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MASTER'S THESIS

THE IMPLEMENTATION OF SOLVENCY II DIRECTIVE IN THE WESTERN BALKAN COUNTRIES

Ljubljana, March 2023 MARIJA APOSTOLOVSKA

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

AOF – Ancillary Own Funds
AS – Assistance
BCBS - Basel Committee on Banking Supervision
BOF – Basic Own Funds
BSCR – Basic Capital Requirement
CIT – Corporate Income Tax
CS – Credit and suretyship insurance
ECAI - External Credit Assessment Institution
EEA – European Economic Area
EIOPA – European Insurance and Occupational Pensions Authority
ERM – Enterprise Risk Management
EU – European Union
EUR – Euro
Fire – Fire and other damage to property insurance
FSB - Financial Stability Board

G-20 – The Group of Twenty
GL – General liability insurance
GWP – Gross Written Premium
IAIS - The International Association of Insurance Supervisors
IDD - Insurance Distribution Directive
IOSCO - International Organization of Securities Commissions
LACDT – Loss-absorbing capacity of deferred taxes
LE – Legal expenses insurance
MAT – Marine, aviation and transport insurance
MCR – Minimal Capital Requirement
Misc – Miscellaneous financial loss insurance
MO – Other motor insurance
MTPL – Motor vehicle liability insurance
NBS – National Bank of Serbia
NSLT – Non-similar-to-life-technique
OECD - Organization for Economic Co-operation and Development
ORSA – Own Risk and Solvency Assessment
PD – Probability of Default
QRT – Quantitative Reporting Templates
RSD – Serbian Dinar
RSR – Regular Supervisory Report
SCR – Solvency Capital Requirement
SLT – Similar-to-life-technique
SNE – Single Name Exposure
USD – United States Dollar

INTRODUCTION

The insurance business model is based on four fundamentals: pooling or sharing of losses, payment of losses occurring by accident or chance, transfer of risk and indemnification. Pooling of losses is being done by spreading the losses incurred by the few over the entire group, by relying on the law of large numbers. This means that it is assumed that losses would occur randomly and that they would be accidental. When unforeseen and unexpected losses occur, the insurance companies would be obliged for their payments. That is being done by transferring the risk from the insured to the insurers, since it is assumed that the insurer would be in a better financial position to cover the losses. By making the payments for losses, the insurers indemnify the insured, as the insured are restored to their approximate financial position before the loss has occurred. Due to the nature of insurance operations, this industry is one of the most regulated ones and the major reasons for its heavy regulation are: solvency maintenance of the insurers, compensation for insufficient customer knowledge, securing proper rates and making insurance accessible (Rejda & McNamara, 2017).

The focus of this thesis is directly linked to the first issue mentioned, i.e. the insurer solvency maintenance. As Rejda and McNamara (2017) continue, solvency maintenance of the insurance companies is very significant from three points of view: the policyholders, the financial system and the overall economic and social system. This would mean that, in case an insurance company becomes insolvent, i.e. incapable of covering its liabilities, first of all – the policyholders would not have their claims settled and would not get the protection that they have been paying for. Secondly, if an insurance company fails, this would cause general financial and economic instability, as it can be connected with other (re)insurers and it could cause a general fear and distrust in the system. Lastly, as an insurance company shuts down, there would be economic and social consequences, such as loss of jobs, reduction of taxes paid, etc.

Since the financial global crisis in 2007-2008, a substantial supervisory and regulatory reform has been introduced in the field of financial services in the European Union (hereinafter the EU). The European Insurance and Occupational Pensions Authority (hereinafter EIOPA) became the authority in the insurance sector and the newly introduced Directive 2009/138/EC (hereinafter the Directive) replaced the existing legislation, by revoking the existing Directives and introducing new solvency capital requirements, a system of governance and techniques of cooperation between supervisory authorities (Marano & Siri, 2017). Bernardino (2014), the chair of the EIOPA, stated that the Directive was introduced as an attempt to make risk-based supervision in the EU. It consists of three areas of focus, i.e. the three pillars. The first one tends to provide better alignment of capital and risks and, moreover, better assets and liabilities valuation on a market-consistent basis. The second one has an aim to make risk management the core of the prudential regime. And

the third one has an aim to significantly enhance the transparency of the regime and to increase public disclosure of the insurance specifics.

