Instituto Superior de Economia e Gestão

UNIVERSIDADE TÉCNICA DE LISBOA

DESDE 1911

MASTER IN

ACTUARIAL SCIENCE

MASTERS FINAL WORK

INTERNSHIP REPORT

CAPITAL CHARGES OF A LINE OF BUSINESS IN SOLVENCY II ENVIRONMENT

ANA RITA BATISTA MARTINS

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Abstract

The Solvency II regime came into force on 1 January 2016. Several rules are being implemented in the insurance sector to achieve the harmonization of procedures and techniques among undertakings, while developing a risk-based culture into insurance business activities and strategic decisions.

All undertakings must calculate the capital requirements according to the risks that they are exposed through the use of a standard formula that, as the name suggests, is the same to every insurance company in the market. However, this formula does not always reflect the true risk profile of insurance companies. An undertaking can prove that the standard formula is not adequately reflecting their risk exposure and therefore, calculate their own undertaking specific parameters, subject to supervisory approval.

During the first phase of implementation, insurer's main concern is to satisfy the regulatory requirements, but in a further phase, companies will focus in the optimization of their risk calculation, monitoring and analysis of their risk exposure to take the best management decisions.

The main goal of this work is to calculate the company specific volatility parameters and to study the impacts of their use in the required capital charges. To do so, it was applied the Quadratic Variance Model to Non Similar to Life Techniques Health premium and reserve risk of a health line of business.

Keywords: Solvency II, Risk Management, Standard formula, Undertaking Specific Parameters, Capital Charges

Resumo

O regime Solvência II entrou em vigor a 1 de janeiro de 2016. Várias regras estão a ser implementadas no sector dos seguros, com o intuito de alcançar a harmonização dos procedimentos e técnicas utilizadas pelas empresas, desenvolvendo ao mesmo tempo uma cultura baseada no risco.

Todas as empresas devem calcular requisitos de capital correspondente aos riscos a que estão expostas através da utilização da fórmula padrão que, como o nome sugere, é comum a todas as companhias de seguros no mercado. No entanto, esta fórmula nem sempre reflete o real perfil de risco das empresas. Uma empresa pode provar que a fórmula padrão não reflete adequadamente a sua exposição ao risco e, portanto, pode calcular os seus próprios parâmetros específicos, sujeitos a aprovação da entidade de supervisão.

Durante a primeira fase de implementação, a principal preocupação das seguradoras é satisfazer os requisitos regulamentares, mas numa fase mais avançada, as empresas irão concentrar-se na otimização da metodologia de cálculo de risco, monitorização e análise da sua exposição ao mesmo, de forma a tomar as melhores decisões de gestão de risco.

O objetivo principal deste trabalho é calcular os parâmetros de volatilidade específicos da empresa e estudar os impactos da sua utilização nas cargas de capital. Para o efeito, foi aplicado o modelo da Variância Quadrática ao sub-módulo de risco de prémios e de provisões de acidentes e doença não-semelhantes a técnicas de vida.

Palavras-chave: Solvência II, Gestão de Risco, Fórmula Padrão, Parâmetros Específicos da Empresa, Cargas de Capital

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Abbreviations

BE - Best Estimate

BSCR – Basic Solvency Capital Requirement

DG ECFIN – Directorate General for Economic and Financial Affairs

EC - European Commission

EIOPA - European Insurance and Occupational Pensions Authority

EU – European Union

IBNR - Incurred but not reported

MCR - Minimum Capital Requirement

NSLT – Non Similar to Life Techniques

ORSA - Own Risk and Solvency Assessment

SCR - Solvency Capital Requirement

SLT - Similar to Life Techniques

USP – Undertaking Specific Parameters

VaR – Value-at-Risk

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1. Introduction

This report is the result of a six-month internship in the Global Risk Department of Tranquilidade. During the internship, it was possible to learn more about the Solvency II regime and to put in practice some of the topics learned in the Masters of Actuarial Science.

The main goal of the internship was to study the capital charges associated to a specific line of business, by applying the new solvency regime (Solvency II), recently enforced in the insurance sector. This regime arose from the need to harmonize the insurance system and to implement a risk oriented management in the sector.

Solvency II will bring the harmonization of standards across European Union. It is expected to bring assets and liabilities into fair value basis and to set higher capital requirements to permit timely intervention.

The Delegated Regulation 2015/35, of October 2014, supplements the Directive 2009/138/EC, defining all the methodologies and procedures to be applied by the undertakings to calculate their risks and consequently their capital requirements. These calculations are based in a standard formula that is common to all. By this method, the calculus of capital requirement does not always reflect adequately the risk profile of the company, so an insurer can calculate their own specific parameters to reflect their true exposure to risks.

During the present work, it will be calculated the Undertaking Specific Parameters for Health Non Similar to Life Techniques for premium and reserve risk of the medical expenses line of business and calculated the capital charges for this risk submodule using

these parameters and the standard formula. Additionally, the Basic Solvency Capital Requirement and the Solvency Capital Requirement are determined by using the structure of risk calculation implemented in Tranquilidade.

The data used throughout this analysis was provided by the Actuarial Department, extracted from the software *SAS*, and applied for the calculation of Undertaking Specific Parameters. It was used the Quadratic Variance Model to premium and reserve risk as specified in the Delegated Regulation.

Insurance companies are also required to do their Own Risk and Solvency Assessment as a complement to their strategic decisions. Along that process, the undertaking should comprise the quantitative and qualitative sides of Solvency II and should define the features that are in the basis of capital requirements calculation and risk management.

2. Solvency II and Risk Management

2.1. Solvency II Regime

The insurance sector has experienced several modifications and improvements throughout the years. The most recent one was the implementation of a new solvency regime called Solvency II. It arose from the need to improve and develop certain aspects of the previous regime, mainly to implement an appropriate and consistent economic and risk-based approach at European level.

Under this risk-based economic approach, assets and liabilities would be valued as closely as possible to their true economic value, in a marked to market perspective, in order to implement a risk-based capital regulatory regime. (DG ECFIN, 2007)

On 10 October 2014, the European Commission (EC) adopted the Delegated Regulation (EU) 2015/35 that contains the implementing rules for Solvency II. This new regime came into force on the European insurance companies at 1 January 2016.

In order to ensure that firms are adequately capitalized with risk-based capital, the European Insurance and Occupational Pensions Authority (EIOPA) defined three pillars as a way of grouping Solvency II requirements. They are defined in the figure below:

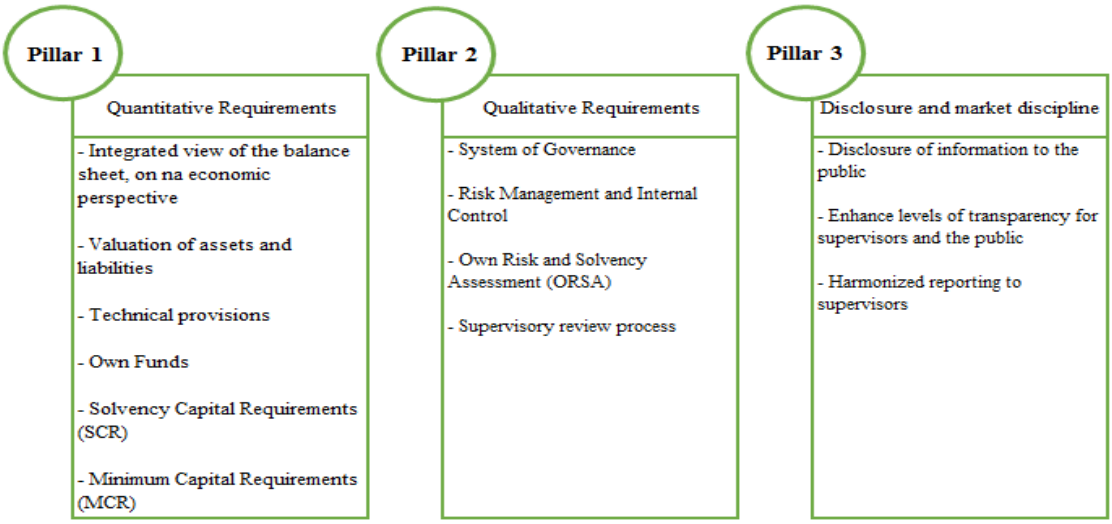

Figure 1 - Pillars of Solvency II (adapted from Solvency II (part I), Solvency Models. (ISEG), Hugo Borginho, October 2015)

This new regime is a deep and comprehensive supervisory process that intends to enhance the insurance sector all around Europe. This new regime has the following main objectives: strengthen the protection of policyholders and beneficiaries; promote a risk management culture in the entire sector; adjust capital requirements to the institution's risk profile; harmonize the reporting process at European level; increase transparency and consistency of information in the decision-making process; enhance the supervisory review process and increase market discipline.

