entity. It helps insurers identify potential risk at earlier stage and act accordingly. This methodology is used for calculating the buffer the insurer has to maintain at all times. The buffers safeguard insurers from significant changes in the financial markets and insurance risks, while keeping their financial position strong and enabling them to meet their obligations even in hard times. However, an obvious disadvantage to the implementation of the mark-to-market approach is the occurrence of pro-cyclical behavior and artificial short-term volatility on the insurer's balance sheet.

1.3 Structure of Capital requirements under Solvency II

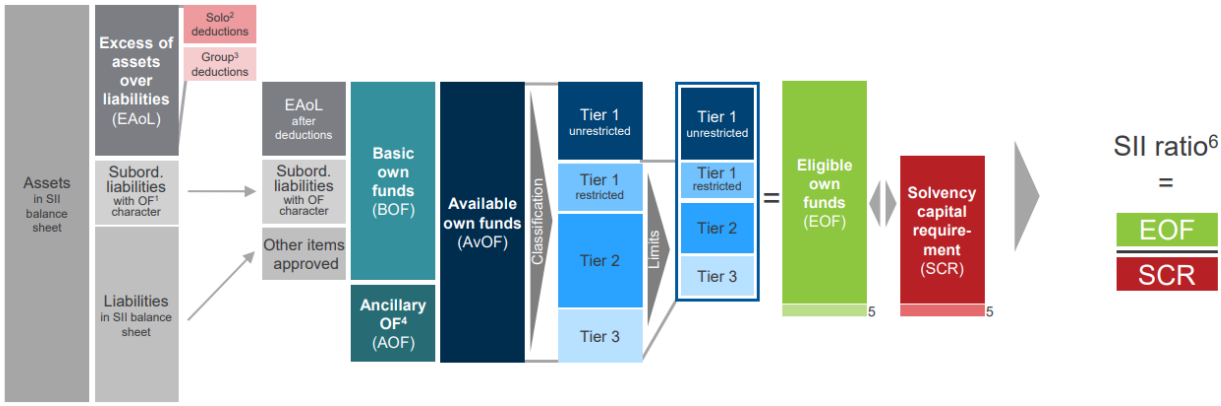
Under Solvency II in the Directive 2009/138/ECC, capital is known as "Own Funds" and it consists of basic own funds and ancillary own funds. Basic own funds are the excess of assets over liabilities valued at fair value and subordinated liabilities. Most common categories of basic funds would be paid-up share capital, share premium reserve and the reconciliation reserve. Ancillary own funds are items that can be activated to absorb losses. Once an ancillary own fund item has been paid in, it is no longer considered to be an ancillary own fund item and it becomes part of the basic own funds. However, ancillary own funds require supervisory approval before taking them into account for determining own funds. Conventional ancillary funds are unpaid share capital or initial fund that has not been called up, letters of credit and guarantees.

The own funds items are further classified into three tiers depending on their quality, based on their permanence and loss absorbency. Another important characteristic for an item to be regarded as a high-quality item is its capacity, more specifically whether the duration of the item can be matched with the duration of the insurance obligations. Items of Tier 1 are of the highest quality, good examples for Tier 1 items are ordinary share capital, non-cumulative preference shares and relevant sub-ordinated liabilities. Instruments that do not fulfill the Tier 1 requirements on permanence or loss absorption can be included in the Tier 2 or 3. Ancillary Own Funds cannot be classified into Tier 1, only in Tiers 2 and 3. The Tier 1 is additionally divided into restricted and unrestricted Tier 1. The unrestricted Tier 1 funds should make up for at least 80% of the total Tier 1 funds. Some of the unrestricted Tear 1 instruments are ordinary shares plus share premium and the equivalent paid up member

contributions in the case of mutuals; surplus funds fulfilling requirements for subordination and permanence and a reconciliation reserve. Tier 2 consists of cumulative preference shares and sub-ordinated liabilities with shorter duration.

This classification of items into tiers is important for the calculation of the eligible own funds. Eligible own funds EOF are the own funds that are qualified for covering the capital requirements imposed by the regulators. EOF represent the financial resources of the entity needed to absorb losses from the assumed risks. Solvency II sets limits on the amounts of each of the tiers that can be used to cover capital requirements to ensure the availability of the items if they are needed to absorb potential losses. In order to be compliant with the SCR calculation, the proportion of Tier 1 items in the eligible own funds should be higher than 50% of the SCR, whereas the proportion of Tier 3 items should be less than 15% of SCR and the sum of Tier 2 and Tier 3 must not exceed 50% of SCR. The limits for covering the MCR are the most restrictive. Ancillary own funds and Tier 3 items cannot be used to cover the MCR. The items eligible for covering MCR must be of highest quality, therefore it is expected that Tier 1 items should make up for at least 80% of the amount of the eligible own funds for MCR and tier 2 must not exceed 20% of MCR. The MCR is derived from the SCR and it is computed as a linear combination of a set of variables: technical provisions, written premiums, capital-at-risk, deferred taxes and administrative expenses, all net of reinsurance. The MCR should not be less than 25% or more than 45% of the SCR.

Figure 2: Eligible Own Funds

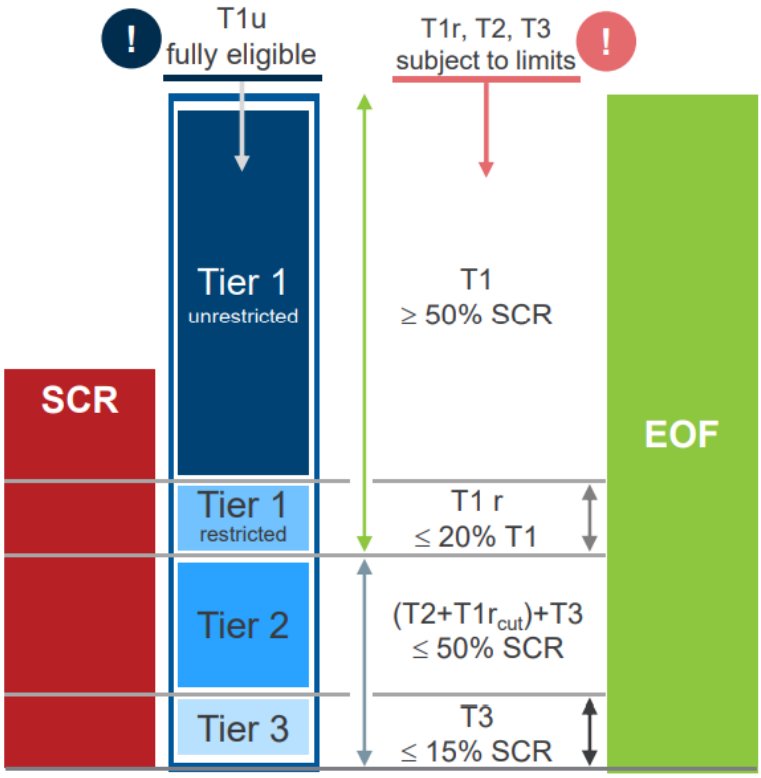


Source: Munich Re (2015).

As previously stated, the insurer is required to hold a certain amount of funds as a buffer to protect its financial position and ensure that its assets are enough to cover its liabilities. If

the insurers' buffers are decreasing, it must take specific measures such as raising capital, lowering dividend payments and increasing their risk aversion. This buffer comes into the form of the capital requirements insurance and reinsurance must hold, the solvency capital requirement SCR and the minimum capital requirement MCR. Both are capital requirements that must be met in addition to technical provisions. They are based on an accounting formula and must be recalculated on a yearly basis. The SCR and MCR apply to both existing and new businesses. They should be understood as soft and hard floors. An intervention process by the regulators begins once the capital of the insurer or reinsurer falls below the SCR and the intervention becomes more intense as the level of capital approaches the MCR.

Figure 3: Tiering Limits



Source: Munich Re (2015).

Regulators expect that insurers at all times hold eligible funds of at least the level of the Solvency Capital Requirement SCR. In case of breach, insurance and reinsurance undertakings are obliged to submit to the authorities a recovery plan within two months of the occurrence of the breach. If the undertaking took immediate recovery measures which restored compliance with the SCR and the supervisors consider them as adequate, the supervisors might consider that the submission of a recovery plan is not needed. In practice only a few breaches have happened so far. In the period 2016-2020, only 12 undertakings have had a breach of the SCR for a period of two consecutive years, which represents only 0,5% of all undertakings under Solvency II. Insurers that are holding own funds

corresponding to the SCR, will with probability of 99,5% be able to cover all unexpected losses that might occur over the course of one year. The SCR limits the possibility of experiencing insolvency to less than once in 200 years. The SCR is calculated by the standard formula approach or calculated using a specific internal model which must be approved by the regulator. In some cases, an internal model is not used for calculating the whole amount of the SCR, but only for individual risk modules or the adjustment for the loss-absorbing capacity of technical provisions and deferred taxes. This model is known as partial internal model. The formula for calculating the amount of SCR is scenario based and takes a modular approach, the individual exposure to each risk category is evaluated and then summed. The standard formula consists of risk charges for different types of risk: operational risk, market risk, non-life underwriting risk, life underwriting risk, health risk, counterparty default risk and intangible asset risk. The SCR for each individual risk is the difference between the net asset value in the unstressed balance sheet and the net asset value in the stressed balance sheet. The calculated amounts per each individual risk are then combined across the risks in the module, using a specified correlation matrix and matrix multiplication. A breach of the SCR results in regulatory intervention to reinstate the SCR level of capital.

According to Solvency II (DIRECTIVE 2009/138/EC), all insurers must have at all time eligible funds of at least the level of the Minimum Capital Requirement MCR. Only highest quality Tier 1 and Tier 2 basic own funds are considered for covering the MCR. The MCR is calibrated to the VaR of the basic own funds subject to a confidence level of 85% over the time period of one year or in other words that the maximum loss of the company will be higher than the MCR once in 6,67 years. The MCR is calculated for each individual line of business by taking the greater between a factor applied to technical provisions for each line of business for the past year, net of reinsurance subject to a minimum of zero; and a factor applied to written premiums in each line of business for the past year, net of reinsurance, subject to minimum of zero. Then the individual MCRs per line of business are summed up to get the overall MCR. The MCR should be in the range of 25-45% of SCR. Having eligible own funds below the level of MCR puts the stakeholders at an unacceptable level of risk. If the insurer's own funds fall below the MCR, the regulator may decide to revoke the insurer's authorization and begin bankruptcy proceeding.

To fully grasp and understand the financial position of an insurer, the solvency ratios are calculated. Under Solvency II, the solvency ratio is the ratio of the eligible own funds to required own funds.

$$Solvency\ ratio\ = \frac{Eligible\ Own\ Funds}{SCR} \tag{1}$$

Insurers with higher-risk investments like equities must have a higher buffer than insurers that invest in lower-risk assets like government bonds. The lowest acceptable ratio is 100%. If the company falls below this level, it needs to notify the authorities and submit a realistic

recovery plan that presents how it aims to restore the Solvency ratio to 100%. If the ratio is higher than 100% it means that the Solvency Capital Requirement is low, or the company has a lot of capital.

However, regulators should be careful when comparing the results of different insurance companies and should never take only one single number into account. Different insurers might use different approaches when calculating the overall SCR. According to EIOPA, there are four general approaches on how to calculate the SCR:

-The Standard Formula – the default approach.

-The Standard Formula with undertaking specific parameters.

-A Partial Internal Model

-A Full Internal Model

If the company, or the regulator, deems the Standard Formula approach not appropriate, a more complex model can be used which better reflects the underlying risk profile of the insurer. This only makes sense if the chosen model does not further complicate the comparability of results. The regulators are aware of the different methods used for calculating the SCR and therefore they require each company to provide their own view of their risk, disclose information in ORSA in the Second Pillar and present additional publicly available information.

2 FINANCIAL RISKS IN INSURANCE

In their daily operations insurers face all sorts of risks. The most important risk in the insurer's operations is the underwriting risk. Underwriting risk might occur because of wrong assessment of the risks associated with issuing an insurance policy or from other uncontrollable factors resulting in the insurer's costs greatly exceeding insurance premiums. An insurance company, as all other financial institutions, is exposed to financial risks. A financial risk, broadly explained, is a specific kind of risk that captures a series of risks related to the company's capital structure, financing, and the finance industry overall. In general, we divide financial risk into four categories: Market risk, Credit risk, Liquidity Risk and Operational risk. The framework of Solvency II mostly concentrates on the credit and market risk as they are significant components when determining the solvency capital requirements of an insurance undertaking. Although the focus on this thesis is Spread risk which is part of the Market Risk module, Credit risk is important when determining the credit rating of borrowers and the bonds they are issuing. The following chapter gives a short overview of credit risk.