The focus of this thesis will be on the first pillar, i.e. the solvency capital requirement (hereinafter SCR), but it is also strongly connected with the second pillar. The Solvency II assessment has a purpose to set a capital requirement (based on a standard formula) which would be sufficient to cope with all of the risks the insurer is exposed to. In order to do so, insurers have to implement the most appropriate set of methodologies regarding the nature, scale and complexity of their risks (Starita & Malafronte, 2014).

The issue that will be analyzed in this thesis is how the capital adequacy is assessed, which risks impact the adequacy the most, and how they differ among the chosen markets.

The research questions that will be answered in this thesis are the following:

1. What is the purpose of the Directive and what does it consist of?

2. How is the Directive implemented and what is the difference in implementation in

the EU and the Western Balkan countries?

3. How is the SCR calculated?

4. Which risk modules impact the capital adequacy the most? Is there a difference in

this impact in the EU vs. the Western Balkan countries?

5. Does the Solvency II standard formula reflect the real and fair evaluation of capital

adequacy?

6. Would the capital adequacy results be significantly different when using different

methodology/assumptions?

In the first part of this research, a brief look will be taken at the principles of the insurance industry. The basics of the insurance business model will be explained, as well as how the profit is made in this industry, and what are the risks and how are they managed. Then, the need for insurance regulation will be reviewed. It will be observed how the regulation affects the insurers and the policyholders.

In the second part, it will be examined how the regulation changed after the global financial crisis and the introduction of the Directive will be described. It will be analyzed what the Directive includes, what do the three pillars refer to, and how the Directive leads to more transparent, secure and stable insurance industry in Europe.

In the third part of the thesis, the implementation of the Directive will be reviewed. The legal bodies responsible for regulation and supervision will be specified and the process of implementation will be explained. The differences between the implementation in the EU and the Western Balkan countries will be pointed out. The Serbian market will be taken as a representative example of the Western Balkan countries and the Slovenian market will be taken as a representative of the EU market.

In the last part of the thesis, there will be a simulation of capital adequacy calculation. This quantitative analysis will show how the capital adequacy is calculated based on the Solvency II standard formula. Specifically, this analysis will be done on the above-mentioned markets with a purpose to compare the results of the countries in and outside the EU. The focus will be on the Western Balkan countries and their capital adequacy results. The most impactful risks in these markets will be analyzed. Additionally, it will be tested how their results differ if assumptions different from the ones provided in the standard formula are used. That will be analyzed in the last part of the simulation, i.e. the capital adequacy calculation assuming changed parameters. Specifically, for the Serbian market, two calculations regarding the capital adequacy will be made. One of them will be according to the Solvency II standard formula and the other will be based on risk-adjusted assumptions. It will be analyzed whether Solvency II standard formula truly reflects the solvency of the insurers and the risks they are exposed to.

1 INSURANCE INDUSTRY

The first chapter of the thesis aims to describe the principles of insurance, by explaining how the insurance business model functions. This part is written with the purpose of better understanding of the insurance industry. By understanding its main characteristics, the need for insurance regulation becomes logical, and subsequently, the purpose and the process of the regulation is described.

1.1 Insurance business model

Even though the principles of the insurance function are based on trade, the insurance business significantly differs from the commodity trade. While in commodity trade the exchanged object is visible and it physically exists, the business in the insurance industry bases the trade on more abstract, intangible objects, i.e. the policies. Although there are different insurance definitions, all of them include the fact that the insurance business depends on expectations and trust. The payments in the insurance trade are being made for a guarantee that the repayment (in a bigger amount) will be accomplished at some point in the future upon the occurrence of a certain event. This means that the buyer must trust that the price being paid is fair and has to expect that the seller will be solvent and able to pay its obligations when the insured event occurs. On the other hand, the seller trusts that the buyer has an acceptable level of moral hazard and has to make sure that the risk taken is insurable.