2.2. Risk Management

With the implementation of Solvency II, EU principles on risk management and supervisory review are being developed. Once a risk based solvency framework is enforced, insurers have the opportunity to challenge themselves in identifying and measuring their own risks and analysing their solvency position. This new approach improves the firm’s understanding and management of its risk, increasing its resilience to adverse events. (Swain & Swallow, 2015)

The new regime also introduces a going concern approach in which insurers determinate their financial requirements under the assumption that they will continue to operate and write new businesses in the future. “This is consistent with the nature of risk management in Solvency II in which firms are required to identify and manage risks on a continuing and forward-looking basis”. (Swain & Swallow, 2015) The Own Risk and Solvency Assessment (ORSA) is a powerful tool to do that. “ORSA can be defined as the entirety of the processes and procedures employed to identify, assess, monitor, manage and report short and long term risks which a company faces or may face and determine the own funds necessary to cover the overall solvency needs at all times.” Additionally, “ORSA involves analysing a company’s financial position from a forward-looking perspective and securing its future solvency.”(Moormann, 2014)

Through a risk-orientated management, insurers must decide which risks to take on and how to manage them, as well as how to integrate their risk appetite on their decision-making and core business processes.

Risk appetite represents the willingness and the ability to take risk. It is a gradual cognitive process to be updated from time to time that helps managers to understand a company’s risk profile and to find an optimal balance between risk and return. “The term risk appetite encompasses (i) the quantitative and qualitative measurement of risk, (ii) the setting of limits and budgets around chosen risk measures, and (iii) the allocation of risk budget and limits across sources of return in the business”. (Aon Benfield, 2012)

The risk measurement process needs to cover all potential risks to which the insurance company is exposed. Under Solvency II, insurers have new ways to calculate their capital requirements, subject to supervisory approval, as we can see developed in more detail in chapter 3 of this report. The capital requirements can be calculated by

using: the standard formula defined at European level; the standard formula with the Undertakings Specific Parameters (USP); the partial internal model or the full internal model. These alternative ways of calculating capital charges intends to improve the institution's risk management allowing insurers to better reflect its true risk profile.

Solvency II could also have an impact on the price of insurance products. This new regime arises the need of a more risk adequate pricing. "Under the existing regulatory rules, insurers tend to price their products on two levels. First, products are priced according to economic value, with the use of actuarial techniques. Second, according to products' position on the market, prices are compared with its competitors'. Solvency II would mean a shift to more "risk-based" pricing." (DG ECFIN, 2007)

2.3. Solvency II and risk management at Tranquilidade

As said above, all insurance and reinsurance companies in Portugal started officially to implement the Solvency II regime in January 2016. It is a gradual process that implies several adjustments at the organizational and computational levels. It is essential to apply good risk management that involves a clear understanding of the risks of the business.

Advanced risk management models and stress testing may help with assessing the quantitative impact of risks, but understanding the company's core competence and the risks before taking them is far more important.

Tranquilidade is a well-known insurance company in Portugal. It has been in the market for more than a century and has been among the greatest insurance companies in the country.

The Solvency II framework has an impact in different areas of the company. Tranquilidade started to create the Global Risk Direction in 2007 divided in three different areas: modelation and risk management, where all quantitative calculation and risk models are executed; operational risk, where everything related with risks of people, processes and systems are analysed; and a technical accessory.

The company has been at the forefront of all quantitative impact exercises promoted in Europe, estimating the risk of the Group Companies in the new Solvency II environment and even suggesting changes to methodologies then presented.

Company has set policies in key areas such as Investment Management, Underwriting, Reinsurance and has been implementing the principles and procedures that are part of the Solvency II legislation such as the code of conduct, anti-fraud policy, the prudent manager and claims management.

3. Capital Charges

With the importance assumed by the insurance sector there is the need to ensure the stability and credibility of the various economic agents.

The protection of insurance policyholders is one of the main goals for the existence of Regulatory Capital Requirements.

Companies need to allocate capital to different risk types, business lines and business units. Capital should be employed to generate enough return for shareholders on a sustainable basis. The level of required return is determined by the level of risk taken. So, as said above, it is essential to identify, to model, to monitor and to manage risks, not only the ones directly related with the insurance sector, as underwriting risk, but also risks that the sector faces that are common to other sectors or financial institutions, such as Market Risk, Credit Risk and Operational Risk. All these risks should be considered in capital requirements once they influence the ability of companies to meet their commitments.

Under Solvency II, undertakings are allowed to calculate their capital requirements using new methods. It can be achieved by using: a standard formula; a standard formula with USPs; a partial internal model or a full internal model. These last three alternatives are subject to supervisory approval.

The standard formula is, by its nature and design, a standard calculation method, and therefore it may not be tailored to the individual risk profile of a particular company.

The figure below illustrates how these methods are set according to their appropriateness to risk profile.

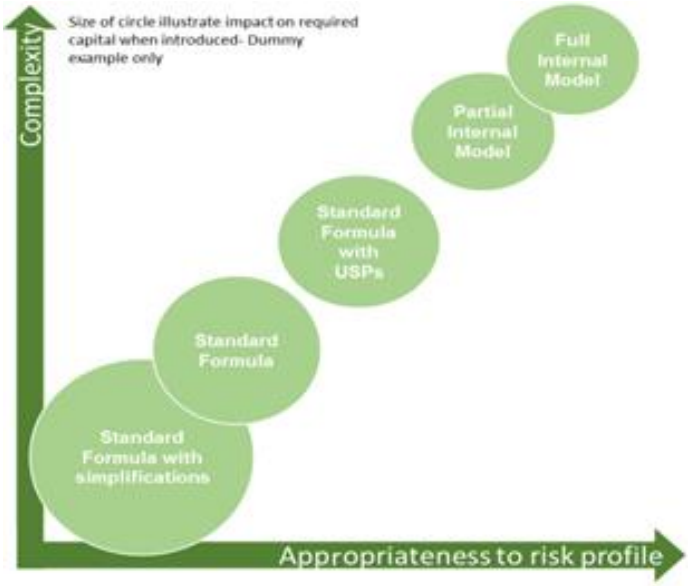

Figure 2 - Methods to calculate Capital Requirements (adapted from "Beyond Solvency 2: What are the challenges for the insurers after the entry in force of the new Directive?", Pierre Devolder, Xavier Maréchal, May 2015, Reacfin.

As Figure 2 suggests, there is an increase in terms of both risk-sensitivity and complexity for the calculation of SCR. In this report, it will be calculated the standard formula with Undertaking Specific Parameters.

3.1. Solvency II Balance sheet

Before dive deep in all the organization of risks, it is important to highlight some changes in terms of balance sheet under the new regime that have effectively a great impact in structuring assets, liabilities and own funds in a company. This topic is about Pillar 1 of Solvency II where all quantitative requirements are analysed and calculated. The main goal is to require companies to construct an integrated view of the balance sheet, on an economic perspective.

The new balance sheet construction is represented in the following figure:

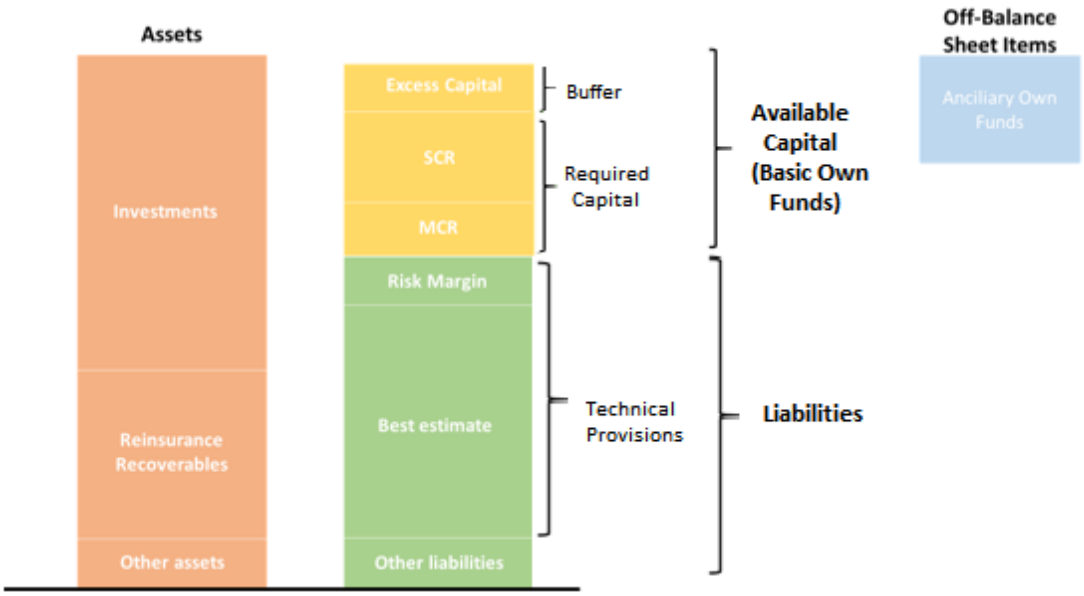

Figure 3 - Solvency II balance sheet (adapted from Solvency II (part I) from Solvency Models. (ISEG), Hugo Borginho, October 2015)

Analysing Figure 3 it is possible to verify that quantitative capital requirements are represented there. Assets are required to be valued at market value and liabilities measured in a consistent manner.