2.1 Credit Risk

Credit Risk represents the probability of loss due to the counter-party's inability to meet its contractual obligations. Properly managing the credit risk can help to soften the severity of losses. When purchasing bonds, investors usually look at the credit ratings of the issues. Credit rating agencies constantly review and evaluate the credit risks of bond issuers. If a certain bond issuer is perceived to have a higher risk, the investors would ask for a higher interest rate. The main variables when measuring credit risk are: probability of default (PD), loss given default (LGD) and exposure at default (EAD). The value of LGD is usually lower than the value of the loan itself. EAD is an assessment of the total loss exposure the lender is exposed to. The most common measure of credit risk is Value-at-Risk (VAR). VAR quantifies the maximum potential loss that the company is expecting for a specific time period (usually one year) and a given confidence level.

Modelling Credit Risk

There are four most commonly used models for modelling credit risk in practice: Merton's model, KMV model, CreditMetrics Model and CreditRisk+ Model (Crouhy, Galai & Mark, 2000).

Merton's model

Merton's model (1974) is considered the simplest and it is the basis for all other models. It is a single-asset model where the company's equity is modelled as a call option on its assets. The model uses the Black-Scholes-Merton option pricing methods and enables us to connect default risk and the asset structure of the company. In the model, equity holders are regarded as residual owners of the company. Everything that is left after covering the liabilities, will be paid out to them. Therefore, we can say that equity holders have a call option on the assets with strike price K, where K represents the value of the liabilities. When the value of the assets is bigger than K, they get V_T-K. If not, they get nothing. On the other hand, bondholders own zero-coupon bonds with par value K. When assets are worth more, they get the value K. If assets are worth less, then they will get only the value V_T. In this case, bondholders are short a put option.

We can use the Merton model formula to value the equity in function of the value of assets corrected for the value of liabilities. For t=0 we have the actual asset price V_{A_0} and the actual equity price V_{E_0}. If we apply the Black- Scholes model based on geometric Brownian options for the actual price:

$$V_{E_0} = V_{A_0}\Phi(d_1) - Ke^{rt}\Phi(d_2) \tag{2}$$

$$d_1 = \frac{\log\left(\frac{V_{A_0}}{K}\right) + \frac{r + \sigma_A^2 t}{2}}{\sigma_A \sqrt{t}} \tag{3}$$

$$d_2 = d_1 - \sigma_A \sqrt{t} \tag{4}$$

The Merton model estimates the probability of default as well. We define probability of default as the probability that a company will not be able to meet its obligations in a certain time period, usually one year. The Merton model can be used to calculate a risk-neutral probability of default. It shows the probability that at maturity the value of assets will be less than the value of liabilities. It can be calculated with the following formula:

$$PD = \Phi(-d_2) \tag{5}$$

The KMV model

The KMV Model is a modified version of the Merton's model, but differs in significant ways. It is an abstract model that estimates the probability of default of the company. According to the model, a company is in a crisis state when the value of its assets is lower than the value of its liabilities. The KMV model allows for any number of debt and nondebt fixed liabilities while the Merton's model allows only a single debt liability. The KMV model a firm is in default if the value of assets is below a certain threshold. According to the model, a firm defaults when the value of the business (market value) falls below the liabilities payable. The default point is approximated as sum of all short-term liabilities and half of long-term liabilities.

$$DPT = STD + \frac{1}{2} LTD \tag{6}$$

Before computing the probability of default, the KMV model computes an index called Distance to default (DD). It is the number of standard deviations between the mean of the distribution of the asset value and the default point (DPT).

$$DD = \frac{E(A_T) - DPT}{\sigma} \tag{7}$$

If we take into account the simplest case of normally distributed assets value after a period T, the probability of default can be estimated as:

$$PD = 1 - \Phi(d_2) = \Phi(-d_2) \tag{8}$$

However, real credit loss distribution typically has fatter tails and the above formula estimates the default probability. For this reason, the KMV framework is based on Expected Default Frequency (EDF) for every position in the portfolio. It is a measure of probability that a company will default in a given period. It is a function of the capital structure; the volatility of asset returns and the current value of assets. When calculating the portfolio EDF, we have to consider the correlation between assets.

CreditMetrics model

The fundamentals of the model stem from Merton's model. The CreditMetrics model assumes that the assets' returns determine not only the probability of default of a company, but also the probability of it moving to another credit rating. We assume that returns are normally distributed and the firm obtains another credit quality when its returns are between certain thresholds in the normal distribution. First the rates of default and migration to another no-default state are determined, and we estimate the conditional distributions of default and migration. Then we find the conditional distributions of the number of events which show the number of defaults and changes of credit quality of the companies. Then the unconditional distribution of the number of events is determined, and in the end the loss distribution of the portfolio is obtained. The probability of default is given by:

$$PD_F = \Phi(-DD_F) \tag{9}$$

$$DD_F = \frac{\log\left(\frac{V_{A_{o,F}}}{K_F}\right) + \left(\mu_{A_F} - \left(\frac{\sigma_{A_F}^2}{2}\right)\right)t}{\sigma_{A_F}\sqrt{t}} \tag{10}$$

where the index *F* means failure.

If the credit rating of the counterparties at time *t* is CCC and the asset value is V_t, we can say that $V_F < V_t < V_{CCC}$. The probability for counterparties to be in a given class is:

$$PD_{CCC} = \Phi(-DD_{CCC}) - \Phi(-DD_F) \tag{11}$$

CreditRisk+ model

In the CreditRisk+, default is modelled as an exogeneous variable with Poisson distribution and a stochastic intensity parameter. The intensity parameter is the default rate over a short period. The default rate is assumed to be Gamma distributed. In the case of default, debtholders incur losses equal to the debt minus the recovery rate. The model estimates the loss distribution due to default of a portfolio. First, we calculate the probability generating

function (pgf) of losses of one counterparty. Then individuals in each sub-portfolio are aggregated to calculate the portfolio pgf. In the end all sub-portfolios are combined, and we determine the loss distribution on the basis of the pgf of the portfolio.

2.2 Market Risk

Market risk is the risk of experiencing losses because of altered conditions on the market where the investor is operating. It reflects the risk arising from the degree of volatility of market prices of financial instruments that impact the value of the company's assets and liabilities. Market risk is the largest component of the SCR. The value-at-risk (VAR) method is commonly used when determining the SCR. Various models have been developed for the purpose of modeling Market risk. (Carol, 2009). The volatility of the financial instruments such as stock prices, interest rates, real estate prices and foreign exchange rates represents the exposure to market risk and qualifies them as potential sources of market risk. The market risk module is split in several sub-modules: interest rate risk, currency risk, equity risk, property risk, market risk concentrations and spread risk. It affects the financial position of the entity because of the fluctuations of market prices of assets and liabilities.

When determining the SCR for debt instruments several sub-modules (part of the Market Risk Module) are taken into consideration:

-Interest rate risk sub-module – implicit risk for all fixed income instruments

-Spread risk sub-module - the main source of the capital requirements for the debt instruments is the spread risk. It is driven by the credit rating of the bond and its sensitivity with respect to its spread (modified duration).

-Market risk concentrations sub-module – displays large exposures to a single risk factor or exposures to multiple risk factors that are correlated.

-Currency risk sub-module – measures the risk of debt instruments that are issued in a currency different than the currency of the insurer.

-Equity risk sub-module – equity risk on convertible bonds and transitory equity positions when convertible bonds are exercised.

-Counterparty default risk sub-module – not directly part of the Market Risk Module- but affects OTC derivatives used for risk mitigation or held through mutual funds. It considers the risk of default of counterparties which is not already covered by the market risk concentrations sub-module.

The SCR calculation for the market risk module is equal to:

$$SCR_{market} = \sqrt{\sum Corr_{i,j} \cdot SCR_i \cdot SCR_j} \tag{12}$$

where SCR_i represents the sub-module i and SCR_j represents the sub-module j (of the whole list of market risk sub-modules) and i,j means the sum of the different terms that should cover all combinations of i and j, meaning all combinations of sub-modules of the market risk module. $Corr_{i,j}$ stands for the correlation parameter for market risk between sub-modules i,j.

Table 1: Correlation matrix

i \ j	Interest rate	Equity	Property	Spread	Concentration	Currency
Interest rate	1	A	A	A	0	0,25
Equity	A	1	0,75	0,75	0	0,25
Property	A	0,75	1	0,5	0	0,25
Spread	A	0,75	0,5	1	0	0,25
Concentration	0	0	0	0	1	0
Currency	0,25	0,25	0,25	0,25	0	1

Source: European Parliament (2015).

The parameter A is 0 when the capital requirement for interest rate risk is the sum of the capital requirements over all currencies for the risk of an increase in the interest rate term structure. In other cases, it is equal to 0,5.

Market risk may affect both sides, assets and liabilities. Therefore, the effect on the assets side can be compensated by the effect on the liabilities side and the other way around. Another point worth mentioning is that according to the standard formula, government bonds are not subject to spread risk and risk concentration.

2.2.1 Spread Risk- definition

When we talk about the different risks that impact the existence of one institution, we must mention and further explore the credit spread risk as an important subcategory of the Market risk. The credit spread is defined as the difference between the yields of two different debt instruments with similar maturity, but different credit rating (Amato & Remolona, 2003). It is the addition for risk to the base interest rate when pricing debt investments. The credit spread reflects the credit rating of the company, the maturity of the bonds, the current spread rates on the market etc (Collin-Dufresn, Goldstein & Martin, 2001). Longer maturity bonds

have higher duration and greater spread sensitivity. Credit spreads have a negative correlation with risk-free interest rates. When spreads are expected to widen, the returns decrease and vice versa. Some of the factors that influence credit spreads to widen are deteriorating credit cycles, weak macroeconomic climate, declining financial markets, credit downgrades and falling liquidity. We could say that the credit spread risk is the risk that credit spreads will widen simultaneously decreasing the value of bonds. It portrays the sensitivity of assets, liabilities and financial instruments' value to changes in the level and volatility of credit spreads over the risk-free interest rate term structure. Credit spread risk is often measured by using spread duration which shows the approximate percentage increase (decrease) in a bond's price given a 1% decrease (increase) in the credit spread.

The change in the price of a bond can be attributed to either changes in the risk-free rate or changes in the credit spread. For effectively measuring the credit spread, four credit spread measures have been proposed: The G-Spread, the I-Spread, Z-Spread and the option-adjusted spread (OAS).

The G-Spread, also known as Nominal Spread, is the difference between government bond yields and corporate bond yield with the same maturity. Government bonds are assumed to have no default risk, therefore the difference between the yield on corporate bonds and government bonds is due to the default risk. The formula for calculating the G-Spread is:

$$G - Spread = Yc - Yg \tag{13}$$

,

where Y_c is the yield of a non-government bond and Y_g is the yield of a government bond of the same maturity.

The I-Spread (Interpolated spread) represents the difference between the yield on a bond and the swap rate. A good example is the LIBOR. It shows the difference between a bond's yield and a benchmark curve to assess the credit risk on different bonds. Higher I-spread means higher credit risk. Usually, the I-spread is lower than the G-Spread.

Z-Spread or zero-volatility spread, is the spread that must be added to each spot interest rate for the present value of the bond cash flows to match the bond's price. Each cash flow is discounted at the appropriate government bond spot rate plus the Z-spread. The Z-Spread determines the difference in yields in reference to a whole term structure of interest rates. To calculate the Z-Spread the following formula is used:

$$P = \frac{CF_1}{(1 + S_1 + Z)} + \frac{CF_2}{(1 + S_2 + Z)^2} + \ldots + \frac{CF_n}{(1 + S_n + Z)^n} \tag{14}$$

where P is the price of the bond, CF_1,CF_2 and CF_n are the first, second and n-th cash flows, S_1, S_2 S_n are the first, second and n-th spot interest rate and Z is the zero-volatility spread.

The Z-Spread measures the spread that the investor will receive over the whole government bond yield curve and gives analysts a better insight in the bond's valuation compared to a single-point metric such as the bond's maturity date.