Having in mind that the circumstances under which the trust and expectations were established can change, it can be assumed that risk and uncertainty can increase over time. The insurance companies manage this issue by spreading the risk, i.e. using the law of large numbers (Pearson, 2010).

According to Rejda and McNamara (2017), insurance is characterized by pooling or spreading of losses, which is defined as transferring the risks to insurers, who agree to compensate the insured upon the occurrence of the insured event. It can be concluded that the insurance arrangements usually include four basic characteristics: pooling of losses, payment of unanticipated losses, risk transfer and indemnification. The essence of insurance is actually the pooling of losses, which is based on risk spreading. By pooling the losses, insurers succeed to spread a few losses incurred over the entire group. By pooling, grouping a large number of exposure units is being made so the law of large numbers can function and, with that, to provide accurate prediction of future losses. From a statistical point of view, the pooling is being done with the purpose of reducing the variation of potential outcomes, as measured by a measure of dispersion, such as standard deviation. The goal is to include additional exposure units to the pooling, which would reduce the standard deviation, but the expected value of the loss would remain the same. The law of large numbers states that "the greater the number of exposures, the more closely will the actual results approach the probable results that are expected from an infinite number of exposures". The logic behind this law is the foundation of the insurance business model. The second characteristic of the insurance arrangements is payment of the accidental losses. The law of large numbers also uses the assumption that the losses that occur are unexpected by the insured and happen randomly, by chance. The third characteristic is the risk transfer and it refers to the risk that is transferred from the insured to the insurer, who usually would be financially more prepared to handle the potential losses. And the last characteristic of the insurance arrangements is the indemnification, i.e. the compensation that would be settled by the insurer to the insured and that would bring the insured in his financial position prior to the loss event.

As specified by Pearson (2010), the very start of insurance, i.e. its non-actuarial form, dates back from the middle ages, when the need for protection of goods and people in transit arose. For example, this encouraged the merging of ship-owners and armed escort services in China, in the Chinese ports, for trade caravans passing through less safe roads between the Chinese provinces. The payment of fees to the military for trade caravans' protection later became common in other regions as well. This payment can actually be taken as one of the earliest forms of premium insurance, paid for insurance of ships and their cargoes.

As Pearson (2010) continues, having in mind that goods were also transported between countries, this insurance was mainly international. Nevertheless, centers of marine insurance were created later on in different countries, and they were subjected to taxation by their rulers. By the 1600s, specialist communities of insurance brokers emerged in more European cities. While the private underwriters and brokers were still operating, some countries in

Europe were creating national institutions for marine insurance. For example, in Genoa, Copenhagen and Naples, state monopolies were established by 1751. In Antwerp in 1756 there were private companies that started undertaking both – marine and fire insurance. Same as marine insurance, the inland transport insurance was mainly international.

Following the historical overview by Pearson (2010), throughout the nineteenth and the twentieth centuries, multiple forms of organization of the insurers existed. There were individual underwriters who operated through brokers, state monopoly insurers, private companies (organized as smaller partnership companies or bigger joint-stock companies), private companies that were incorporated by the states etc. The existence of many different insurers provided protection of goods in transport even if some of the insurers were forced to withdraw from the market.

Finally, as reported by Pearson (2010), throughout the years, marine insurance had a part in the contribution in the actuarial techniques – the risks involved were different from the aspect of the cargo type, the ship type and the route, while the level of information regarding the risks was increasing with time. Some of the information was formally organized, but mostly they were transferred by word of mouth. Besides marine insurance, new lines of accident insurance were developing and by 1914 there were around 50 of them. On the other side, regarding life insurance, ever since the fourteenth century, lives have begun being insured as a side insurance of marine insurance for the passengers or slaves travelling on the ships. In the beginning, life insurance started on a non-actuarial, non-premium basis, where fixed or variable contributions were paid according to mortality. However, by the end of the nineteenth century, a lot of life insurance companies in the United Kingdom that were selling insurance based on premiums appeared.