In the **assets side** it includes **investments** like government bonds, corporate bonds, shares, real estate (Dieckhoff , 2015), **reinsurance recoverable (**that is the portion of an insurance company's losses from claims that can be recovered from reinsurance companies. It includes the amount owed to the insurer by the reinsurer for claims and claims-related expenses, the amount owed for estimated losses that have occurred and had been reported, the amount of Incurred But Not Reported (IBNR) losses, and the amount of unearned premiums paid to the reinsurer) and **other assets**. An insurer should hold sufficient assets to pay expected insurance benefits and bear unexpected losses.

Regarding the **liabilities side**, they cover **technical provisions** and **other liabilities. Technical provisions** measure the amount necessary to fulfil all the liabilities assumed in the insurance policies. It is the sum of the best estimate and the risk margin.

Best Estimate (BE) is the expected value of insurance liabilities until run-off and it is calculated through the equation:

$$Best\ estimate = E\left(\sum_{i} \frac{Cash\ Flow_i}{(1 + r_i)^i}\right)$$

Where r_i is the risk-free interest rate for maturity i.

This calculation implies all cash flows until maturity i to be projected and discounted by a risk-free interest rate.

The projected cash flows for best estimate of premiums include: costs of future claims, expenses (like administrative expenses, investment management expenses, claims management expenses, acquisition expenses, including commissions, fixed costs) and premiums receivable in the future; the projected cash flows for best estimate of reserves includes: costs for claims incurred, expenses and repayments arising from salvage and subrogation.

Afterwards, the expected value of the discounted cash flows gives the value of the BE that is, as the name suggests, an estimation for the company provisions. “Technical provisions should only incorporate cash flows from existing contracts (but not from future contracts)”.

Relatively to risk margin, that is the cost of providing amount of own funds equal to the SCR needed to support the run-off of (re)insurance obligations. It also “increases

the technical provisions from the best estimate up to an amount equivalent to a theoretical level needed to transfer obligations to another insurer" (Zaremba, May 2012). The value of risk margin is calculated through the formula:

$$Risk\ Margin\ = \sum_{t\geq 0} \frac{CoC\ .\ SCR_t}{(1+r_{t+1})^{t+1}}$$

Where:

- *CoC* = Cost-of-Capital rate and it is equal to 6%;
- SCR_t = Solvency Capital Requirements at time *t*;
- r_{t+1} = risk-free interest rate for *t+1* year's maturity.

For risk margin calculation, it is necessary to project the SCR for future years once they are unknown. There are several methods to do that. It can be through the full calculation of risks and items that constitute SCR or through the use of simplifications, that will be the case for this report. The simplification is called proportional approach. This method consists in running-off SCR in proportion to the BE through the following equation:

$$SCR_t = BE_t \times \left(\frac{SCR_0}{BE_0}\right) \quad t = 1,2,3,\dots$$

There is a particularity in this method. The SCR_0 is not the full SCR, meaning that it does not include market risk. Conceptually, the risk margin is calculated through the perspective of a third party. It is the additional amount required by that party to accept the transfer of the insurance portfolio. One of the assumptions underlying is that the one

who accepts the assets amount, eliminates the market risks to its extent (once it is impossible to completely eliminate the market risk, it is assumed to be equal to zero when calculating the risk margin, by simplification). Thus, the risk margin calculation just includes underwriting risk, credit risk and operational risk, that will be explained deeply further in this chapter.

Through this method, the future Solvency Capital Requirements, SCR_t, are projected until run-off, starting from the values of best estimate and SCR at time 0 that are known values.

Finally, there is the **available capital**. An insurance company needs capital in order to be able to take risks from its policyholders. The appropriate amount of capital is determined according to some solvency regulatory rules. A solvency system distinguishes between several levels of capital: the available capital ("risk bearing capital") and the capital required to meet the risks ("target capital"). The available capital determines the level of capital that the insurer sees as necessary to achieve its business strategy and to maintain the confidence of clients and investors. The capital required to meet the risks ("target capital") corresponds to the minimum level of capital that the supervisor demands from the insurance company in order to ensure the protection of policyholders and beneficiaries.

The Basic Own Funds result from the difference between market value of assets and the sum of risk margin, best estimate liabilities (amount of technical provisions) and other liabilities not eligible to own funds. They are the financial resources available to the insurer to create new business and to serve as a buffer to absorb unexpected losses.

$$Basic\ Own\ Funds\ =\ Market\ value\ of\ assets\ -Other\ Liabilities\ -$$
$$Consistent\ value\ of\ technical\ provisions$$

Own funds are separated between Basic Own Funds, that are items that belong to the balance sheet and ancillary own funds that are off-balance sheet items.

The **required capital** is a risk-based capital. It is the capital amount required by supervisors. Under Solvency II there is a Solvency Capital Requirement (SCR), its calculation is based on 99,5% confidence interval, and a Minimum Capital Requirement (MCR) whose calculation is based on 85% confidence level. Insurers need legally to hold own funds to cover the SCR and the MCR, they should absorb losses and be of sufficient quality (permanently available, subordinated, sufficient duration) and should be based on market - consistent valuation of assets and liabilities.

The **buffer** is an extra amount that is not mandatory, and provides insight in credit standing above the BBB level. This item is different for each insurance company and it is related with the business strategy of the company and its risk appetite.

There are two types of capital: the economic capital and the regulatory or rating agency capital. The economic capital is based on calculations which are specific to the company's risks, while regulatory or rating agency capital are based on industry averages, which may or may not be suitable to any particular company.

After identifying the several items and aspects of Solvency II balance sheet it is interesting to catch up the details behind the calculation of capital requirements.

3.2. Designing capital requirements

3.2.1. Features

There are several aspects to be taken into account when designing capital requirements. Target, protection level and time horizon, risk measures, aggregation method and objective are the fundamental features that need to be decided and studied in order to get good management decisions. These are tools to measure the risk profile of a company and its choice depends on the strategic goals of each undertaking and help to define its risk appetite.

In the following topics, these features will be described in more detail.

a) Target

There are two types of targets: the going concern basis or the run-off basis. These two goals differ from each other once they require different needs of capital. A run-off situation entails an absolute minimum requirement for liquidation costs and assumes a closed portfolio. It is "a method of considering the financial situation assuming that no new business will be written, but that the company will continue to operate with in-force business until the end of the term set by the policy conditions" (Consultatif, March 2007). On the other hand, a going-concern is "a method of considering the financial situation assuming that an entity will continue to operate" (Consultatif, March 2007). It considers the possibility of new business.

The economic capital assumes a going concern approach and the regulatory capital depends on the assumed action in case of failure of an insurer (transfer of the whole portfolio to another insurer or run-off of liabilities by the original insurer).

b) Protection level and time horizon

Policyholder's protection is one of the main goals of Solvency II regime. This is directly related with the time horizon used. For Solvency II regulatory terms, a time horizon of one-year is used to determine regulatory capital. However, it is important to note that different time horizons may be appropriate for different risks as they develop over time. In the measurement of internal required economic capital, different time horizons can be used. According to a study (Lowe, Morin, & Swallow, 2011) where a survey was applied, the following time horizons are among the best practices in insurance sector: one-year risk horizon and run-off risk horizon.

Risks can look very different over time. A risk that can dominate the risk landscape over a short time horizon can be more benign over a longer time horizon. The problem with the one-year view is that it misses latent, developing risks that build over time to affect capital. Another possible alternative is to adopt the ORSA time horizon that should correspond to the company's business planning horizon. It is common to consider between 3-5 years.

c) Risk measures

Risk measures are an important tool in order to quantify a loss. There are ways to quantify a loss by using a risk measure. The following measures are the most used and well known: Value-at-Risk (VaR), Tail Value-at-Risk, Conditional Tail Expectation and Expected Shortfall.