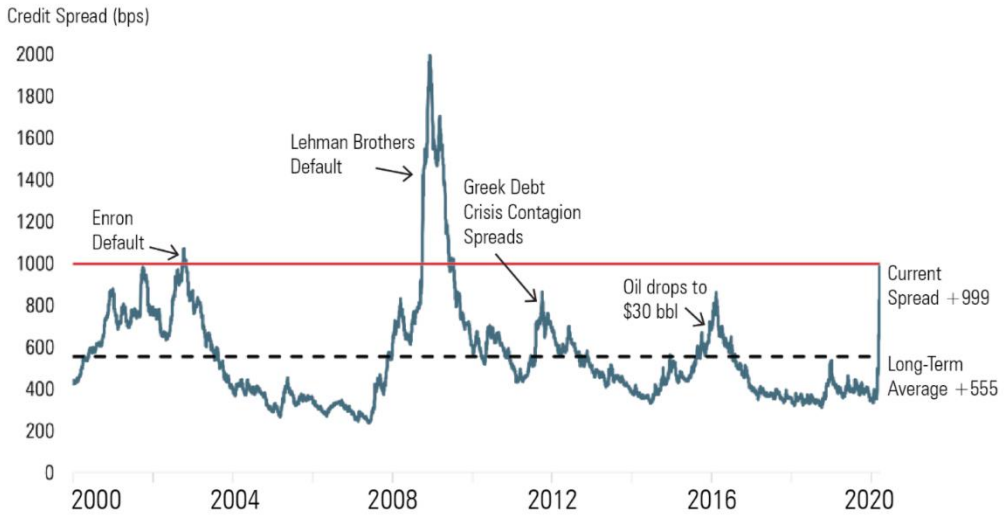
The option-Adjusted Spread (OAS) is the measurement of the spread of a fixed-income security rate and the risk-free rate of return (usually government bonds yields), which is then adjusted to take into account an embedded option. It can be calculated as zero-volatility spread minus the call option's value. OAS considers how a bond's embedded option can change the future cash flows and the overall bond value.

In the figures bellow, we can observe the movement of credit spreads of corporate bonds over the years.

Figure 4: Corporate bond credit spreads

Source: Morningstar (2018).

Figure 5: Credit spreads



Source: Morningstar (2020).

2.3 Corporate bonds market in the EU

An efficient bond market is crucial for raising long term public and private debt to support economic activity and growth. The European corporate bond market is the second largest market in the world, behind the US bond market. In recent years, the issuance of corporate bonds has increased and is today more than twice the level of 2007. Some of the reasons for this trend are the low interest rates and the Corporate Sector Purchase Programme (CSPP) of the European Central Bank. In the period after the financial crisis banks have become more reluctant to finance corporate debt, so a big portion of corporate issuers rely on the corporate bond markets to obtain funding Strong corporate bond markets provide businesses with more diverse sources of funding and widen the investment opportunities for the market participants. The proceeds from bond issuances are most commonly used for general corporate purposes such as: maturities refinancing; funding organic corporate growth (capital expenditures) and increased operating costs; operational financing (regular operating expenses and working capital); and adequacy to optimal capital structure.

Corporations have the option to choose between the loan market and the bond market when in need for funding. Over the past years, the bond market is becoming more attractive to corporate borrowers. Main reasons for this phenomenon are:

-Flexibility: customized terms of bond issuance increase the attractiveness of the corporate bond markets for funding.

-Agility: on average bond markets give quicker access to funds compared to bank funding.

-Longer maturity: bond markets offer longer term funding in comparison to bank funding. In general, bank loans do not exceed 5 years (eventually 7), on an unsecured basis.

-Diversification: bond markets give access to a new investor base and reduce the corporations' dependency on banks.

-Pricing: depending on the current market conditions, bond prices could be very attractive.

Historically speaking, European corporations are more oriented towards bank funding than bond funding, in comparison to the USA, for example. However, this trend has dramatically changed recently and the activity on the bond markets has increased significantly (European Comission, 2017). Banks are more reluctant to underwrite corporate bond transactions due to the increased capital requirements and the lower appetite for credit risk for certain industries or specific issuers. Corporate issuers obtain funding necessary to run their businesses through the primary market and corporate bond markets have become more flexible and have relaxed some of the restrictions for entering the markets (in normal market conditions). However, there is a big difference from one member state to another. For instance, corporate bonds are more significant in France, Portugal and the United Kingdom as opposed to other member states. Six countries (France, the UK, the Netherlands, Italy, Germany and Luxembourg) account for 80% of all European corporate bonds by value.

Over the past few decades, the diversity of the participants has grown considerably. In the past, high yield bonds were generated by only a few participants and were mainly used for financing mergers and acquisitions. Today the market includes many dealers and issuers with broad needs.

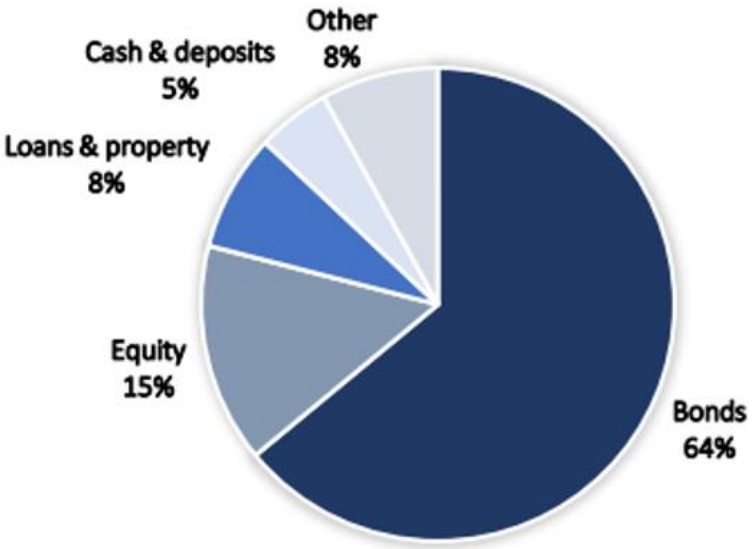
On the demand side, investors usually buy corporate bonds because the bonds' risk-return profile matches their investment strategies. Despite the credit risk they pose, bonds offer more attractive yields than government bonds with similar maturity or certificates of deposit, and have lower price volatility compared to stocks. Corporate bonds are often part of the investors's risk management strategies. European banks often hold investment grade corporate bonds to serve as inventory for market making operations or for asset-liability management purposes. Insurance companies invest in fixed income securities such as corporate bonds to match their liabilities (duration and predictability). Insurers need to hold sufficient funds to satisfy potential claims and withdrawals in the future, and for that reason they need predictable, long-term cash flows, resulting in investing a good portion of their investment portfolio in fixed income securities. Similar to insurers, pension funds invest in corporate bonds because their investments cover their long-term liabilities.

European insurers are the largest institutional investors in the European financial markets. Traditionally, insurers have been regarded as stabilizers of the financial markets. They are long-term investors and usually hold assets until maturity. In 2017 alone, insurance companies and pension funds held 14,1% of the 8,7 trillion EUR in long-term securities issued by financial and non-financial corporations in the euro area. Most insurance companies have yield targets that generate a certain stream of income. The set yield target determines the amount of risk an insurer is willing to take. Generally, they invest in fixed income securities with predictable long-term cash flows to match their liabilities towards

customers, including claims and underwritings in the future. According to data published by the European Insurance and Occupational Pensions Authority (EIOPA), a significant portion of the insurance companies' investment portfolios is invested in corporate bonds. A traditional insurer's portfolio consists of government bonds 31,4%, corporate bonds 32,2%, listed and unlisted equity 15,1%, cash and deposits 5,2%, mortgages and loans 5,7%, property 2,2% and other assets 8,2% (Figure 4).

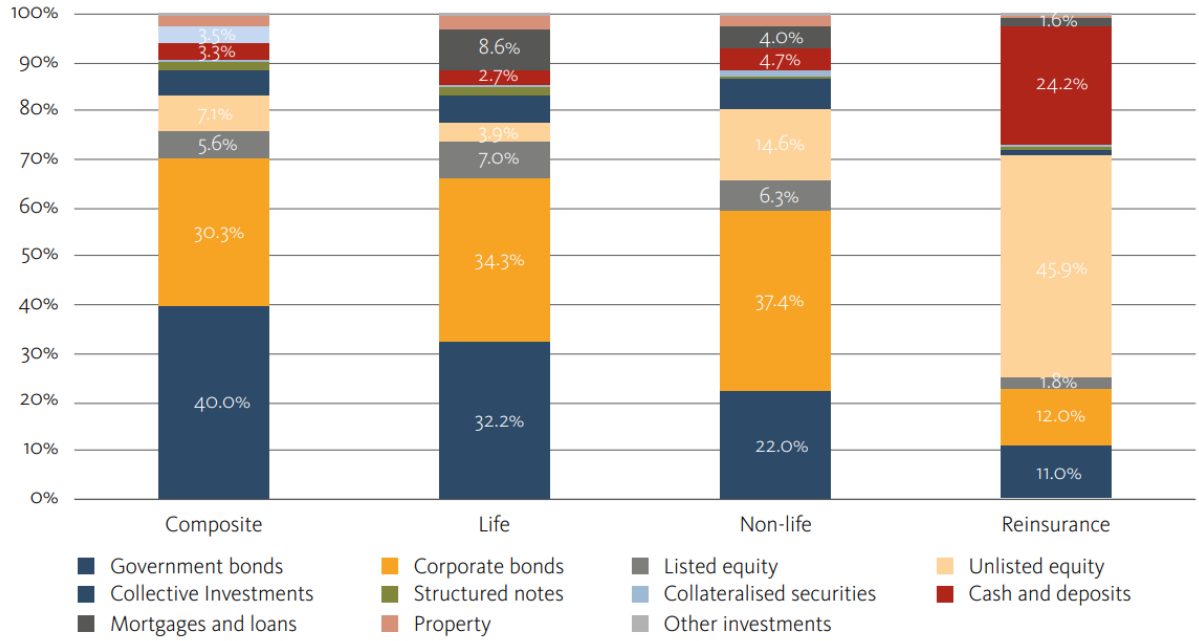
The type of investments is chosen to fit the insurers' needs in term of their obligations. The investments should allow insurers to be able to service the payments to their policyholders and to optimize the financial performance of the insurer. Non-life undertakings have the largest share in their investment portfolios in corporate bonds with 37,4%, followed by life insurers with 34,3% and insurers that have both life and non-life insurance lines of business invest 30,3% of their investment portfolios in corporate bonds (Figure 5).

Figure 6: Asset allocation by insurance companies



Source: EIOPA (2019).

Figure 7: Investment Split by type of undertaking



Source: EIOPA (2019).

The majority of bonds held by the European insurers are investment grade, of high quality. According to QIS4 data about 87% is invested in the three most senior rating classes (AAA, AA and A according to Standard&Poor's).

Table 2: Distribution of bond investments of European insurance undertakings

Rating class	
AAA	37.8%
AA	27.4%
A	22.2%
BBB	6.7%
BB	0.8%
B	0.5%
CCC or lower	0.1%
Unrated	4.6%

Source: Eiopa (2007).

The duration of these investments is higher in the more senior rating classes as seen in the table below:

Table 3: Durations of bond investments of European insurance undertakings

Rating class	10th percentile	25th percentile	Median	75th percentile	90th percentile
AAA	1.1	2.7	4.4	6.3	8.9
AA	1.2	2.5	4.3	5.7	7.5
A	1.0	2.5	4.0	5.6	7.6
BBB	1.0	2.5	4.0	5.4	7.1
BB	1.0	1.9	3.7	5.5	6.7
B	0.8	1.9	3.3	4.8	6.4
CCC or lower	1.0	2.3	3.8	4.6	6.7
Unrated	0.8	1.2	3.0	4.0	6.0

Source: Eiopa (2007).

However, the insurers' investment portfolios at country level are quite heterogeneous across countries, resulting in different countries investing a different portion of their investment portfolios in corporate bonds. Some countries (France, Germany, Italy and Spain) are more oriented towards holding bonds (both government and corporate) compared to other countries where the proportion of equity (Denmark and Sweden) and other assets (Finland) is higher. Countries such as Estonia, Norway and Luxembourg invest mostly in corporate bonds. On the other hand, countries like The Netherlands and Belgium, have a high exposure in mortgages and loans. Direct exposure of the European insurance sector towards emerging markets is very restricted. Some countries continue to be heavily dependent and interconnected with the bank sector. (Figure 6).