Moreover, in the 1980s, as the new literature and market offer on portfolio insurance was created, the difference between insurance and finance became more complicated to understand. At this time, in the literature, insurance got its own label, and moreover, the insurance's key terms were taken into a new field, which made the confusion between insurance and finance even bigger. A lot of the key terms from then are widespread in the insurance literature today, such as risky assets, risk-free assets, market risk, risk profile, risk tolerance, etc. (Hufeld, Koijen & Thimann, 2017). For clarification, the main differences in definition of these terms are presented in the Table 1.

Table 1: Key concepts in insurance and finance compared

Concept	Insurance	Finance
Risk	Possibility of actual damage, injury, liability, or loss	Uncertainty in value over time
Risk Materialization	Relatively rare occurrence, happening 'out of normal', as a consequence of an external event	Inherent feature 'within normal', happening continuously

(table continues)

Table 1: Key concepts in insurance and finance compared (continued)

Concept	Insurance	Finance
Value	Actual endowment regarding property, health or life	Price of an asset or a portfolio at a given point in time
Loss	Partial or total damage of the object insured or personal injury experienced	Negative change in asset value
Purchase of protection	Possible only if an exposure to the risk exists	Possible also if no exposure to the risk exists
Trigger for payouts	Damage	Event
Compensation level	Determined by actual damage	Determined by product terms
Compensation differentiation	Case-by-case	Same for all instrument holders
Profits possible?	No. Insurance cannot create profits for policyholders (except for life insurance products); loss compensations cover at best the loss in full	Yes. Profits are possible; payouts can exceed a possible loss from event and even occur if there is no loss
Tradability of contracts	Generally not possible	Generally possible

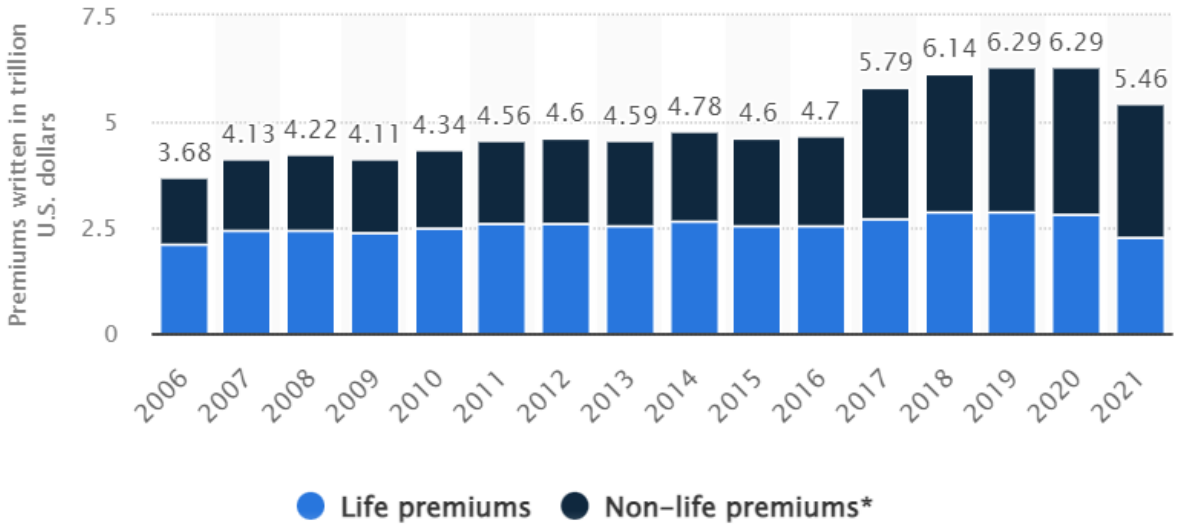
Source: Hufeld, Koijen & Thimann (2017).