VaR is the most used measure for regulatory purposes. As said above, EIOPA (2014) defines the SCR of an insurance or reinsurance company as the VaR of the Basic Own Funds subject to a confidence level of 99,5% over a one-year period.

d) Aggregation method

The aggregation methods can contemplate several possibilities: the sum, the weighted sum, the correlation matrix (matrices used to describe the dependence between pairs of random variables), copulas (an approach by which the marginal distributions of a set of variables are combined into a single multivariate distribution), among others.

e) Objective

The objective can be defined by:

- **A value -** for which the metric is the present value of future profits and has the goal of measuring the value of a company during a defined projection period and allows the company to analyse the value of the company in function of the risks considered;
- **The solvency** – This allows the company to protect itself against risks and to fulfil regulation goals and is expressed by the solvency ratio;
- **Profitability** – allow the shareholders to monitor the impacts of risk in the company profitability.
- **Commercial performance** – measured by a resilience tax or a tax of re-evaluation of the tariff in N+1. It is a performance indicator with the basis made by choice of the company, which reflects the clients value.

3.2.2. Risks under Solvency II

The standard formula is a generic way of calculating the SCR. According to the underlying assumptions of the standard formula from EIOPA for the calculation of the SCR, "the SCR standard formula follows a modular approach where the overall risk which the insurance or reinsurance undertaking is exposed to, is divided into sub-risks and in some risk modules also into sub-sub risks. For each sub-risk (or sub-sub risk), a capital requirement is determined. The capital requirement on sub-risk or sub-sub risk level is aggregated with the use of correlation matrices in order to derive the capital requirement for the overall risk" (EIOPA, July 2014).

The structure of SCR following the standard formula, is presented in the figure below:

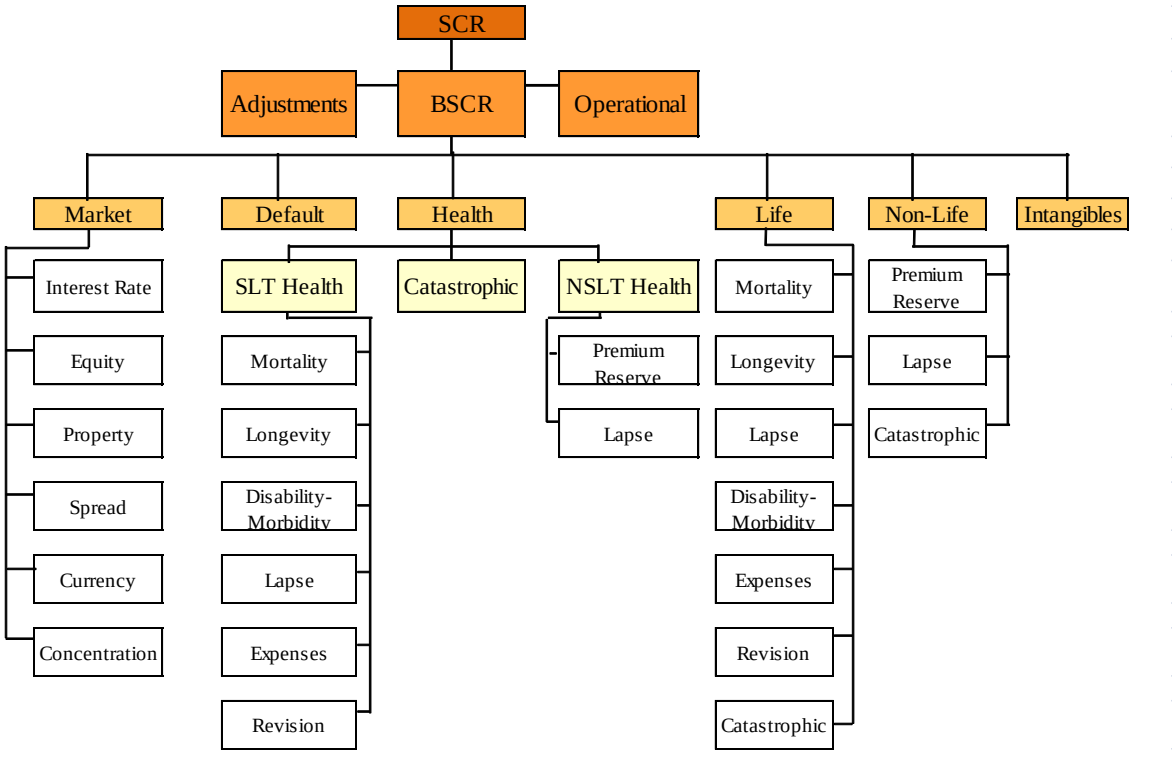

Figure 4 - SCR Structure under Solvency II (adapted from "The underlying assumptions in the standard formula for the Solvency Capital Requirement calculation", EIOPA - 14-322, 25 July 2014)

According to EIOPA guidelines, "The SCR should correspond to the Value-at-Risk of the Basic Own Funds of an insurance or reinsurance undertaking subject to a confidence level of 99,5% over a one-year period." In order "to ensure that the overall SCR is calibrated using the Value-at-Risk of the Basic Own Funds of an undertaking subject to a confidence level of 99,5% over a one-year period this calibration objective applies to each individual risk module in a consistent manner" (EIOPA, July 2014).

The SCR is the result of the standard formula calculation that is composed by:

$$SCR = BSCR + Adjustments + SCR\ Operational \qquad \textbf{(3.2.2.1)}$$

As set in the 2009/138/CE Directive of European Parliament and the Council, the Basic Solvency Capital Requirement (BSCR) is divided in six risk modules: Market, Health, Default, Life, Non-Life and Intangibles and it is calculated through:

$$BSCR = \sqrt{\sum_{i,j} Corr_{i,j} . SCR_i . SCR_j} \qquad (\mathbf{3.2.3.2})$$

Where:

- SCR_i = the risk module *i*
- SCR_j = the risk module *j*
- $\sum$ = the sum of all possible combinations between *i* and *j*.
- $Corr_{i,j}$ = the correlation coefficient for the BSCR of *i* and *j* modules

The SCR_{market}, $SCR_{default}$, SCR_{life}, $SCR_{non\text{-}life}$ and SCR_{Health} substitute the SCR_i and SCR_j in the formula above. The correlation matrix for the BSCR is shown in Annex I. (EIOPA, 2014)

Under the structure of Solvency II the following risks are essential to define the risk profile of a company:

- **Underwriting risks,** as the non-life, life and health underwriting risks;
- **Market risk**;
- **Credit risk**;
- **Liquidity risk;**
- **Operational risk**.

In the scope of underwriting risks only the non-life and the health underwriting risks will be discussed in this report once Tranquilidade is a non-life insurance company. The underwriting risks are one of the principal sources of risk of insurance companies once it is related with the insurance sector itself. They are associated to the management of the insurance policies, as underwriting, pricing, claims handling, provisioning, among others.

The **non-life underwriting risk module** is constituted of the following sub-modules: the non-life premium and reserve risk sub-module; the non-life catastrophe risk sub-module; the non-life lapse risk sub-module.

The **health underwriting risk sub-module** covers the Health Non-Similar to Life Techniques (the NSLT health premium and reserve risk and the NSLT health lapse risk), the Health Similar to Life Techniques (mortality risk, longevity risk, disability- morbidity risk, lapse risk, expenses risks and revision risk) and the catastrophic risk.

The **market risk** is related with fluctuations on the level or volatility of the market prices of assets and other relevant financial indicators. The exposure to this risk is measured by the impact of movements in the level of financial variables as interest rates, stock prices, and exchange rates in investments. This risk module includes the following sub-risks:

- **Interest rate risk** reflects the impact of an up or down shock in interest rates on the level of own funds;
- **Equity risk** reflects the exposure of a company to equity, like participations;
- **Currency risk** indicates the exposure of a company to different currencies;
- **Property risk** reflects the exposure to investments in property;
- **Spread risk** indicates the exposure to financial debt instruments by rating and duration;
- **Concentration risk** refers to all risk exposures with a loss potential, which is large enough to threaten the solvency or the financial position of the undertakings. This specific risk is strongly related to the financial sector, and market forces. The investment decisions of a company are heavily related to this risk.

According to the Directive 2009/138/CE, **credit risk** should reflect possible losses due to unexpected default of the counterparties. It includes risk-mitigation contracts, as reinsurance arrangements, securitizations and derivatives, receivables from intermediaries, and other credit exposures that are not covered in the spread risk sub-module.

The **liquidity risk** is one of the risks that are not explicitly formulated in the standard formula. It is considered more suitable to cover such risk by an explicit liquidity risk management policy within the overall risk management system. This risk represents the inability of a company to realize investments and other assets in order to settle their financial obligations.

Finally, the **operational risk** is the risk of loss arising from inadequate or failed internal processes, from people and systems or from external events.