Recently, large European insurers have increased their capital allocation in lower rated investment grade bonds which have higher yield in order to maintain their yield targets. However, the introduction of the new regulatory framework, Solvency II imposes capital requirements related to credit spreads of long-term corporate bonds potentially disincentivizing long term investors to invest in corporate bonds.

Figure 8: Investment Split at country level

	Government bonds	Corporate bonds	Equity	Cash and deposits	Mortgages and loans	Property	Other
EU/EEA	31.4%	32.2%	15.1%	5.2%	5.7%	2.2%	8.2%
AUSTRIA	25.0%	31.3%	20.0%	4.1%	3.9%	7.1%	8.7%
BELGIUM	48.1%	22.3%	8.1%	2.7%	12.2%	2.7%	4.0%
BULGARIA	50.2%	15.3%	11.2%	10.8%	6.5%	2.5%	3.6%
CROATIA	64.1%	4.5%	8.3%	5.6%	7.2%	7.8%	2.5%
CYPRUS	18.5%	36.1%	11.8%	15.6%	2.9%	6.0%	9.1%
CZECH REPUBLIC	50.8%	17.6%	8.5%	7.6%	8.5%	0.4%	6.6%
DENMARK	18.0%	39.7%	27.0%	3.1%	3.8%	2.7%	5.6%
ESTONIA	27.0%	53.1%	1.5%	14.0%	0.7%	0.0%	3.7%
FINLAND	9.6%	33.3%	6.9%	7.5%	4.5%	5.6%	32.5%
FRANCE	33.4%	35.1%	12.3%	3.4%	1.9%	2.3%	11.6%
GERMANY	25.3%	35.8%	21.5%	4.1%	5.5%	2.1%	5.8%
GREECE	61.8%	20.6%	4.7%	6.6%	0.8%	1.9%	3.6%
HUNGARY	81.2%	3.0%	4.7%	4.8%	0.4%	0.1%	5.8%
ICELAND	26.2%	19.3%	28.8%	6.0%	2.7%	1.5%	15.4%
IRELAND	27.7%	32.6%	7.1%	19.3%	5.0%	1.3%	6.9%
ITALY	52.6%	21.1%	12.5%	2.1%	1.3%	1.0%	9.4%
LATVIA	59.9%	17.5%	2.5%	13.5%	2.1%	0.9%	3.5%
LIECHTENSTEIN	26.2%	39.5%	7.4%	19.3%	2.4%	0.1%	5.0%
LITHUANIA	70.8%	14.8%	1.6%	6.5%	1.1%	0.8%	4.2%
LUXEMBOURG	28.4%	41.5%	8.0%	11.8%	4.8%	0.8%	4.7%
MALTA	33.6%	20.9%	8.9%	18.5%	5.3%	1.8%	11.0%
NETHERLANDS	35.2%	17.2%	6.1%	4.5%	26.1%	1.8%	9.1%
NORWAY	13.0%	46.5%	22.9%	2.6%	10.2%	0.5%	4.3%
POLAND	56.6%	7.6%	20.9%	3.7%	3.9%	0.3%	7.1%
PORTUGAL	44.9%	27.7%	8.8%	11.9%	1.1%	2.2%	3.4%
ROMANIA	68.2%	7.7%	5.8%	14.7%	1.0%	1.8%	0.8%
SLOVAKIA	45.3%	35.9%	5.6%	6.9%	1.7%	0.5%	4.0%
SLOVENIA	37.5%	33.7%	18.2%	5.3%	0.9%	1.4%	3.0%
SPAIN	58.6%	20.7%	5.7%	7.7%	0.8%	2.4%	4.0%
SWEDEN	14.5%	31.9%	33.2%	4.3%	3.8%	3.1%	9.1%
UNITED KINGDOM	19.2%	36.0%	12.9%	10.4%	10.8%	2.3%	8.5%

Source: EIOPA (2019).

2.4 Spread Risk in Solvency II

The focus of this thesis is on the Spread risk sub-module and its impact on the calculation of the capital requirements. According to Solvency II, spread risk is the risk resulting from the sensitivity of the value of assets, liabilities and financial instruments to changes in the level or volatility of credit spreads over the risk-free interest rate term structure. It is the risk that the credit spread for a specific investment is not high enough to justify investing in that bond as opposed to investing in another lower default risk investment. The spread risk sub-module covers all assets, debt and financial instruments that are sensitive to a credit spread. The Spread Risk Sub-Module is covered in the Delegated Act subsection 5, articles 175-181.

There are three types of SCR spread that relate to:

-Bonds and loans SCR_{bonds} – including both government and corporate bonds and loans but excluding mortgage loans.

-Credit derivatives SCR_{cd} -CDS and structured products based on synthetic credit instruments.

-Securitizations SCR_{sec}

The total SCR for the spread risk sub module is calculated as:

$$SCR = SCRbonds + SCRcd + SCRsec \quad (15)$$

EIOPA has published a paper named "The underlying assumptions in the standard formula for the Solvency capital requirement calculation" (2014) which explains the assumptions used for calculating the SCR. In the paper it is assumed that the spreads increase for all instruments in 1 in 200 years event. It is supposed that the spreads on all instruments rise and the insurers are only exposed to the risk of increasing credit spreads. The components of the spread risk sub-module are perfectly correlated and there is no possibility for diversification. All three quantities are taken into consideration only if, they are positive.

The main components of the spread risk are the credit quality and the instrument's sensitivity with respect to a shock on the credit spread.

The credit quality is represented by a Credit Quality Step (CQS). A CQS of 0 is equivalent to a credit rating of AAA, a CQS of 1 is equal to credit rating of AA and so on, with 6 corresponding to a rating of CCC. The CQS of an asset is set according to the second-best rating from three external credit assessment institutions or more. The three main credit assessment institutions are Moody's, Standard & Poors and Fitch. If the asset has a rating from only one institution available, then the sole rating should be used. If the asset has only two ratings available, the worse rating is used. The choice of which external credit assessment institutions are going to be used cannot be changed over the lifetime of the instrument and must be the same for similar instruments. European insurers generally invest in high quality bonds. Durations of these investments are generally higher in the more senior rating classes.

The sensitivity of an instrument in respect to a shock on the credit spread for bonds and loans is a function of the spread duration that is defined for each CQS. The function is based on the type of the instrument (government bond, corporate bond, securitization, etc.). For credit derivatives on the other hand, it is a variation of the present value under shocks whose size depends on the CQS.

Spread duration represents the sensitivity of a bond's price to changes in its credit spread. It is denoted in years. For a fixed rate bond, it does not differ substantially from the interest

rate duration. For a floating rate bond, the spread duration is calculated by taking the forward value of each floating rate and considering them as fixed. In this instance, the spread duration and the interest rate duration can differ a lot. For callable bonds, there is no direct way of calculating the duration.

The capital requirement for spread risk is calculated using shocks to credit spreads with a 0,5% probability of occurrence during the time period of one year. Its goal is to make sure that the value of the assets exceeds the value of the liabilities with 99,5% certainty after significant widening of credit spreads within one year. The SCR for spread risk increases for lower ratings and higher durations.

2.5 Relevance of spread risk for capital requirements

Spread risk on bonds and loans SCR_{bonds}

The calculation for bonds and loans depends on a combination of the duration and the credit quality assigned to each bond. It mostly covers all bank and corporate bonds and loans (public or private), regardless of the subordination of the debt. The capital requirement for spread risk on bonds and loans SCR_{bonds} should be equal to the loss in the basic own funds following a relative decrease of stress in the value of each bond or loan. Shocks are applied to the market value of the bond or loan. The risk factor stress depends on the modified duration of the bond or loan *i* denominated in years, dur_i. The spread duration is floored at 1. For variable interest rates bonds or loans, dur_i is the modified duration of a fixed interest rate bond or loan of the same maturity and with coupon payments equal to the forward interest rate. Bonds and loans that have an available credit rating by an External Credit Assessment Institution are assigned a risk factor stress depending on their CQS and the spread duration dur_i.

Some bonds and loans are exempt from the solvency capital requirement calculation, such as bonds and loans of the European Central Bank, the central government and certain local authorities and banks of the member states issued in their national currency and some multilateral development banks and international organizations. For bonds and loans of central banks and states of other countries shocks apply, although for highest quality issues, CQS 0 and 1, they are 0.

For non-rated bonds that are collateralized, it is possible to lower the amount of SCR_{bonds}, in some cases even to divide the classic SCR_{bonds} in half. In order to be able to use this reduction method certain criteria have to be met:

-If a credit event happens, the insurer can realize or retain the collateral.

-The collateral has a stable value and an adequate liquidity and credit quality.

-It is guaranteed by a counterparty with no risk factor for concentration.

-No material correlation between the credit quality of the collateral and the counterparty

If the collateral is eligible a formula is used to calculate the reduction of the SCR_{bonds}. The calculation is based on Risk Adjusted Value of Collateral RAVC. It depends on the RAVC whether the SCR_{bonds} is going to be reduced or not. According to the Delegated Act Article 197, the RAVC is calculated as the difference between the Market Value of Collateral MVC and the Market Risk of Collateral MRC.

$$RAVC = MVC - MRC \tag{16}$$

The MRC is obtained as the difference between the following capital requirements:

-The theoretical SCR for Market Risk of the insurance or reinsurance undertaking that would apply if there was not any collateral included in the calculation.

-The theoretical SCR for Market Risk of the insurance or reinsurance undertaking that would apply if collateral was included in the calculation.

For the purpose of the calculation, we denote the market value of the bond or loan with MV, F^{up} is the shock to the bond or loan without collateral as a proportion of MV and $F^{up}(collat)$ to a bond or loan with collateral. There are three different cases where the calculation applies:

-$RAVC \geq MV$, the shock is divided by 2 or $F^{up}(collat) = 0{,}5 * F^{up}$

-$RAVC < MV * (1 - F^{up})$, the shock is the same $F^{up}(collat) = F^{up}$

-$RAVC < MV$ and $RAVC \geq MV * (1 - F^{up})$, a new shock is calculated as a linear combination between the two above $F^{up}(collat) = 0{,}5 * F^{up} + 0{,}5 * \frac{MV - RAVC}{MV}$

The value of the stressed collateral is compared to the value of the bond or loan. If the value of the stressed collateral is higher than the market value of the bond or loan the effect on the SCR spread is advantageous.

For infrastructure debt there are some specific shocks that apply since April 2nd, 2016 (Commission Delegated Regulation (EU) 2016/467). If the specific infrastructure project meets certain criteria, the infrastructure debt benefits from shocks reduced by 30% in comparison to corporate debt. Some of the conditions that have to be fulfilled are:

-The infrastructure project is located in the European Economic Area EEA or the Organization for Economic Co-operation and Development OECD.

-If the debt is unrated, the bond is senior to all other claims. If the bond is unrated, but it satisfies the specific criteria then it is considered as if it has a CQS of 3 (BBB). Instruments with CQS less than 3 are not taken into consideration.

-The bond holders are protected covenants regarding the utilization of the cash flows generated by the project.

The capital charge is calculated as:

$$Mkt_{sp}^{bonds} = \sum_{i} MV_i \times Duration \times F(duration_i) + \Delta Liab_{ul} \tag{17}$$

where

F(rating$_i$) is a function of the rating class of the credit risk exposure which is calibrated to deliver a shock consistent with VaR 99.5%

$\Delta Liab_{ul}$ is the overall impact on the liability side for policies where the policyholders bear the investment risk with embedded options and guarantees of the stressed scenario with a minimum value of 0. The stressed scenario is a drop in value of the assets used as the reference to the valuation of the liabilities by *F(rating$_i$)*.

In QIS4 the capital charge for spread risk for bonds is calculated by multiplying the market value of the bond with its modified duration and a function *F* of the rating class of the bond.

$$Mkt_{sp}^{bonds} = Duration \times F(rating_i) \tag{18}$$

Modified duration allows investors to measure the bond's sensitivity to changes in interest rates. It measures the average cash-weighted term to maturity of a bond. The modified duration shows how much the duration changes for each percentage change in the yield and how much a change in the interest rates affects bond prices.

In the following table the values of the function *F* and caps and floors for the duration measure are displayed.