As Hufeld, Koijen and Thimann (2017) continue and as it is shown in Table 1, the differences are much smaller when it comes to comparing life insurance and finance. Life insurance with a savings component is similar to finance since there is a guaranteed paid-in capital and/or minimum return at some point in the future. That way the insurer is exposed to financial risks, and it has to hedge the risks with different derivatives. Despite the similarities, the nature of the insurance contracts, life or non-life is that the insurance company bears the risks (including the financial ones) through pooling, diversification or hedging.

Generally speaking, the business model of an insurance company can be defined by the type of the products it sells – life (where the policies refer to insurance of individual's life) or non-life insurance (where the policies refer to insurance that is not associated with individual's life). Aside from product segmentation, the business model among insurance companies can differ depending on the type of distribution in terms of sales – sales can be done by brokers, agents (who can be independent or tied), banks or it can be done by direct selling. Although there are many different types of insurance companies, they all have the same basis on which their models are built – risk pooling (Weert, 2011).

As shown on Figure 1, regarding the more recent indicators and trends in the insurance environment, global insurance gross premiums written (life and non-life insurance) in 2021 amount to 5.46 trillion United States dollars (hereinafter USD) (Statista, n.d.). This means that only two countries in the world had higher gross domestic product (hereinafter GDP) than this market value of the insurance industry in 2021 and those are the United States (hereinafter the US) and China. However, as it can be seen on Figure 1, in comparison with 2020, the gross premiums are lower for 0.8 trillion USD, which is considered a sharp fall.

Figure 1: Global gross premiums written in 2021 (in trillion USD)



Source: Statista (n.d.).

1.2 Insurance regulation

Having in mind the described principles of the insurance business, its development and similarities to the financial sector, the need for the regulation of the insurance industry becomes clear and necessary. First of all, as mentioned, the insurance sector contributes to the protection of the households, companies and community and by doing so, it also contributes to the GDP of the economies. Second, the insurance contracts which are the essence of this business, are by their nature, mostly long-term. This emphasizes the need for regulation, since the insurers must remain credible and able to pay their obligations in the future. And lastly, since the insurance model is based on pooling of risks, and using the law of large numbers, it means that collective management of risk is being done, which also explains the need for regulation.

Faure and Hartlief (2003) also define criteria for safety regulation as a role of the government: information asymmetry, insolvency risk, the threat of a liability suit and administrative costs. Regarding the first criterium, according to Shavell (1984), the parties involved in an accident setting would usually know much more information about the accident risk itself than the regulatory body. However, when an accident happens, the regulatory body would be able to acquire the needed information at the least cost. As Faure and Hartlief (2003) continue, the second criterium explains that the potential accidents can be so high that they would exceed the wealth of the insurance company and safety regulation would be the solution for this problem, in terms of ex ante care of solvency. Thirdly, some activities can cause damages for whose obtainment lawsuits would never be brought and the potential injurer might not take efficient care for the injured. That is why safety regulation would be necessary, to ensure that protection exists. And the last important part of the safety regulation are the administrative costs, i.e. all the costs related to passing and enforcing the

regulations, and those are costs that exist no matter of the accident occurrence or non-occurrence.

As a consequence of the financial crisis in 2007-2008, the regulation of financial services in general has increased. This was generally due to two main reasons: the global response to the financial crisis and the cooperation between sectors to achieve that response. The European Commission suggested that the general rules in banking and insurance should be compatible insomuch as necessary, meaning that similar products should be treated similarly in banking and insurance, but the regulatory regimes for the two industries would have to differ, considering that their activities in terms of economics and business differ (Gatzert & Wesker, 2012). As reported by Marano and Siri (2017), during that period, the Group of Twenty (hereinafter G-20) was functioning as a crisis responder in the beginning, and later it became an economic international forum, that had a purpose of conducting, facilitating and balancing the dynamics in the financial services networks internationally. Based on the recommendations of G-20 and other transnational bodies (that the member states of the EU were a part of), there was a newly introduced supervisory and regulatory reform. The EIOPA has become the authority of the insurance sector, instead of the Committee of European Insurance and Occupational Pensions Supervisors (hereinafter the CEIOPS), and a new Directive was introduced which replaced the existing Directives. With the new Directive, new solvency capital requirements were introduced, as well as a new governance system and techniques for cooperation among the supervisory authorities. Also, the harmonization of the business conduct rules of insurers and insurance intermediaries has increased on account of the Insurance Distribution Directive (hereinafter IDD), which led to enhancing the customers' protection in the EU.