In summary, the SCR is a bottom-up measure where risk calculations are made at risk submodules level, then at risk modules level until it gets to the top of SCR structure. It is calculated risk by risk and determined the loss at the proper percentile. Thus, many would use the BSCR formula as noted above, where module or sub-module VaR is calculated, and then aggregate using correlation coefficients.

3.3. Methods of calculating capital charges

As explained above, Solvency II has in its basis the calculation of capital requirements through the use of a standard formula. This standard method of calculating capital charges may not reflect the true risk profile of a specific company so there is the possibility, under supervisory approval, to compute them through the use of USP or internal models (partial or total) that better reflect each undertaking case.

For the purpose of this report, the standard formula and USP for NSLT health premium and reserve risk will be explained in detail.

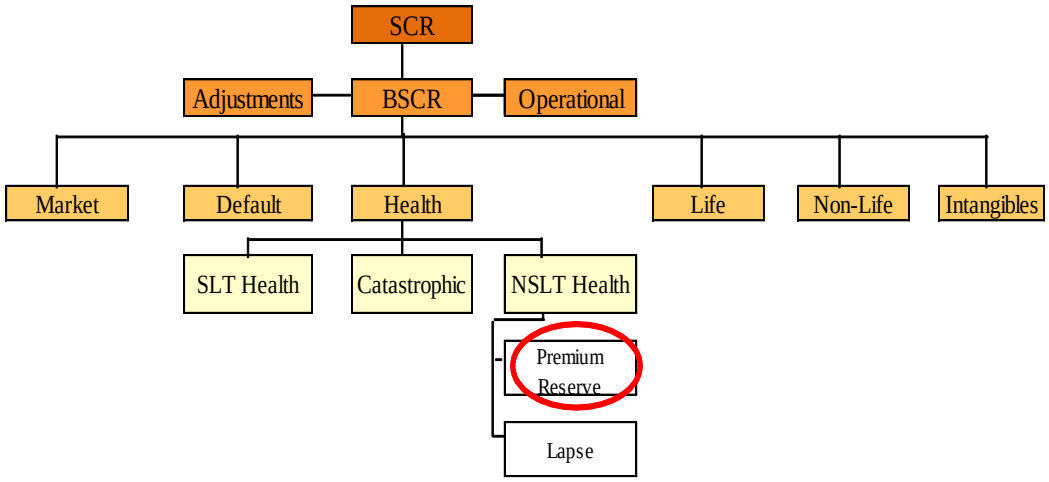

Figure 5 - SCR Structure under Solvency II – Risk modules and Health Risk submodules (adapted from "The underlying assumptions in the standard formula for the Solvency Capital Requirement calculation", EIOPA - 14-322, 25 July 2014)

3.3.1. Standard formula for NSLT health underwriting risk – premium and reserve risk

The specific module of Health Underwriting risk is composed by three sub-modules: the NSLT health risk sub-module; the catastrophe risk sub-module and the Health SLT risk sub-module.

In order to calculate the capital requirements for the Health underwriting risk, the Delegated Regulation (EU) 2015/35 defined the following formula:

$$SCR_{Health} = \sqrt{\sum_{i,j} CorrH_{(i,j)}.SCR_i.SCR_j} \qquad (\mathbf{3.2.2.3})$$

Where the correlation parameter for health underwriting risk for sub-modules *i* and *j*, $CorrH_{(i,j)}$, is substituted by the respective value of the correlation matrix of annex II and the SCR_i and SCR_j are the capital requirements for risk sub-module *i* and *j*, respectively.

The capital requirement for the specific sub-module of NSLT health is composed, according to the Delegated Regulation (EU) 2015/35, by the SCR premium and reserve risk and the SCR lapse risk. And for its calculation:

$$SCR_{NSLTh} = \sqrt{SCR^2_{NSLTh,prem\,res} + SCR^2_{NSLTh,lapse}} \qquad (\mathbf{3.2.2.4})$$

For the scope of this report, the particular case of NSLT health premium and reserve risk sub-module will be specified, as this specific risk sub-module will have an important role in further analysis.

In order to calculate the capital charge for that risk sub-module under the standard formula, the following formula is used, as stated in the Delegated Acts:

$$SCR_{(NSLTh,prem\,res)} = 3\,.\,\sigma_{NSLTh}\,.\,V_{NSLTh} \qquad (\mathbf{3.2.2.5})$$

The design of the formula for the combined premium and reserve risk results of an approximation to quantile 99,5% of a lognormal distribution with standard deviation, σ_{NSLTh}. The volume measure for health premium and reserve risk, V_{NSLTh}, is calculated by using the equation:

$$V_{NSLTh} = \sum_s V_{(prem,s)} + \sum_s V_{(res,s)} \qquad (\mathbf{3.2.2.6})$$

The standard deviation for health premium and reserve risk, σ_{NSLTh}, is calculated through:

$$\sigma_{NSLTh} = \frac{1}{V_{NSLTh}} \cdot \sqrt{\sum_{s,t} CorrHS_{(s,t)} . \sigma_s . V_s . \sigma_t . V_t} \qquad (\mathbf{3.2.2.7})$$

Where:

- $CorrHS_{(s,t)}$ = correlation parameter presented in annex III
- σ_s and σ_t = standard deviations of segment *s* and *t*
- V_s and V_t = volume measure for segment *s* and *t*

In order to calculate the standard deviation for a particular segment *s,* σ_s, the Delegated Acts appoint the following formula:

$$\sigma_s = \frac{\sqrt{\sigma^2_{(prem,s)} . V^2_{(prem,s)} + \sigma_{(prem,s)} . V_{(prem,s)} . \sigma_{(res,s)} . V_{(res,s)} + \sigma^2_{(res,s)} . V^2_{(res,s)}}}{V_{(prem,s)} + V_{(res,s)}} \qquad (\mathbf{3.2.2.8})$$

Where:

- $\sigma_{(prem,s)}$ = the standard deviation for premium risk of segment *s*. This parameter is determined by multiplying the standard deviation for NSLT gross premium risk of the segment by the adjustment factor for non-proportional reinsurance. For NSLT health segments set out in Annex IV the adjustment factor for non-proportional reinsurance shall be equal to 100 %.
- $\sigma_{(res,s)}$ = the standard deviation for reserve risk of segment *s*. This parameter is obtained directly through the Annex IV.
- $V_{(prem,s)}$ = the volume measure for premium risk of segment *s*. This amount is obtained by applying the equation below:

$$V_{(prem,s)} = max[P_s\,;\, P_{(last,s)}] + FP_{(existing,s)} + FP_{(future,s)} \qquad (\mathbf{3.2.2.9})$$

In formula above, the parameter P_s is an estimate of the premiums to be earned by the undertaking in the segment *s* during the following 12 months and the $P_{(last,s)}$ refers to premiums earned by undertaking in the segment s during the last 12 months.

Additionally, $FP_{(existing,s)}$ stands for the expected present value of premiums to be earned in the segment *s* after the following 12 months for existing contracts. The variable $FP_{(future,s)}$ represents the expected present value of premiums to be earned in the segment *s* for contracts where the initial recognition date falls in the following 12 months but excluding the premiums to be earned during the 12 months after the initial recognition date.

The variable $V_{(res,s)}$ is the volume measure for reserve risk of segment *s*. This volume measure is equal to the best estimate of the provisions for claims outstanding for the segment, after deduction of the amounts recoverable from reinsurance contracts and special purpose entities.

In order to calculate the volume measure for health premium and reserve risk of a particular segment *s*, V_s, we have:

$$V_S = \left(V_{(prem,s)} + V_{(res,s)}\right).(0{,}75 + 0{,}25\,.\,DIV_s) \qquad (\mathbf{3.2.2.10})$$

Where:

- *DIVs* = default factor for geographical diversification of a particular segment *s*. This factor calculation is stated in Annex V of this report.

3.3.2. Undertaking-Specific Parameters for NSLT health premium and reserve risk

Under Solvency II, undertakings are allowed to use undertaking-specific parameters, subject to prior supervision approval. According to the Directive 2009/138/CE, the aim of undertaking specific parameters is to achieve a better estimation of the volatility (risk) that the undertakings bears. Where it is inappropriate to calculate the SCR in accordance with the standard formula, because it is not adequate to the risk profile of the insurer, the undertakings can replace the standardized parameters by a subset of specific parameters, based on the previously determined risk profile, subject to supervisory approval.