Table 4: Calibration parameters for corporate bonds

Rating class	F(Rating$_i$)	Duration floor	Duration cap
AAA	0.25%	1	-
AA	0.25%	1	-
A	1.03%	1	-
BBB	1.25%	1	-
BB	3.39%	1	8
B	5.60%	1	6
CCC or lower	11.20%	1	4
Unrated	2.00%	1	4

Source: EIOPA (2007).

The table below outlines spread shocks for different rating classes. Then, these shock factors are multiplied with the modified duration of a bond to calculate the capital charge for spread risk of bonds.

Table 5: Calibration results for function F

F(Rating$_i$)	Rating class
AAA	1.27%
AA	1.53%
A	1.77%
BBB	2.47%
BB	4.48%
B or lower	7.54%

Source: EIOPA (2007).

All rating classes have a duration floor of 1 and duration caps for the lower classes should be applied. If a bond is not rated, the rating of the issuer can be used as a proxy. Variable interest rate bonds are exposed to substantial credit spread risk. Therefore, we use the modified duration for the calculation of the capital charge and it should be equivalent to fixed income bonds with coupon payments equal to the forward interest rate.

The final calibration of the function F(Rating$_i$) is displayed in the following table:

Table 6: Final Calibration proposal for function F

$F(Rating_i)$	Rating class	Duration floor	Duration cap
AAA	1.3%	1	-
AA	1.5%	1	-
A	1.8%	1	-
BBB	2.5%	1	-
BB	4.5%	1	8
B or lower	7.5%	1	6
Unrated	3.0%	1	-

Source: EIOPA (2007).

Spread risk on credit derivatives

In the case of credit derivatives, the shock is based on the difference between the present value PV under stressed and initial market conditions. The SCR_{cd} for spread risk on credit derivatives is equal to the higher of the following capital requirements:

The loss of Present Value PV because of an increase in credit spreads in absolute terms, depending on the CQS of the underlying reference entity. The absolute shock in credit spreads of the instruments underlying the credit derivatives for which there is an available credit assessment by an ECAI is calculated according to the following table:

Table 7: Absolute shock in credit spreads of the instruments

Credit quality step	0	1	2	3	4	5	6
Instantaneous increase in spread (in percentage points)	1,3	1,5	2,6	4,5	8,4	16,20	16,20

Source: European Parliament (2015).

The loss of PV because of a decrease in the credit spreads of the instruments underlying the credit derivatives, equal to 75% regardless of their CQS.

If the underlying reference entity is one of the governmental entities that is exempted from SCR_{bonds}, the shock for the credit derivative is 0.Credit derivatives which are part of the entity's risk mitigation technique are not subject to a capital requirement for spread risk, as

long as the entity holds either the instruments underlying the derivative or another exposure with respect to which the basis risk between that exposure and the instruments underlying the derivative is not material in any circumstances.

Spread risk on securitization positions

There are two types of securitization positions, Type 1 and Type 2 and a third more conservative approach regarding re-securitizations. The capital requirement on securitization positions $SCR_{securitization}$ for spread risk on securitization positions is the sum of the capital requirement for type 1 securitization positions, the capital requirement for type 2 securitization positions and the capital requirement for re-securitization positions.

Type 1 Securitization positions

Type 1 securitization positions are referring to the less risky assets. Even in the case where the capital requirement for Type 1 securitizations is higher than the capital requirement for corporate bonds, it is still much lower than the capital requirement for the Type 2 securitization positions. For a securitization position to be considered part of the Type 1 securitizations some of the following conditions have to be fulfilled:

-The position has a CQS of 3 or better.

-The securitization is listed on a regulated market of a member country of the EEA or the OECD, or it is listed on an organized trading venue that is sufficiently liquid and for which there exists a robust market infrastructure.

-The position is in the most senior tranche or tranches of the securitization and has the highest level of seniority during the life of the transaction. A tranche that is the most senior at the moment and will be so during the rest of the life of the transaction, can be considered to be the most senior, even if in the past this tranche was subordinated to another tranche that has been amortized.

-The notes are issued by a Special Purpose Entity and the note holders do not carry any risk on the seller of the note.

-The securitization position is backed by a pool of homogeneous underlying exposures from the following types: residential loans (with mortgages or collateral); commercial loans; leases and facilities to finance operations (except for acquisition of commercial real estate if at least 80% of the borrowers are small and medium firms); auto loans and leases; loans and credit facilities to individuals for personal, family or household consumption.

-If it is not a re-securitization.

-If the underlying position does not include exposures to credit-impaired debtors on the day of issue of the securitization.

If a Type 1 securitization position is guaranteed by the European Investment Fund or the European Investment Bank, its $SCR_{securitization}$ is 0.

Type 2 Securitization positions

All securitization positions that do not qualify as Type 1 Securitizations and which is not a re-securitization are Type 2 Securitization positions.

In an effort to determine the $SCR_{securitization,}$ the contribution of each position is calculated. The contribution of a Type 1 securitization position with a CQS from 0 to 3 is given by multiplying its market value by $\min(b_i \cdot dur_i;1)$, where dur_i refers to the spread duration of a securitization position *i* denominated in years and b_i is assigned depending on the CQS of the securitization position *i* according to the following table:

Table 8: Contribution of a Type 1 securitization position

Credit quality step	0	1	2	3
b_i	2,1%	3%	3%	3%

Source: European Parliament (2015).

The contribution of a Type 2 securitization position with a CQSc is obtained by once again multiplying its market value by $\min(b_i \cdot dur_i;1)$, and here b_i is assigned depending on the CQS of the securitization position i in the table:

Table 9: Contribution of a Type 2 securitization position

Credit quality step	0	1	2	3	4	5	6
b_i	12,5%	13,4%	16,6%	19,7%	82%	100%	100%

Source: European Parliament (2015).

The contribution of a re-securitization position with a CQSc is given by multiplying its market value by $min(b_i \cdot dur_i;1)$. In this case b_i is assigned depending on the CQS of the securitization position *i* in the table:

Table 10: Contribution of a re-securitization position

Credit quality step	0	1	2	3	4	5	6
b_i	33%	40%	51%	91%	100%	100%	100%

Source: European Parliament (2015).

The spread duration should not be lower than 1. Securitization positions that do not have a credit rating from a nominated External Credit Assessment Institution ECAI should contribute with 100% to the $SCR_{securitization}$ calculation.

2.6 Risk of sovereign bonds

In the current Capital Requirements Regulation, insurers are receiving preferential treatment for their exposures to government bonds denominated in domestic currency. Despite having lower yields, sovereign bonds denominated in euro are more attractive to insurance entities than corporate debt because they are exempt from capital charges. In addition, there are no concentration limits and government bonds can amount to a large part of the insurer's capital. Sovereign debt denominated in national currency is considered (nearly) riskless and therefore insurers can benefit from the more relaxed regulation and special treatment. This incentivizes European insurers to hold domestic sovereign bonds in larger amounts. When calculating the SCR with the standard formula approach, sovereign debt is only included in currency and interest risk and not in spread or concentration risk. However, insurers are guided by the prudent person principle when investing. According to the principle, they should invest only in assets whose risks they can accurately identify, measure, monitor, manage and control.

Composite undertakings (both life and non-life insurance), traditionally invest most of their assets in government bonds with 40%, followed by life insurers with 32,2%, non-life insurers with 22% and re-insurance undertakings with 11% (Figure 9). Taking a look across countries in the EU, different countries invest a different portion of their assets in government bonds. Hungary 81,2%, Lithuania 70,8% and Romania 68,2% invest most in government bonds, while Sweden 14,5%, Norway 13% and Finland 9,6% are the countries that invest least in sovereign debt (Figure 9).

Although, sovereign debt is considered as less risky than other investments, this does not mean that there are no risks. Entities face sovereign risk when investing in government bonds. Sovereign risk refers to the risk that the government will not be able to service its debt and the probability of default. Usually, a sovereign risk rating is assigned to each borrower by the credit rating agencies such as Moody's, Standard and Poors and Fitch. Sovereign risk ratings are based on the assessment of both the ability and willingness of a

country to meet its obligations. Sovereign risk is heavily influenced by economic factors, however political factors and the country's history as a borrower are important as well. The risk of a country defaulting increases when: the fiscal conditions are deteriorating, during deep recessions or depressions, wars, political and social unrest, deflation, losing control over sovereignty, inability to print its own money etc. Garcia-de-Andoain and Kremer (2017) argue the importance of stress on the sovereign markets. Stress usually comes from a few countires, but we must take into account that the spillover patterns change over time as well.

The zero-risk charge in the standard formula does not necessarily mean that the risk is not taken into account by insurers at all. Many insurers, especially larger insurance groups, use internal models where they incorporate the risk that the government bonds bear.

3 THE MATCHING ADJUSTMENT

3.1 Overview and Rationale

Under the Solvency II balance sheet, the liabilities of the entity are valued at their market value. The mark-to-market approach leads to the appearance of volatility in the insurance undertaking's financial statements which makes businesses look more volatile than they actually are (Van den Broek, 2014). This occurrence is better known as the problem of "Artificial Volatility". Insurers have long-term liabilities, and they usually hold long-term assets to maturity and do not engage in active buying and selling on volatile markets. The price changes on the markets should not have an impact on the economic value of these instruments in the insurer's balance sheet. Peleckienė and Peleckis (2014) explore the need regulators to ensure proper treatment of insurance products with long term guarantees. The regulators have introduced additional measures to mitigate the effect of this artificial volatility on the solvency ratio of the entities that usually hold fixed income assets until maturity. These measures significantly lower the amount of capital requirements that is corresponding to the risk of short-term spread fluctuations. This leads to insurers having a larger amount of own funds to invest. In order to reduce artificial volatility and pro-cyclicality, a package of measures was introduced through the Omnibus II Directive including the Matching Adjustment (MA), the Volatility Adjustment (VA), extrapolation of the risk-free interest rate, two specific transitional measures and the extension of the recovery period (Alonso, 2014). In other words, the market values of assets could fluctuate because of market movements other than default risk and due to the long-term nature of their businesses, the Solvency II framework allows insurance companies' Own Funds not to vary according to such temporary changes by adding a spread to the liability discount rate to neutralize the movements in asset values. This prevents pro-cyclicality because otherwise entities would have to buy more of the same types of assets as those that are losing their value.

The most widely used measures are the Volatility Adjustment VA and the Matching Adjustment MA. Both aim to prevent fluctuations in the own funds caused by artificial volatility, but their use and requirements are quite different. The Volatility Adjustment VA is one of the Long-Term Guarantee (LGT) measures under Solvency II that is intended to ensure adequate treatment of insurance products with long-term guarantees. The purpose of the measure is to correct the market-consistent valuation of assets and liabilities from dis-incentivizing insurance entities to invest in appropriate assets that the insurer would hold taking into account the nature and duration of liabilities. Under the VA, insurers are allowed to adjust the risk-free interest rates that are used to value the Best Estimate Liabilities in order to mitigate the artificial volatility of bond spreads on their solvency positions. The VA improves the Solvency II balance sheet and reduces the Solvency Capital Requirement SCR. Requirements for using the VA usually fall under the risk management sector. The VA is used to mitigate the effect of large movements in spreads from unrealistic assessment of expected losses or unexpected credit risk. It is published and updated by EIOPA and can be different for every major currency and country. The VA is calibrated at 65% of the risk-adjusted spread of assets in the representative portfolio. The application of the measure improves the Solvency II balance sheet in terms of Own Funds and minimizes the SCR. The Volatility Adjustment is a standardized measure and requires the insurance entities to fulfill fewer conditions than the Matching Adjustment MA.

The Matching Adjustment is a measure of the additional return in excess of the risk-free return that insurers earn on illiquid assets which are held to maturity in order to match their illiquid liabilities. The MA represents the part of the credit spread that corresponds to the liquidity risk of assets. It is an upward adjustment made to the risk-free rate used for discounting. The adjustment reflects the fact that this artificial volatility in the balance sheet could give a false impression of the firm's solvency. The Matching Adjustment is used when the insurer is able to set aside a portfolio of long-term assets which are held to maturity that match the portion of their long-term predictable liabilities. Assets in the MA portfolio must cover the best estimate of liabilities of the same portfolio. They must cover the expected insurance payments and no additional payments. They are not exposed to the risk of changing spreads on their assets due to the market prices changes, however they are still exposed to the risk of default. When insurers use this measure, they have to calculate separately the SCR for each MA portfolio, resulting in the SCR for the undertaking to be a sum of the separate SCRs for each portfolio and other business. The MA is calculated as the spread over risk-free rates on the matching assets less an allowance for defaults and costs of downgrades. It is based on the assets held by the entity. EIOPA publishes the fundamental spreads that insurance undertakings use for the calculation. The MA calculation is specific to each undertaking. It gives undertakings immunity to spread movements when they hold assets to maturity. Applying the Matching Adjustment increases the risk-free interest rate term structure causing a decrease in the market value of long-term liabilities. In practice the MA is much less used than the VA, but it is as important because of its significant impact on the insurers' financial statements.