As Marano and Siri (2017) continue, Solvency II set out rules for entering in the (re)insurance activity, rules for executing this activity and rules for coordination among the national regulators for supervising this activity. These rules were meant to be a regulation basis for the insurance sector in the EU member states, but also a benchmark for the non-EU countries. The latter is done so that the EU regulation could increase its influence and for it to become a regulatory source for other jurisdictions. For this purpose, three areas for equivalence assessment are included in Solvency II, which empower the European Commission to decide about the equivalence type of the third country's solvency. This assessment would be a motive for third countries to apply to be evaluated. This way, different jurisdictions can be more harmonized in terms of regulating the (re)insurance undertakings. While the insurance regulation represents defining all the rules governing the EU insurance market, the insurance law refers to a part of those regulations, i.e. to the rules that can apply in a case of violation of the regulation. The insurance law is based on the paradigm "command-control", i.e. commands are being made when there is non-compliance with the regulation. The insurance regulation also consists of some non-binding rules that are not a part of the above-mentioned paradigm, that demand the regulated entities to have a certain type of behavior no matter the sanctions in a case of non-compliance. These non-binding rules are part of the so-called soft law, as opposed to the rules based on the "command-

control" paradigm, that are part of the hard law. There are a few main differences between the soft and the hard law, showed in the Table 2 as comparison between the two:

Table 2: Main differences between soft and hard law in the EU

	Soft law	Hard law
Process of lowering the costs of contracting and amendment	More flexible procedure	More formal and time-consuming procedure
Sovereignty costs	Less	More
Risk of uncertainty	Low	High

Source: Marano & Siri (2017).

As reported by Marano and Siri (2017), these "more relaxed" conditions of soft law make its use very popular, similar to the financial industry. This enables the different authorities to exchange ideas, responses and potential solutions to given issues and take actions more easily relying on less formal instruments, compared to the hard law. This practice is known as the "network theory" in the financial sector. However, soft law differs from the principle of proportionality defined in Solvency II and IDD. According to the principle of proportionality, requirements should be implemented in a proportionate way, regarding the risks existing in the business – their nature, scale and complexity. It means that this principle does not refer to not applying the requirement, but it aims to apply the requirements proportionally. This principle adds flexibility to the hard law, which also increases the uncertainty as it gives discretion to national supervisors. That is why EIOPA, in order to encourage coordinated EU supervisory response, is requested to pay a lot of attention to how the principle of proportionality is being implemented by the national supervisors, and to make sure that an effective and consistent level of regulation and supervision is ensured. If these findings are summed up, it is clear that the insurance regulation sources are being globalized, influenced mainly by the trend of creating cross-sectoral rules in the financial services. The rules directed to the banking and financial sectors that are applied with the purpose of consumer protection and financial stability are followed by the rules in the insurance sector.

According to Marano and Siri (2017), after the financial crisis, G-20 plays the main role in designing the regulatory framework, which is later implemented by the technical organizations – the Financial Stability Board (hereinafter FSB), the International Association of Insurance Supervisors (hereinafter IAIS), the International Organization of Securities Commissions (hereinafter IOSCO) and the Basel Committee on Banking Supervision (hereinafter BCBS). This global network creates rules that are not based on the command-control paradigm, but they are mainly addressed to the members of the network with the goal to coordinate the contents and priorities in their own decision-making processes. Nevertheless, due to their technicalities and transnational use, the EU tends not to depart from them. Insurance regulations consist of both soft and hard law. Sometimes, there are commands of implementation of certain standards; however, the way of implementing them can differ for different recipients of the command. Otherwise, there could also be rules that are just suggesting an action or behavior in a certain direction. These

rules are not obligatory, but their refusal can sometimes cause introduction of new rules based on the command-control paradigm. Additionally, the EU's decision-making process requires the stakeholders to define how they would like to be involved in the process. Very often the measures in regulation are being created as a product of a negotiation between the EU bodies and the stakeholder that would be affected by those measures. In order to implement better regulation, the market needs to be better understood, which is why the stakeholders in the EU are requested to participate throughout the whole regulatory process until the adoption of the rules.