As stated in the Directive 2009/138/CE, a subset of standard parameters for some risk modules could be replaced by undertaking-specific parameters. These parameters are the following:

- Standard deviation for premium risk, $\sigma_{(prem,s)}$, and standard deviation for reserve risk, $\sigma_{(res,LoB)}$ for non-life premium and reserve risk sub-module;
- **Standard deviation for premium risk, $\sigma_{(prem,LoB)}$, and standard deviation for reserve risk, $\sigma_{(res,LoB)}$ for NSLT health premium and reserve risk sub-module;**
- Standard parameter of revision shock in the SLT health Revision risk;
- Standard parameter of revision shock in the Life Revision risk.

For all other parameters, undertakings should use the values of standard formula parameters.

Undertakings should explain the reasons why the use of alternative methods seems to be more appropriate than the use of standardized ones. They have also to guarantee that USP are not being used to "cherry-pick"[1] the areas which give the lowest SCR.

For the purpose of this report, we will focus on the methods of estimating undertaking-specific standard deviations for Health NLST premium and reserve risk of a particular line of business.

The European Commission (EC) and the Parliament stated in the Delegated Regulation of 10 October 2014 the appropriate steps and methods that undertakings should use to calculate the USPs. These methods will be subject of analysis along this chapter and put into practice.

In the NSLT health premium and reserve risk sub-module, the sub-set of standard parameters that may be replaced by USP are the following:

- Standard deviation for NSLT health premium risk
- **Standard deviation for NSLT health gross premium risk**
- Adjustment factor for non-proportional reinsurance
- **Standard deviation for NSLT health reserve risk**

The standard parameters to be replaced in this report are the **standard deviation for NSLT health gross premium risk and the standard deviation for NSLT health reserve risk** whose formulae are stated below.

[1] "To choose in a highly selective manner; select only the best or most suitable of" (Publishing, 2013) .

a) Premium Risk

In order to estimate the volatility parameter for premium risk, the Delegated Regulation (EU) 2015/135 specifies a particular model that is known as Quadratic Variance Model and has in its basis the estimation by maximum likelihood.

This model consists in specifying a lognormal model to the quadratic variance and its resolution is performed using the maximum likelihood method. Under this method, it is defined a variable y_t that represents the aggregated losses due to premium risk, following a lognormal distribution. The variance of this variable is proportional to the square of the premiums earned, denoted as a variable x_t.

In the scope of this method, there are some assumptions that data must satisfy in order to be adequate for application:

A1) The expected aggregated losses are linear proportional in premiums earned;

A2) The variance of aggregated losses is quadratic in premiums earned in a particular accident year;

A3) The aggregated losses follow a lognormal distribution and the maximum likelihood estimation is applicable.

Through this model, the USP for NSLT health gross premium risk, $\sigma_{(prem,s,USP)}$, is calculated by applying the formula:

$$\sigma_{(prem,s,USP)} = c.\hat{\sigma}_{(\hat{\delta},\hat{\gamma})}.\sqrt{\frac{T+1}{T-1}} + (1-c).\sigma_{(prem,s)} \qquad (\mathbf{3.2.2.11})$$

A credibility mechanism should be applied when calculating $\sigma_{(prem,s,USP)}$ since the estimators used in the standardised methods include a significant estimation error. Thus, it is used a credibility factor, denoted by *c*, set out in Annex VI.

In the equation 3.2.2.11, *T* denotes the latest accident year for which data are available and $\sigma_{(prem,s)}$ stands for the standard parameter set out in Annex IV. The estimate $\hat{\sigma}_{(\hat{\delta},\hat{\gamma})}$ is the standard deviation function set out by the equation:

$$\hat{\sigma}_{(\hat{\delta},\hat{\gamma})} = exp\left(\hat{\gamma} + \frac{\frac{1}{2}.T + \sum_{t=1}^{T} \pi_{t(\hat{\delta},\hat{\gamma})}.\ln\left(\frac{y_t}{x_t}\right)}{\sum_{t=1}^{T} \pi_{t(\hat{\delta},\hat{\gamma})}}\right) \qquad (\mathbf{3.2.2.12})$$

Here, y_t represents the aggregated losses and x_t the premiums earned in the segment *s*, in a particular accident year *t*. For $\pi_{t(\hat{\delta},\hat{\gamma})}$, it comes:

$$\pi_{t(\hat{\delta},\hat{\gamma})} = \frac{1}{\ln\left(1+\left((1-\hat{\delta}).\frac{\overline{x}}{x_t}+\hat{\delta}\right).e^{2.\hat{\gamma}}\right)} \qquad (\mathbf{3.2.2.13})$$

Where $\overline{x}$ denotes the following amount:

$$\overline{x} = \frac{1}{T}.\sum_{t=1}^{T} x_t \qquad (\mathbf{3.2.2.14})$$

The logarithmic variation coefficient, $\hat{\gamma}$, and the mixing parameter, $\hat{\delta}$, are got by minimizing the following function:

$$\sum_{t=1}^{T} \pi_{t(\hat{\delta},\hat{\gamma})} \cdot \left(\ln\left(\frac{y_t}{x_t}\right) + \frac{1}{2\,.\,\pi_{t(\hat{\delta},\hat{\gamma})}} + \hat{\gamma} - \ln\left(\hat{\sigma}_{(\hat{\delta},\hat{\gamma})}\right) \right)^2 - \sum_{t=1}^{T} \ln\left(\pi_{t(\hat{\delta},\hat{\gamma})}\right) \quad (\mathbf{3.2.2.15})$$

Where, $0 < \hat{\delta} < 1$

b) Reserve Risk – Method 1

For the calculation of the undertaking-specific standard deviation for health reserve risk, the Delegated Regulation (EU) 2015/135 states two alternative methods: method 1, also known as the Quadratic Variance Model in which the premium risk methodology is applied in an analogous way to reserve risk, and method 2 denoted by Merz-Wüthrich Model, based on run-off triangle accident year data. For the scope of this report, only method 1 for reserve risk was applied.

Method 1 is similar to the previous method presented for the standard deviation of premium risk. It follows the same main formulas but applying the for the reserve risk.

Under this method, it is defined a variable y_t that represents the aggregate losses due to the reserve risk. This variable follows a lognormal distribution and its variance is proportional to the square of the BE of claims provision, denoted by x_t.

In order to get the undertaking-specific standard deviation for health reserve risk, $\sigma_{(res,s,USP)}$:

$$\sigma_{(res,s,USP)} = c.\hat{\sigma}_{(\hat{\delta},\hat{\gamma})}.\sqrt{\frac{T+1}{T-1}} + (1-c).\sigma_{(res,s)} \qquad (\mathbf{3.2.2.16})$$

Equation 3.2.2.16 for calculation of $\sigma_{(res,s,USP)}$ follows the same purpose as for obtaining $\sigma_{(prem,s,USP)}$ in terms of credibility. In the formula, *c* and *T* stands for the credibility factor and the latest accident year for which data are available, respectively, and $\sigma_{(res,s)}$ denotes the standard parameter for reserve risk. The $\hat{\sigma}_{(\hat{\delta},\hat{\gamma})}$ is an estimator calculated through:

$$\hat{\sigma}_{(\hat{\delta},\hat{\gamma})} = exp\left(\hat{\gamma} + \frac{\frac{1}{2}.T + \sum_{t=1}^{T} \pi_{t(\hat{\delta},\hat{\gamma})}.\ln\left(\frac{y_t}{x_t}\right)}{\sum_{t=1}^{T} \pi_{t(\hat{\delta},\hat{\gamma})}}\right) \qquad (\mathbf{3.2.2.17})$$

And:

$$\pi_{t(\hat{\delta},\hat{\gamma})} = \frac{1}{\ln\left(1+\left((1-\hat{\delta}).\frac{\overline{x}}{x_t}+\hat{\delta}\right).e^{2.\hat{\gamma}}\right)} \qquad (\mathbf{3.2.2.18})$$

In the formulas above:

- y_t stands for the sum of the best estimate provision at the end of the financial year for claims that were outstanding in segment *s* at the beginning of the financial year and the payments made during the financial year for claims that were outstanding in segment *s* at the beginning of the financial year;
- x_t is the best estimate of the provision for claims outstanding in segment *s* at the beginning of the financial year.

The logarithmic variation coefficient, $\hat{\gamma}$, and the mixing parameter, $\hat{\delta}$, are got by minimizing the same function stated in premium risk. In this case, data has also to fulfil some assumptions. They are:

A1) y_t is linear proportional in the best estimate of the provision for claims outstanding

A2) The variance of y_t is quadratic in the provision for claims

A3) y_t follows a lognormal distribution

A4) Maximum likelihood estimation is appropriate

4. ORSA – brief introduction

ORSA denotes for Own Risk and Solvency Assessment. As the name suggests, it is the undertaking self-evaluation of the risks that it is exposed to and its solvency position. It should reflect the undertakings global solvency needs taking into account its risk profile and the strategic limits of risk appetite approved by the company. It connects the quantitative and qualitative dimensions of Solvency II. This assessment should not be used to calculate capital requirements. It should be used as integrant part of the business strategy and should help in the decision process of the company.