3.2 Calculating the Matching Adjustment

The Matching Adjustment is calibrated using a methodology prescribed in the Solvency II Regulation Framework. The methodology is designed to work in a way that the allowance of liquidity premium in the calculation of the Best Estimate Liabilities BEL is related to how well the insurer's assets and liabilities match. When applying the MA, the insurance entity is compensated by holding its assets to maturity and not being exposed to liquidity risk. However, the insurer is exposed to default risk which is introduced by the Fundamental spread. For this purpose, the MA is calculated by subtracting the Fundamental spread from the credit spread in the MA portfolio.

The credit spread of the MA portfolio $\widehat{(CS)}$ is calculated as the difference between the yield of the assets included in the MA portfolio and the risk-free rate applied to the liabilities to which the MA is applied. The credit spread is calculated as the difference between:

The single yield rate $(\widehat{yield})$ which results in a market value of liabilities, equal to the sum of the market value of the asset cash flows based on the following yield curve:

$$MV_{Asset}^{yield\ curve} = \sum_{t=0} \frac{CF_t^{liab}}{\left(1 + \widehat{yield}\right)^t} \tag{19}$$

The single risk-free discount rate $(\widehat{RFR})$ which results in a market value of liabilities equal to the sum of the market value of the liability cash flows based on the risk-free term structure:

$$MV_{Liab}^{RFR} = \sum_{t=0} \frac{CF_t^{liab}}{\left(1 + \widehat{RFR}\right)^t} \tag{20}$$

The Fundamental spread is set by EIOPA as part of the Solvency II Framework. It is calibrated for every rating and duration and takes into account the long-term average spread LTAS which is based on historical data for the past 30 years. It represents the cost of downgrade (CoD) and the probability of default (PD) which are based on long-term default statistics. The fundamental spread (FS) is expressed as:

$$FS = max(PD + CoD; 35\% * LTAS) \tag{21}$$

Resulting from the above formulas, the Matching Adjustment can be calculated as:

$$MA = \left(\widehat{CS}\right) - FS = \left(\widehat{yield}\right) - \left(\widehat{RFR}\right) - FS \tag{22}$$

In the effort of assigning an overall matching adjustment, the portfolio of assets backing liabilities should be split into two components:

-Component A - the value of assets that match the probability of default.

-Component B – the value of assets that match the cost of downgrades.

Splitting assets into these two components can have a significant effect on the resulting matching adjustment's value.

The Matching Adjustment is customized to the entity's asset-liability profile and secures protection against artificial volatility on the balance sheet, but at the same time it restricts the investment options and liability structures. The MA can turn negative when spreads are generally low and in those cases the amount of required technical provisions is going to increase with the application of the Matching Adjustment.

3.3 Conditions under which the Matching Adjustment applies

3.3.1 Technical and documentation requirements

Solvency II allows insurers to use the Matching Adjustment, but they require approval from their supervisors. The regulators require a set of strict conditions the insurer must meet to be classified as qualified to use the Matching Adjustment. The firm has to fulfil a set of qualitive and quantitative requirements for the matching adjustment-compliant portfolio. The conditions range from the assets' nature and quality to liquidity planning for upcoming cash outflows. Once an insurance entity has started using the MA for a MA Portfolio, it cannot return to using a different approach that does not use it. If a MA Portfolio ceases to be eligible for the MA and compliance to the requirements cannot be regained in an appropriate timing, the insurer will be prohibited from using the MA for two years. There are three important aspects to the rules:

-The entities must receive approval from the regulator to use the MA, and in the approval application they must enclose how the portfolios will be managed in a way that is in accordance with all relevant rules and guidance.

-The insurers must, at all times, follow what is set out in their regulatory approvals.

-The entities must receive approval by the Regulator to make any changes to their existing MA portfolios that are out of scope of their current approvals.

The central requirement for insurers is for the companies to adopt the buy-to-hold investment strategy. Entities hold their assets to maturity and do not engage in active buying and selling on the markets. Under this strategy, the insurer is not exposed to short term volatility in the market value of the assets, but is exposed to the risk of downgrades and defaults of the assets.

The buy-to hold strategy is achieved by investing in fixed cash flow assets which match the liabilities in timing, amount and currency.

With the aim to obtain authorization from their supervisors, the insurance and reinsurance entities are obliged to submit an official application requesting approval for applying the Matching Adjustment. Insurance portfolios that meet the criteria, will be proclaimed as eligible for using the measure by the regulatory body. The measure is not compatible with the use of the volatility adjustment or the application of the transitional measure on the interest rates.

Among the most important are the eligibility conditions for the assets and matching liabilities to which the MA is applied. There is no prescribed list of eligible assets for MA purposes provided by the regulators. On the contrary, the entities are expected to be able to demonstrate that their portfolios meet the eligibility criteria in their applications for MA approval. During the approval process, the regulator reviews each asset portfolio on a case-by-case basis considering the evidence the insurers have submitted in their applications. When demonstrating assets' eligibility, firms are supposed to consider all features of their assets considering all relevant conditions, not just the conditions they consider to be most material. A key challenge for the entity is to identify which assets are eligible. For assets to be considered eligible they have to meet rigorous criteria such as:

-Assets should be maintained during the whole lifetime of the insurer's liabilities unless the cash flows have materially changed for matching purposes.

-Assets covering liabilities in the MA portfolio cannot be used for covering losses from other activities of the insurer.

-The expected cash flows from the MA Assets should replicate the expected cash flows of the MA Liabilities in the same currency.

-Asset cash flows should be fixed and cannot be changed by the insurer or any third party. Cash flows linked to inflation qualify if the liabilities they back are similarly inflation-linked.

-There should not exist any mismatch giving rise to potential material risks. The assets' projected cash flows net of defaults should match the liability cash flows with a high level of exactness.

-The assets' cash flows that depend on longevity, morbidity, realizable value of property and exposure to pre-payment risk do not qualify for the Matching Adjustment.

Separate Special Purposes Vehicles SPV for holding the eligible assets are not required, however the MA assets must be identified and managed separately from other assets of the firm and for any reason whatsoever cannot be used for covering other losses happening

elsewhere in the business of the insurer. The MA Portfolio should consist only of MA eligible assets.

To prove that the liabilities satisfy the eligibility criteria for applying the Matching Adjustment, insurers have to include a complete breakdown of their liabilities in their applications. They must determine all policyholder options and contractual terms. Conditions for applying the MA include:

-The liabilities in the MA portfolio should not give rise to any future premium payments.

-The only underwriting risks related to the MA portfolio should be the longevity risk, the expense risk, the revision risk or the mortality risk.

-In the case of the mortality risk, the best estimate of the portfolio of insurance and reinsurance obligations does not increase by more than 5% under a mortality risk stress test.

-The only options allowed for the insured person should be a surrender option with a surrender value that does not exceed the value of the assets backing the obligations.

-When composing the portfolio of insurance and reinsurance liabilities, the insurance or reinsurance liabilities of an insurance or reinsurance contract must not be split into different parts.

The supervisor expects from insurers to demonstrate in their applications that the expected cash flows of the assets replicate the expected cashflows of the liabilities in the same currency in the MA portfolio. One possible technique is to split the portfolio of assets into three components:

-Component A – assets whose cash flows match the expected liability cash flows after adjustment for the component of the fundamental spread equivalent to the probability of default.

-Component B – additional assets, that when added to component A, result in the value of the asset portfolio corresponding to the best estimate liabilities within a MA portfolio when discounted at the risk-free rate plus the MA.

-Component C – other assets regarded as surplus for covering liabilities which may or may not be needed for displaying compliance with the rest of MA conditions.

To ensure the quality of the cashflow matching, the regulators have developed tests which seek evidence that the portfolio of assets generates sufficient cashflows to meet the liabilities. The insurers are supposed to perform an extensive, quantitative cash flow-based projection evaluating the amount of any cashflow surplus or shortfall arising in each following year. The projection is based on conducting three tests:

-Test 1: Accumulated Cash-Flow Shortfall Test - the Best Estimate Liability cash flows in the MA portfolio and the cash flows from assets in component A, after adjustment for the part of the fundamental spread that fits the probability of default, are projected at annual intervals. Then any cash flow surpluses or shortfalls in the year are calculated and accumulated at the risk-free rate. Then insurers include the highest accumulated shortfall from all future years in the projection and calculate the present value of liabilities in the MA portfolio discounted at the risk-free date. The maximum accumulated shortfall in any year should not be higher than 3% of the discounted liabilities.

-Test 2: 99,5th Percentile Value at Risk (VaR) Test – the 99,5% one-year VaR of the MA portfolio for each of the interest rate, inflation and currency risk is calculated. The calculation considers the change of value in both assets and liabilities in the portfolio as a result of each stress. Then the insurers are displaying the Best Estimate Liabilities of the MA portfolio, calculated by discounting at a rate equal to the relevant risk-free rate plus the MA. After that, the undiversified 99,5% one-year VaR capital requirement for the MA portfolio for interest rate, inflation and currency risk is calibrated and the result of dividing them by the Best Estimate Liabilities of the MA portfolio. The undiversified 99,5% one-year VaR capital requirement should not be higher than 1% of the insurer's Best Estimate Liabilities for any of the three risks.

-Test 3: Notional Swap Test – this test shows by how much the MA would change if the insurer managed to eliminate any surplus or shortfall in its net cash flows by investing in a notional swap which reproduces a perfectly matched position. The insurers calibrate the notional MA computed by using only assets in component A; the notional MA calculated by scaling the market value and cash flows of the assets in component A up or down by a single factor until the present value of the future surpluses or shortfalls is zero when discounted by the relevant risk-free interest rate; and the market value of the assets in component A. The test shows that sufficient assets are allocated to meet the liabilities.

A crucial residual risk in the MA portfolios is the potential for credit deterioration. Credit-spread widening increases the probability of downgrades, defaults and higher haircuts. Rating downgrades increase the haircuts applied to asset cashflows and demand cash injections to restore it to the level before the rating downgrade. Rating Downgrades increase the cost of downgrade adjustment CoD, resulting in an increase of the fundamental spread and a decrease of the MA. Managing rating transition risk is crucial for MA portfolios. A fundamental credit analysis based on a great number of metrics is performed on each bond in order to control their credit profiles and mitigate downgrade risk. The exposure to rating downgrade risk is expressed by applying parallel rating shocks and calculating the effect on the Solvency II Ratio under these scenarios. This strategy informs insurers about their priority risk management areas.

As part of the application documentation, the insurance and reinsurance institutions have to disclose, in detail the calculation process used to determine the Matching Adjustment. In

addition, firms are supposed to disclose relevant links and references to supporting documentation that confirm their eligibility for applying the Matching Adjustment. They need to deliver substantial evidence proving that the assigned portfolio of assets meets all relevant conditions, a detailed description of every asset within the assigned portfolio together with the procedure of grouping them by asset classes, credit quality and duration in order to calculate the fundamental spread and a detailed explanation of the process used to maintain the assigned portfolio of assets. Further, they have to demonstrate that the conditions regarding their obligations are not violated and information about cash-flow matching and portfolio management. Firms forward the complete documentation to the regulatory body to request an approval and have to wait for official permission to begin using the Matching Adjustment.

3.4 Advantages and disadvantages of using the Matching Adjustment

The Matching Adjustment has extensive implications for the insurers, policy holders and overall, for the whole economy. The most evident benefit of the MA is offering protection against the unwanted artificial volatility on the insurer's balance sheet when insurers intend to hold their assets until maturity. It has an effect on the firms' investment strategies as well. The MA encourages entities to match the assets and liabilities of similar maturities, reducing the risk of cashflow mismatches and increasing returns for the stakeholders. Without its existence, firms would be encouraged to invest solely in government bonds or assets with shorter duration to meet Solvency II criteria, which would result in weaker matching of assets and liabilities. These rules set out by the Regulators are designed to guarantee the proper use of the Matching Adjustment and to protect policyholders. By introducing the Matching Adjustment in the Solvency II Framework, the quality of risk management increases. Entities have to perform a detailed analysis on their asset portfolios to receive approval (and on ongoing basis when it comes to new investments) which has led to identifying possible sources of optionality in asset cash flows. This has helped insurers to plan ahead in order to mitigate these potential risks by installing appropriate limit frameworks.