In comparison with the previous Solvency I requirements, Solvency II was defined as a Framework Directive that contains principles, which means that it is part of a system. Solvency I, on the other hand, only represented several directives and it was not a part of a system. The purpose of Solvency II is more comprehensive harmonization and more similar conditions for running the insurance business throughout the internal market (Loguinova, 2019).

2 INTRODUCTION OF SOLVENCY II DIRECTIVE

Regarding the EU market, from 1970s there have been implementations of rules in order to coordinate insurance markets and regulations. Financial services regulation has been an important issue ever since, especially with the creation of the general single EU market. Solvency I regulations have been implemented in member countries by January 2004. However, creating the risk-based capital standards according to Solvency II was a major step ahead for the supervisory framework (Eling, Schmeiser & Schmit, 2007, Doff, 2016).

As stated by Marano and Siri (2017), the implementation of Solvency II Framework Directive was one step further towards the establishment of internal insurance market in the EU. For implementing the Solvency II Framework Directive, the conditions for organizing the insurance business need to be uniform in the internal market and, for that purpose, if the EU member states significantly differed among each other in terms of the conditions – the differences would have to be eliminated. As stipulated in the Directive, the Supervisory Review Process traces the following principles: supervision that is risk-oriented (which means that the supervision needs to be aligned with the risk position of the insurance undertakings), the principle of proportionality (the specific circumstances of each insurance undertaking should be considered and evaluated whether they meet the supervisory requirements), and the principle of materiality (which means that only material circumstances dictate supervisory activities and regulatory requirements). Based on the Directive, the supervisory authorities have the purpose of reviewing and evaluating whether the (re)insurers' strategies, processes and reporting procedures comply with all the requirements of the Directive.

The main goal of the introduction of the Directive is to ensure the financial firmness of the insurance companies and specially to ensure that they would be solvent during difficult

periods. Their solvency protects the policyholders and keeps the financial system stable (Peleckienė & Peleckis, 2014). By transforming and modernizing the insurance business, Solvency II also increases the importance of financial management due to the interdependence of this sector with investment activity (Istrate & Badea, 2017).

The Directive aims to secure an adequate risk assessment, efficient capital allocation and increased transparency. The Directive aims to conduct standards that would help create a single EU market, where different EU member states would have a common system of control (Butt, 2007).

The EIOPA (n.d.) defines three pillars of Solvency II regulatory framework: pillar one that sets the quantitative requirements, pillar two that sets the qualitative requirements (including risk management and internal governance) and pillar three that sets the supervisory reporting and public disclosure.

2.1 The first pillar – quantitative requirements

As reported by Dreher (2015), when it comes to the solvency requirements, the first principle based on which the requirements are determined is the economic valuation of the whole balance sheet, which would differ from the accounting balance sheet. The excess of assets over liabilities would actually be the amount of own funds based on Solvency II. The end result of this way of valuing the own funds is increased protection of insureds and insurance beneficiaries. In order to ensure this protection, the legislator determines which resources can be identified as own funds. The own funds can be split in two groups: basic own funds (hereinafter BOF) and ancillary own funds (hereinafter AOF). Then the own funds are classified into three tiers, based on their character as basic or ancillary, and on their level of subordination and permanent availability. So, the own funds must be established under supervisory law, same as the insurance undertaking's capital requirements should.