The ORSA should include the extent to which the company's risk profile differs from assumptions underlying the SCR, calculated using the standard formula, or partial or full internal model approved by the company.

The company must therefore assess whether the risk profile deviates from the assumptions underlying the calculation of the SCR presented in Directive of Solvency II and, if so, whether the deviation is significant.

The ORSA should be done at least annually, however after any significant change in company risk profile, it must be performed immediately. It is a medium and long-term perspective of the global solvency needs of the company and a prospective analysis of the fulfilment of the regulatory requirements, including potential changes in the risk profile of the company.

Additionally, in the cases that the company concludes that the standard formula is not appropriately reflecting its risk profile, the company can calculate its own USPs, subject to supervisory approval. This should be reflected on the company’s ORSA.

The features presented in chapters above are an important integrated tool of ORSA. Defining the features to be used in the construction of ORSA allows the company to plan its business strategy and go beyond the regulatory requirements.

Table 1 specifies the different goals of features chosen for regulation proposes and used in pillar I or in the ORSA for strategic purposes:

Table 1 - Pillar 1 features versus ORSA features. (adapted from Workshop Solvency II, "ORSA, Os Fatores Chave de uma Implementação Bem-Sucedida/Medida de desvio do perfil de risco", April 2016, APS)

	Pilar 1	**ORSA**
Objective	Value	Value
Time Horizon	1 year	3, 5 or more years
Confidence Level	99,5%	Vary in function of the strategic goals of the company
Risk measure	Value at risk	Other possible risk measures like Tail-VaR, Conditional Tail Expectation, Expected Shortfall
Target	Going-concern basis	Run-off basis
Aggregation method	Correlation matrix between risks	Correlation matrix between risks

5. Practical application

The main purpose of this report is to study the capital charges of a line of business under the Solvency II environment.

Some questions should be arisen in order to achieve this purpose: What is the target, time horizon, the protection level and risk measure to be considered? The standard formula catches the risks that the undertaking is effectively exposed to? If not, what is the way to get closer to it?

In order to answer those questions, the theoretical concepts introduced and explained so far will be applied in practice and subject to analysis.

It will be estimated the undertaking-specific parameter for premium and reserve risk for the medical expenses line of business. According to Delegated Regulation of 10 October 2014 this line of business encloses "medical expenses insurance obligations where the underlying business is not pursued on technical basis similar to that of life insurance, other than obligations included in the line of business worker's compensation insurance and proportional reinsurance". In practice, we get it by the sum of individual and group medical expenses that are considered part of the same homogeneous risk group.

Afterwards, we will compare the standard parameters with the calculated USP and also the differences in the capital charges calculated through the standard formula or through the use of USP.

The tool used in this chapter was *Microsoft Office Excel* for the premium risk and for reserve risk method 1.

All the calculations applied in this report will be based on Pillar 1 features described above. It will be used the Value-at-Risk with a 99,5% confidence for a one- year time horizon as adopted in Delegated Acts for the calculation of the standard formula.

Additionally, it will be used *pseudo data* for all the calculations and analysis made in this report. Data was provided by the company but subject to transformations in order to ensure confidentiality.

5.1. USP – Premium Risk

The first analysis is to calculate the USP for NSLT health premium risk. For this purpose, it was applied the formulae specified in chapter 3.3.2, a).

The aggregated losses, $y_{t,}$, and the premiums earned, x_t, in the segment of medical expenses by accident year t were the data necessary to apply the Quadratic Variance Model. These data were provided by the Actuarial Department.

These data had to fulfil some assumptions and requirements in order to be appropriate to use. Such requirements are to be representative for the premium risk that the company is exposed to during the following twelve months; to be available for at least five consecutive accident years; the aggregated losses has to include the expenses and are adjusted for catastrophe claims.

In respect to the assumptions, once the number of accident years in study are relatively small (15 years), it was not possible to perform sufficiently robust statistical tests to assess the fitness of the data to the assumptions. Nevertheless, it was assumed that this is the case.

In the practical application of the model for premium risk for the segment of medical expenses, the volatility standard parameter was 5%, as stated in annex IV of this report.

The data concerns the years 2001 to 2015, so the last year for which data is available is 2015 (T = 15) and the credibility factor used was 100% once we have more than 10 year of occurrence for which data was available, as presented in annex VI.

After the calculation of likelihood estimators, $\hat{\gamma}$ and $\hat{\delta}$, using the data presented above, the equation 3.2.2.10 can be applied to get the volatility parameter, $\sigma_{(prem,1,USP)}$.The following results were obtained:

Table 2 – Standard parameter and USP for premium risk

	Premium Risk
Standard Parameter	5,00%
USP under method 1	4,34%
Variation (p.p.)	0,66

As we can see in Table 2, for premium risk of medical expenses line of business, the standard volatility parameter reveals to be higher than the specific volatility parameter calculated for the undertaking. Meaning that it has 0,66 percentage points less volatility in premiums than what was obtained when considering the use of the standard formula.

5.2. USP - Reserve Risk

Under method 1 for the calculation of USP for NSLT health reserve risk, similar procedures to the premium risk were applied. This method is also based in maximum likelihood estimations but different data was required.

For reserve risk USP we need the best estimate provision at the beginning of the year, x_t, and the sum of payments made that are outstanding at the beginning of the year and the best estimate for claims outstanding at the beginning of the year, y_t. These data were provided by the Actuarial Department. To use this data, it had to fulfil some assumptions and requirements. These are to be representative for the reserve risk that the insurance company is exposed to during the following twelve months; to be available for at least five consecutive financial years; data had to be adjusted for amounts recoverable that are in place to provide cover for the following twelve months and data had to include the expenses incurred. Once the number of accident years in study are relatively small (6 years). It was not possible to perform sufficiently robust statistical tests to assess the fitness of the data to the assumptions. Nevertheless, it was assumed that this is the case. For the calculation of reserve risk volatility parameter under method 1, it was used equation 3.2.2.15, for which data refers to financial years 2010 to 2015 so the last year for which data is available is 6 (T = 6), the credibility factor *c* is 51% once we have 6 years of occurrence, as we can see in annex VI. The standard parameter for reserve risk for segment of medical expenses is 5%, as stated in annex IV.

For reserve risk volatility parameters, we got the following volatility parameters:

Table 3 – Standard Parameter and USP for reserve risk

	Reserve Risk
Standard Parameter	5,00%
USP under method 1	6,95%
Variation (p.p.)	-1,95

From the results above we can see that there is a higher volatility in terms of reserves. The standard parameter stated for this risk is 5% while the actual volatility parameter is 6,95%. It is 1,95 percentage points above the standard.

5.3. Capital charges for NSLT Health premium and reserve risk

In order to verify the impacts of the USP in the capital charges of NSLT health premium and reserve risk we precede to calculation according to standard formula, presented in chapter 3.3.1, and according to standard formula plus the use of USP, as stated in chapter 3.3.2.

The capital requirement for this submodule of risk results from multiplying 3 times the volatility parameter, σ_{NSLTh}, and the volume parameter, V_{NSLTh}, as described in formula 3.2.2.5.

When calculating the capital charges by using USPs or the Standard Formula, the following aspects occurred:

- V_s differs in the formula 3.2.2.10 once the DIV component changes in the two ways of calculation. When standard formula is applied, this factor is calculated according to the equation stated in annex V. For the medical expenses line of business there is some volume of business in some geographical areas so the value obtained for DIV was less than 100% but higher than 90%. When it is calculated through the use of USPs, this parameter is defined equal to 100%, as specified in annex V.

- σ_s, as equation 3.2.2.8 suggests, depends on volatility parameter of premium risk, $\sigma_{(prem)}$, and reserve risk, $\sigma_{(res)}$ so it changes when it is calculated through standard formula or USPs. In the first one, the volatility parameters are the standard ones and in the second one they are calculated;
- σ_{NSLTh} is expected to change once it depends on V_s and σ_s, as equation 3.2.2.7 suggests. So this parameter will be different in the two ways of calculation;
- V_{NSLTh} does not change when using standard formula or USPs once this parameter depends on V_{prem} and V_{res} that are equal in both ways of calculation.

The following table shows the variation of σ_{NSLTh}:

Table 4 - Standard deviation for NSLT health premium and reserve risk for the segment of medical expenses

	Standard Formula	**USP under Method 1**	**Variation (SF - USP) (p.p.)**
Standard deviation for NSLT health premium and reserve risk for segment 1, σ_{NSLTh}	4,63%	4,31%	0,32

Finally, after the application of the information stated above the undertaking is able to decrease in 6,810% the value of SCR of NSLT health for premium and reserve risk by using the USPs calculated for that specific line of business.