On the other hand, using the Matching Adjustment has its drawbacks. Investing in assets with relatively predictable, but contractually uncertain cashflows like some mortgages for example, is discouraged which leads to the risk that the insurers' portfolios will be skewed towards assets meeting the MA criteria. Implementing the MA in the firms' practices requires extensive and strict procedures that have to meet the criteria in order to get approval. At times, these criteria are too restrictive and hard to reach, especially for smaller insurance companies. This leads to a limited use of the MA and at times it is regarded as only a "theoretical solution".

3.5 The Matching Adjustment – the case of a simplified hypothetical insurance company

In order to further explain and illustrate how the Matching Adjustment works and its influence on the capital requirements, I will take a simplified version of a hypothetical insurer, Insurance company X. Insurance companies are balance-sheet-driven businesses. Their annual financial statement is a lengthy and detailed document presenting every aspect of the insurer's business. As with any other company, the balance sheet is an image of the company's financial position at a particular moment in time and the income statement shows the company's operating results from the previous period. The policyholder's surplus (assets minus liabilities) represents the company's financial cushion against losses and to fund expansion. The data in the following tables are fictional and by no means represent an existing insurance company.

Insurance company X is a composite insurer, operating in both life, and casualty and property insurance businesses. The unit for asset management and investments is overlooking the financial planning, investing and asset allocation of the company. Its asset management is oriented towards identifying investment opportunities and generating income to satisfy all clients while efficiently managing risks. The company is oriented towards maximizing investment returns for their preferred risk appetite by diversification, while maintaining an adequate level of asset-liability matching. The company, as most insurance businesses, is generally exposed to underwriting, operational, credit and financial risks. For the purpose of the thesis, as aforementioned, the most important risk is the financial risk, especially interest rates and spread movements. The Insurance company X uses the general principle for valuing assets and liabilities according to the economic, market-consistent approach prescribed by the Solvency II Directive. Assets and liabilities are valued according to the IFRS standards using methods consistent with fair value measurement. The technical provisions are calculated as the sum of the best estimate of liabilities and the risk margin, a calculation required by the Solvency II Directive. The following tables represent the financial statements of a hypothetical insurance company.

Table 11: An example of an insurance company's balance sheet
Insurance company X

(In thousands of euros)

Balance Sheet of Insurance Company X	
Assets	
Cash and cash equivalents	**7.200**
Intangible Assets	**9.357**
Goodwill	8.250
Other intangible assets	1.107
Tangible Assets	**2.320**
Land and Buildings (self used)	2.000
Other Tangible Assets	320
Investments	**483.500**
Bonds	214.750
Preferred Stocks	7.900
Common Stocks	83.200
Loans and receivables	152.450
Real Estate (investment properties)	5.800
Other invested assets	19.400
Receivables	**23.050**
Receivables arising from direct insurance operations	19.560
Other Receivables	3.490
Other Assets	**36.000**
TOTAL ASSETS	**561.427**

Table continues

Table 11: An example of an insurance company's balance sheet
Insurance company X

(cont.)
(In thousands of euros)

Equity and Liabilities	
Shareholder's equity	**37.253**
Share capital	2.800
Other equity instruments	200
Capital Reserves	13.295
Revenue reserves and other reserves	18.358
Reserve for unrealized gains and losses on available for sale financial assets	2.600
Other Provisions	**1.600**
Insurance Provisions*	**282.854**
Financial Liabilities	**62.000**
Financial liabilities at fair value through profit or loss	58.000
Other financial liabilities	4.000
Payables	**112.400**
Payables arising out of direct insurance operations	109.850
Other Payables	2.550
Other Liabilities	**65.320**
Liabilities directly associated with non-current assets and disposal groups classified as held for sale	59.942
Deferred tax liabilities	1.800
Tax payables	2.378
Other liabilities	1.200
TOTAL SHAREHOLDERS' EQUITY AND LIABILITIES	**561.427**

***Insurance Provisions -Techincal Provisions**	**282.854**
Mathematical Provision	206.283
Provision for unearned premiums	23.450
Provision for claims outstanding	50.915
Provision for profit sharing and premium refunds	1.300
Other Provisions	906

Source: Own work.

Table 12: An example of an insurance company's income statement
Insurance company X

(In thousands of euros)

Income Statement of Insurance Company X	
Net earned Premiums	68.326
Fee and commission income and income from financial service activities	1.038
Net income from financial instruments at fair value through profit or loss	237
Income from other financial instruments and land and buildings (investment properties)	15.312
Other income	180
Total Income	85.093
Net insurance benefits and claims	-49.230
Fee and commission expenses and expenses from financial service activities	-1.350
Expenses from other financial instruments and land and buildings (investment properties)	-2.692
Administration expenses	-6.300
Other expenses	-4.520
Total Expenses	-64.092
Earnings before taxes	4.234
Income taxes	-1270
Earnings after taxes	2.964

Source: Own work

The financial reports presented above are an evidence of the company's good business practices and suitable results.

If we take a further look at the company's investments, it is clear that most of its investment portfolio consists of fixed income investments, mainly bonds. A good portion of the bond portfolio is made of government bonds (52,7% or 113.173,25) and high-quality corporate bonds (38,2% or 82.034,5). The company is exposed to credit spread risk coming from

financial markets. The insurer must possess knowledge about the specific conditions under which the business and markets function in the environment where the company operates. The financial and actuarial units provide a detailed analysis to identify and mitigate potential issues. One of the most important processes is risk management. Insurance company X is maintaining a detailed risk management process, composed of risk identification, risk measurement, risk management and control and risk reporting. Risk identification aims to discover all material risks that the company is exposed to and make sure that the company takes adequate measures to prevent them. Then, material risks are quantified through their contribution to the Solvency Capital Requirement SCR. Each material risk must be covered by an adequate amount of capital that will absorb the loss if the risk materializes. The company decides for itself about the risk appetite, risk preferences, metrics and target levels that the company is willing to operate with. The aim of risk reporting is to inform the relevant stakeholders about the development of the risk profile, single risks and breaches of the risk tolerance. The main risk the company is exposed to is the underwriting risk, but as mentioned before, the focus of the thesis is the credit spread risk and that is why underwriting risk will not be covered.

Insurance company X has a good number of investments in financial assets and therefore it is exposed to market and credit risk that are driven by asset price volatility. However, the company holds mostly long-term investments which are able to resist fluctuations in the market prices of assets. In addition, as prescribed by Solvency II, the company holds a capital buffer to preserve a sound solvency position. This contributes to an efficient mitigation of financial risks. The most material credit risk for the company is the spread risk, due to the amount of investments in debt security assets. The credit risk assessment is based on credit ratings assigned to the financial instruments by credit rating agencies. In order to successfully reduce risks, the company must ensure that the value of the financial assets backing insurance contracts is sufficient to meet the obligations arising from them. The company is implementing a liability-driven asset management and allocation strategy which limits the impact of the market spread volatility.

In accordance with EU Regulation, Insurance Company X is obliged to prepare its own Solvency and Financial Condition report. Solvency II demands a detailed description of the essential aspects of the business including, performance and activities taken by the undertaking, system of governance, risk profile, valuation of assets and liabilities and capital management. The aim of the regulator is to improve transparency in insurance markets by obliging (re)insurance undertakings to disclose publicly reports about their solvency and financial state. On the authority of Article 75 of Solvency II directive, (re)insurers must use economic, market-consistent approach when valuating assets and liabilities assuming that market participants use when valuating the same assets and liabilities. Solvency II mainly relies on IFRS accounting principles to evaluate assets and liabilities with the exception of some adjustments:

Elimination of intangible assets, including goodwill. Goodwill is not recognizable in the Solvency II balance sheet. Other intangible assets that are non-monetary assets without physical substance are only recognized if they are separable and there is evidence of exchange transactions for the same or similar assets.

Assets have to be measured at fair value in the SII balance sheet. Properties, plant and equipment, both held for own use and as investments are recognized at amortised cost in the IFRS Balance sheet, while in the SII Balance Sheet they are recognized at fair value.

Investments in equities are measured at fair value in the SII Balance sheet which is consistent with the IFRS Balance sheet and there are no big differences in the shown values. Bonds are measured at fair value in the SII Balance sheet.

The main difference between the SII Balance sheet and IFRS valuation in the case of bonds depends on whether the bonds are classified as “loans” or “held to maturity” that are measured at amortised cost according to IFRS.

Other investments are measured at fair value according to SII and IFRS values them both at fair value and amortised cost depending on the asset class. In the case of Insurance company X, no bigger material difference is present in the valuation between SII and IFRS.

Assets held for index-linked and unit-linked contracts are valued at fair value both in IFRS and SII financial statements.

Loans and mortgages are valued at fair value in SII and at amortsed cost in IFRS.

Receivables, cash and cash equivalents and any other assets do not differentiate materially between SII and IFRS.

Financial and subordinated liabilities have to be measured at fair value in the SII balance sheet, while in IFRS financial statements they are measured at amortised cost.

Payables and any other liabilities are not significantly different in SII and IFRS financial statements.

Deposits from reinsurers are deposits from ceded reinsurance. Under Solvency II they are measured by the fair value approach and under IFRS they are measured at amortised cost.

Other provisions (non-technical) are liabilities that have uncertain timing and amount. They are valued according to the best estimate approach, both in Solvency II and IFRS.

Technical provisions are measured at fair value in the SII balance sheet. Under Solvency II, technical provisions are calculated as the sum of the best estimate liabilities (BEL) and the risk margin (RM). This component is not included in the valuation of IFRS reserves. IFRS reserves are calculated in accordance with local accounting principles as ultimate cost. Discounting future cash-flows is not performed.

The impact that the changes above have on deferred taxes. The difference between SII and IFRS is due to the differences in the valuation principles for assets and liabilities.

Table 13: An example of an insurance company's SII Balance Sheet
Insurance Company X

(In thousands of euros)

SII Balance Sheet of Insurance Company X	
Assets	
Intangible assets	0
Deferred tax assets	1.012
Property plant and equipment (self used)	2.820
Investments (without assets held for index-linked and unit-linked contracts)	275.329
Assets held for index-linked and unit-linked contracts	64.583
Reinsurance recoverables	2.032
Loans and mortgages	149.660
Receivables	23.050
Cash and cash equivalents	7.200
Other assets	37.956
Total Assets	**563.642**
Liabilities	
Technical Provisions	285.313
Other Provisions	1.600
Deposits from reinsurers	925
Deferred tax liabilities	10.208
Financial liabilities	59.300
Payables	112.400
Subordinated liabilities	10.230
Other liabilities	44.427
Total Liabilities	524.403
Excess of assets over liabilities	**39.239**

Source: Own work.

According to Solvency II, technical provisions are calculated as the sum of the best estimates of the liabilities BEL and the risk margin RM. The BEL is a probability weighted average of the present values of the future cash flows related to the liabilities at the valuation date.

All cash-flows are considered, including future premiums and cash out-flows due to the occurrence of insured events, exercising contractual options and the expenses needed for servicing the obligations. The risk margin guarantees that the whole value of the technical provisions matches the value a third party would have to pay to take over and meet the insurance liabilities.

Table 14: Solvency II Technical Provisions
Insurance Company X
(In thousands of euros)

SII Techical Provisions	
Best Estimate of liabilities	282.060
Risk Margin	3.253
Techical Provisions	285.313

Source: Own work.

Under The Solvency II Directive, Solvency II's excess of assets over liabilities is valued by using the IFRS shareholder's equity as a starting point. Then assets and liabilities are adjusted at fair value according to the regulations. Intangible assets are omitted, revaluating assets that are not accounted at fair value (ones that should be according to SII), measuring technical provisions as a sum of best estimate of liabilities and a risk margin and recalculating the impact of net deferred taxes on these adjustments. The calculation of net deferred taxes is out of scope of the thesis. In the table below the reconciliation between IFRS shareholder's equity and Solvency II's excess of assets over liabilities is presented.