5.4. Impacts on BSCR and SCR

Once studied the impact of the use of USPs for premium and reserve risk of medical expenses line of business, it is interesting to know the impacts of it not only at risk module level but also at a higher level.

The figure below shows the changes in SCR structure caused by the use of USPs:

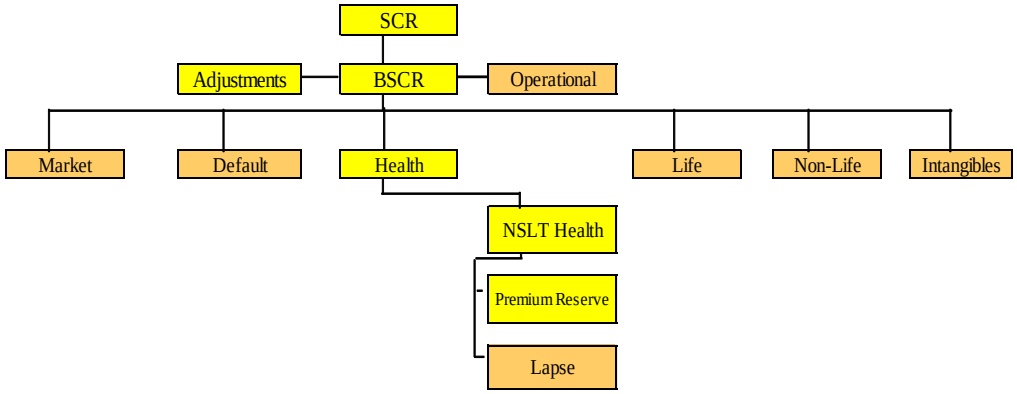

Figure 6 – Impacts of the use of USPs in the SCR.

As it can be observed by figure 6, the use of USPs for NSLT health premium and reserve risk for the particular segment of medical expenses, keeping every other risk modules constant and using the standard parameters for all other lines of business, will cause a reduction in SCR NSLTh and consequently a decrease of SCR Health. It decreases 0,805% and 0,553% respectively.

As a result of the previous changes, BSCR is also expected to vary. This is not a proportional change once the BSCR formula does not result of the sum of risk modules SCR. It takes into account the correlation between the capital requirements of the different risks, as we can see in formula 3.2.2.2.

For the BSCR, the use of USPs for medical expenses line of business, will cause a reduction of 0,071%.

Finally, at SCR level, it is expected to decrease once it results from the sum of Operational risk (kept constant), BSCR (that decreased) and the adjustments (that increased but not significantly) (equation 3.2.2.1). So the final result for the SCR is a decrease of 0,069%.

All the calculations presented in this chapter are the result of the application of the USPs calculated into the structure of the risk calculation that the risk department work in a daily basis. So the details of its formulas are not specified in this report.

The changes presented above are a small piece in the big structure of risks and lines of business. This report presents only the analysis of the impact of USPs for premium and reserve risk of a single line of business of medical expenses.

6. Conclusion

During the internship in Tranquilidade, I had the opportunity to work and apply the Solvency II rules. Once integrated in Global Risk Department, it was possible to understand what those theoretical rules mean in practice and real business situation.

It is a phase of adaptation of the insurance companies to the new regime in terms of implementing all the new regulations, to comply with the capital requirements and policies.

It was possible to learn how the standard formula operates in practice, its features and limitations. Several theoretical researches made me realize that many insurance companies still apply the standard formula to calculate their capital requirements and the first steps are made to calculate the undertaking specific parameters in order to get closer to the real risk profile of each company.

In this report I studied the capital charges associated to a specific line of business applying the standard formula and applying the USPs calculated for the NSLT health premium and reserve risk.

From this analysis, it was verified that the volatility standard parameter for premium risk was higher than the volatility parameter calculated. On the other hand, the reserve risk standard deviation was lower than the parameter calculated, meaning that the former parameters were not adequately reflecting the risk profile of the company. Despite one of the undertaking specific parameters being higher than the standard ones, integrating them in the calculation of the NSLT health volatility parameter, σ_{NSLTh}, results in a lower outcome than using the standard parameters. Consequently, if the company is exposed to

a lower volatility it results in lower capital requirements for the NSLT health submodule and Health risk module.

To get closer to the real risk profile of the company allow undertakings to go further in their business decisions and improve the way they manage investments.

In terms of BSCR and SCR, the use of USPs for the medical expenses line of business results in a decrease of these two components. Although it is not a significant decrease once it was applied only to a single line of business it is sufficient to realize that in some cases, the standard formula is not the most adequate to a specific company.

7. Further developments

There is a lot of work to be done under Solvency II regime. Once it came into force at 1 January 2016, all the tools are being implemented.

The next steps in this field will go in the direction of optimizing management decisions and build a risk culture inside the insurance companies. This improvement will lead to companies more aware of their risks and more prepared to deal with adverse and unexpected situations.

Further developments can be done. Extend the calculation of USPs to other lines of business and study if they reflect the risk that company is exposed.

Another interest study that can be done is the application of other features in order to optimize the economic capital. In a first phase, the company's main awareness is to get sufficient capital to fulfil the regulatory requirements. In later phases, companies can go further and optimize the capital by defining their risk appetite, meaning their limits to investments and willingness to accept the risk.

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Annexes

Annex I - Correlation coefficient between risk modules of BSCR, $Corr_{i,j}$ (Adapted from Annex IV of the Directive 2009/138 / EC of the European Parliament and of the Council of 25 November 2009)

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

Annex II – Correlation coefficient $CorrH_{(i,j)}$ (Adapted from Article 144 - Health underwriting risk module of the Commission Delegated Regulation (EU) 2015/35 of 10 October 2014)

i \ j	**NSLT Health Underwriting**	**SLT Health Underwriting**	**Health Catastrophe**
NSLT Health Underwriting	1	0,5	0,25
SLT Health Underwriting	0,5	1	0,25
Health Catastrophe	0,25	0,25	1

Annex III - Correlation coefficient *CorrHS(i,j)* (Adapted from Annex XV - Correlation Matrix for NSLT Health Premium and Reserve risk of the Commission Delegated Regulation (EU) 2015/35 of 10 October 2014)

t / s	**Medical expenses insurance (1)**	**Income protection insurance (2)**	**Worker's compensation insurance (3)**	**Non-proportional health reinsurance (4)**
Medical expenses insurance (1)	1	0,5	0,5	0,5
Income protection insurance (2)	0,5	1	0,5	0,5
Worker's compensation insurance (3)	0,5	0,5	1	0,5
Non-proportional health reinsurance (4)	0,5	0,5	0,5	1

Annex IV - Segmentation of NSLT health insurance and standard deviations for NSLT health premium and reserve risk sub-module (Adapted from annex XIV of the Commission Delegated Regulation (EU) 2015/35 of 10 October 2014)

	Segment	Standard deviation for gross premium risk of the segment	Standard deviation for reserve risk of the segment
1	**Medical expenses insurance**	5,0%	5,0%
2	**Income protection insurance**	8,5%	14,0%
3	**Worker's compensation insurance**	8,0%	11,0%
4	**Non-proportional health reinsurance**	17,0%	20,0%

Annex V – Factor for geographical diversification of premium and reserve risk (Annex III of the Commission Delegated Regulation (EU) 2015/35 of 10 October 2014).

According to the regulation:

- "For all segments set out in Annexes II and XIV, the factor for geographical diversification of a particular segment s"…" shall be equal to the following:

$$DIV_S = \frac{\sum_r \left(V_{(prem,,r,s)} + V_{(res,r,s)}\right)^2}{\left(\sum_r \left(V_{(prem,,r,s)} + V_{(res,r,s)}\right)\right)^2}$$

Where:

(a) each of the sums cover all the geographical regions set out in paragraph 8;

(b) $V_{(prem,r,s)}$ denotes the volume measure for premium risk of the segment s and the region r;

(c) $V_{(res,r,s)}$ denotes volume measure for reserve risk of the segment s and the region r.

- "… the factor for geographical diversification for a segment set out in Annex XIV shall be equal to 1 if insurance and reinsurance undertakings use an undertaking-specific parameter for the standard deviation for NSLT health premium risk or NSLT health reserve risk of the segment to calculate the NSLT health premium and reserve risk sub-module."

Annex VI - Credibility Factor (Adapted from Section G of Annex XVII of the Commission Delegated Regulation (EU) 2015/35 of 10 October 2014)

Time lengths in years	Credibility factor c
5	34%
6	51%
7	67%
8	81%
9	92%
10 or more	100%