Table 15: Reconciliation of IFRS equity to SII excess of assets over liabilities
Insurance company X

(In thousands of euros)

Reconciliation	
IFRS equity	**37.253**
Intangibles	**-9.357**
Fair value adjustment of assets	**10.560**
Bonds	8.462
Real Estate	900
Loans	-2.790
Other assets	3.988
Fair value adjustment of liabilities	**-8.179**
Tehnical Provisions	2.459
Financial Liabilities	-2.700
Subordinated Liabilities	-498
Other liabilities	-7.440
Net deferred taxes	-7.396
Excess of assets over liabilities	**39.239**

Source: Own work.

After calculating the excess of assets over liabilities we can calculate the basic own funds needed for further calculations. According to Solvency II, basic own funds are defined as the sum of the excess of assets over liabilities reduced by the value of own shares held by the undertaking and subordinated liabilities. Ancillary own funds are not included in the own funds of the company.

Table 16: Own Funds components
Insurance company X

(In thousands of euros)

Own Funds	
Excesss of assets over liabilites	39.239
Subordinated liabilities elegible in basic own funds	10.230
Forseeable dividend	-1.230
Other deductions	-950
Own Funds	47.289

Source: Own work.

As prescribed by Solvency II, Own funds are classified into three tiers representing different levels of quality. Quality means the ability to absorb losses is meant.

Tier 1 unrestricted own funds include: ordinary share capital and the related share premium account, reconciliation reserve and additional own funds.

Tier 1 restricted consists of undated subordinated liabilities.

Tier 2 includes the remaining subordinated debt that is classified as dated.

Tier 3 contains net deferred tax assets.

After calculating the excess of assets over liabilities we can calculate the basic own funds needed for further calculations. According to Solvency II, basic own funds are defined as the sum of the excess of assets over liabilities reduced by the value of own shares held by the undertaking and subordinated liabilities. Ancillary own funds are not included in the own funds of the company.

Table 17: Own Funds by tiering
Insurance company X

(In thousands of euros)

Own Funds by tiering					
	Total	**Tier 1 unrestricted**	**Tier 1 restricted**	**Tier 2**	**Tier 3**
Ordinary Share Capital	2.800	2.800	0	0	0
Reconciliation Reserve	35.074	35.074	0	0	0
Subordinated liabilities	10.230	0	2.762	7.468	0
Net deferred tax assets	130	0	0	0	130
Own funds that should not be represented by the reconciliation reserve and do not meet the definition of Solvency II own funds	-52	-52	0	0	0
Deductions	-893	-893	0	0	0
Own Funds	47.289	36.929	2.762	7.468	130

Source: Own work.

The sum of Tier 2 and Tier 3 should not be larger than 50% of the Solvency Capital Requirement, SCR. For the Minimum Capital Requirement, MCR, more rigorous eligibility criteria apply. The amount of Tier 1 items is at least 80% of the MCR and Tier 2 items must not exceed 20% of MCR. Tier 3 items are not considered eligible for covering the MCR.

The reconciliation reserve is calculated as the sum of the following components:

-Excess of assets over liabilities.

-Less own shares.

-Less foreseeable dividends.

-Less other basic own funds.

-Less other non-available own funds.

Other Basic own funds are the sum of ordinary share capital and related share premium accounts and net deferred taxes.

Table 18: Reconciliation Reserve
Insurance Company X
(In thousands of euros)

Reconciliation Reserve	
Excess of assets over liabilities	39.239
Own shares	0
Forseeable dividens	-1.230
Other basic own funds items	-2.930
Other non avaiable own funds	-5
Reconciliation Reserve	35.074

Source: Own work.

For the purpose of calculating the solvency capital requirement SCR, the standard formula approach is used. A risk charge is calculated for each type of risk that the company faces (the procedure is not shown as part of the thesis). The individual SCR charges are calculated as the difference between the net asset value in the unstressed balance sheet and the net asset value in the stressed balance sheet. Based on this process, the calculated SCR for the year amounts to 22.316. In the following table the SCR breakdown is shown, together with the contribution of each individual risk to the total SCR_{bonds}

Table 19: Solvency Capital Requirement Breakdown by individual risk
Insurance Company X

(In thousands of euros)

Total SCR by risks		
	Absolute value	Impact (%)
Financial risks	10.112	45,31
Credit risks	5.670	25,41
Life underwriting risks	2.285	10,24
Health underwriting risks	201	0,9
Non-life underwriting risks	2.522	11,3
Intangible risk	120	0,54
Operational risk	1.406	6,3

Source: Own work.

The most relevant risks are financial risks with 45,31% and credit risks with 25,41% contribution to the total Solvency Capital Requirement. At this point, the Matching Adjustment is not applied. From here we can calculate the Solvency Ratio of Insurance Company X.

Table 20: Solvency Ratio
Insurance Company X

(In thousands of euros)

Solvency Ratio	
Own Funds	47.289
SCR	22.316
Excess of Own Funds over SCR	24.973
Solvency Ratio	211,90%

Source: Own work

Insurance Company X invests mainly in bonds, some of them bear a greater risk and that is why the company has to have a higher solvency ratio. The MCR for the year is 15.621. It is calculated following instructions prescribed by EIOPA (calculation not included in the thesis).

As prescribed by EU Regulation, every year Insurance Company X publishes the Solvency II Balance sheet. The items in the balance sheet are valued at their market value and some of the company's assets and liabilities are long-term. This occurrence causes the issue of

artificial volatility. The company holds a good portion of its assets until maturity and some of the liabilities are long-term due to the nature of its business. In order to mitigate this artificial volatility, Insurance Company X has opted for applying the Matching Adjustment. This would lead to lower capital requirements for the risk of short-term spread fluctuations and more own funds that can be invested in future projects and expansion. The company has applied and received regulatory approval to use the MA, meaning that it satisfies the prescribed conditions. For this purpose, the company is obliged to create a MA portfolio from its assets and liabilities. The assets and liabilities in the MA portfolio are considered eligible for using the Matching Adjustment and comply with the rules set by the Regulator. The MA portfolio consists of assets whose expected cash flows cover the Best estimate of Liabilities plus a small surplus. Expected cash flow of an asset is the cash flow of the asset adjusted for the probability of default of the asset.

Let's assume that the company has a portfolio of 5-year zero-coupon bonds in its assets. All bonds are of highest quality and have AAA rating according to Standard&Poor's nomenclature. It is estimated that the expected cash flows for the portfolio of bonds over the whole period is 100.000. This portfolio of assets is exactly matched by a portion of the long-term liabilities the company should meet. The BEL of these liabilities is exactly 100.000 as well. To analyze the effect the Matching Adjustment has on the solvency capital requirements we will assume that prices changed on the bond markets and the credit spreads have increased. The values of the bonds have decreased and the portfolio of assets and liabilities is not exactly matched anymore. The company must increase the value of the assets in the portfolio in order to meet its liabilities.

In the first scenario, the company has applied and has received approval to use the Matching adjustment. The assets and liabilities are exactly matched. The assets in the portfolio are held to maturity assets and the insurer will not be actively trading with them. The change of the credit spread doesn't affect these assets. We can ignore the decrease in prices and the solvency capital requirement should not increase as a consequence.

In the second scenario, the insurer is not using the Matching adjustment. If the credit spreads go up the value of the company's assets goes down. The portfolio is not exactly matched and the company will have to increase the solvency capital requirements. Spreads tend to move in the same direction in a stressed scenario and we make an assumption that spreads on all bonds increase. To calculate the capital charge for spread risk we needed the following elements:

-MV_i – the credit risk exposure i as determined by reference to market prices (exposure at default)

-$rating_i$- the external rating of credit exposure i

-$duration_i$-the duration of risk exposure i

In our case MV is 100.000, the rating is AAA and the duration is 10. We are using the calibrated function F proposed by EIOPA to calculate the capital charge for spread risk.

The capital charge is calculated as:

$$Capital\ charge = 100.000 \times 5 \times 1.3\%$$

The capital charge for spread risk for the portfolio is 6.500. We can clearly see that by using the MA the insurance company is able to put aside less value as SII reserves.

CONCLUSION

Implementing a new, more prudent regulative framework is a necessity in the insurance industry. The new framework has introduced a new set of rules in the insurance industry that promote comparability, transparency and competitiveness. Solvency II succeeds in recognizing all relevant risks insurers face in their everyday businesses. Regulators expect from insurance companies to hold additional capital on the side in the form of the SCR and MCR, as a guarantee that they will be able to meet their obligations in adversity. The capital requirements are calculated using a carefully designed formula on a yearly basis. Imperative in the calculations is the market risk, in particular the spread risk sub-module. Spread risk is the main source of capital requirements for debt instruments. Solvency II requires firms to use the mark-to market method for valuation of their assets. For that purpose, they use existing fair prices that can be observed on the relevant markets. Insurers usually hold long-term assets in order to match their long-term liabilities. These long-term assets are usually held to maturity and the insurers are not involved in active trading of their assets on the markets. Resulting from the use of the mark-to-market valuation approach, a phenomenon known as artificial volatility appears on the insurer's balance sheet. Insurers argue that they do not engage in buying and selling their assets actively and the changed prices should not affect their financial statements. As a response to this issue a package of measures was introduced, known as Omnibus II. One of the most commonly used measures is the Matching Adjustment. The Matching Adjustment is a measure of additional return on top of the risk-free-return on assets held to maturity. It protects firms from spread movements on the markets. Despite its careful design and the supposed benefits of the Omnibus measures, some argue that they do not provide the insurance sector with the desired effect. Experts often criticize the complexity and onerous documentation requirements for the approval of Matching Adjustment capital relief and doubt the effectiveness of the measures especially for smaller insurance companies. That is why a lot of critics define it as only a theoretical solution with limited use in practice.

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APPENDIX

Appendix 1: Povzetek (Summary in Slovene language)

V svoji magistrski nalogi sem raziskovala tveganje kreditnih pribitkov in načine, kako ga ublažiti. Uvedba nove, bolj previdne regulative v zavarovalniški industriji, je nujna. Solvency II je uvedla nov sklop pravil v zavarovalniški industriji, ki spodbujajo primerljivost, preglednost in konkurenčnost. Solventnost II prepozna vsa pomembna tveganja, s katerimi se zavarovalnice srečujejo v svojem vsakdanjem poslovanju. Regulatorji od zavarovalnic pričakujejo, da imajo na strani dodatni kapital v obliki SCR in MCR kot zagotovilo, da bodo v stiski, lahko izpolnile njihove obveznosti. Kapitalske zahteve se izračunajo po skrbno zasnovani formuli na letni ravni. Imperativ pri izračunih je tržno tveganje, zlasti podmodul tveganja kreditnih pribitkov. Tveganje kreditnih pribitkov je glavni vir kapitalskih zahtev za dolžniške instrumente. Solventnost II od podjetij zahteva, da za vrednotenje svojih sredstev uporabljajo metodo tržne ocene. V ta namen uporabljajo obstoječe cene, ki jih je mogoče opaziti na trgih. Zavarovalnice običajno hranijo dolgoročna sredstva, njih uskladijo s svojimi dolgoročnimi obveznostmi. Ta dolgoročna sredstva se držijo do zapadlosti in zavarovalnice niso vključene v aktivno trgovanje s svojimi sredstvi na trgih. Kot rezultat uporabe pristopa vrednotenja od tržne vrednosti se v bilanci stanja zavarovalnice pojavi pojav, znan kot umetna volatilnost. Zavarovalnice trdijo, da se ne ukvarjajo aktivno z nakupom in prodajo svojih sredstev in spremenjene cene ne bi smele vplivati na njihove računovodske izkaze. Kot odgovor na to vprašanje je bil uveden paket ukrepov, znan kot Omnibus II. Eden najpogosteje uporabljenih ukrepov je Uskladitvena Prilagoditev. Uskladitvena Prilagoditev je merilo dodatnega donosa poleg netvegane donosnosti sredstev v posesti do zapadlosti. Kljub skrbni zasnovi in domnevnim koristim ukrepov Omnibus nekateri trdijo, da zavarovalniškemu sektorju ne zagotavljajo želenega učinka. Strokovnjaki pogosto kritizirajo kompleksnost in dokumentacijske zahteve za odobritev kapitalske olajšave in dvomijo v učinkovitost ukrepov, zlasti za manjše zavarovalnice. Zato ga številni kritiki opredeljujejo le kot teoretično rešitev z omejeno uporabo v praksi.