According to Marano and Siri (2017), when examining the balance sheet based on Solvency II, the compliance with requirements on technical provision needs to be evaluated. The technical provisions need to be calculated in line with the market, based on the principles of prudence, dependability and objectivity. The technical provisions have two components: best estimate and risk margin. The best estimate should be equal to the probability/weighted average of future cash flows, with time value of money and risk-free rate term structure taken into account. The calculations of best estimate should be done based on reasonable assumptions and adequate methods and data.

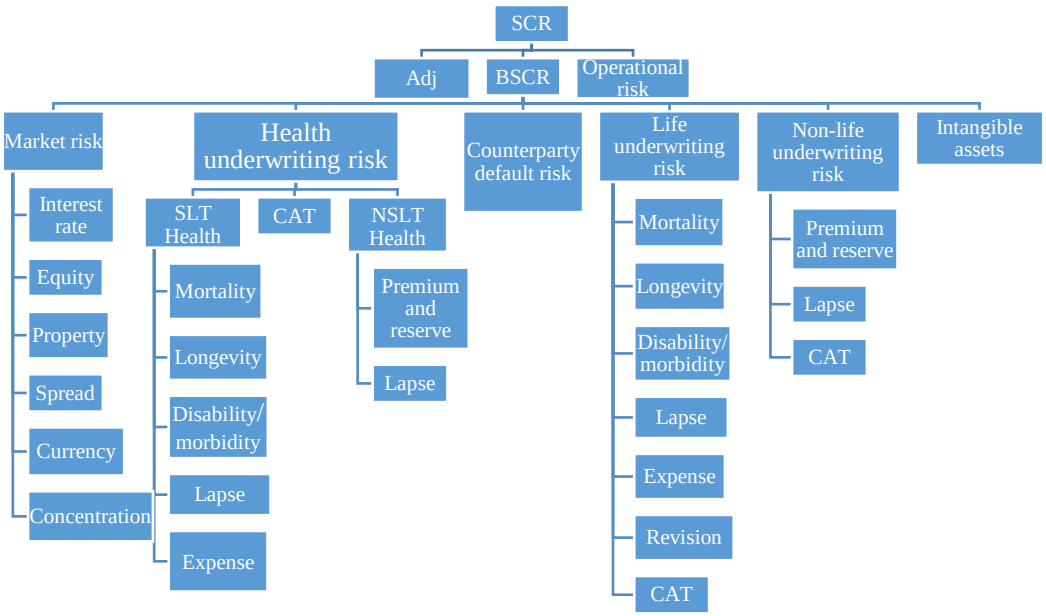
As Marano and Siri (2017) continue, the risk margin, on the other hand, needs to ensure that the reserves are equal to the amount that needs to be paid for meeting the obligations from the insurance undertakings. Moreover, the technical provisions need to be estimated, having in mind the inflation, the expenses for servicing insurance obligations, payments to policyholders, potential future decisions of policyholders about exercising contractual

options, financial guarantees given and recoverables from reinsurers and special purpose vehicles (hereinafter SPV).

When calculating the SCR, the focus is on the exposure of the insurance undertaking to risks, and not on its business volume (that is measured by premium income). For that purpose, the supervisory regime defined separate risk modules that must be considered when calculating the SCR. The end goal is that the insurance undertakings hold enough eligible own funds to cover the SCR. This means that the insurance undertaking would be solvent according to Solvency II regime when its solvency ratio (i.e. the ratio of own funds to the SCR) is at least 100%. This SCR should be calculated and reported to the supervisory authorities at least once a year (Dreher, 2015).

Another capital requirement besides the SCR is the Minimum Capital Requirement (hereinafter MCR). The MCR defines the lowest amount of capital resources (met only with eligible BOF) that needs to be met by insurance undertakings. The MCR ensures that policyholders and beneficiaries are exposed only to an acceptable level of risk. The MCR should be calculated and reported to the supervisory authority every quarter (Dreher, 2015). Conceptually, the SCR is defined in a way such that assets exceed liabilities with a specified level of safety over a defined time horizon, where as the MCR is the lowest level that would trigger supervisory actions (EIOPA, 2011). The structure of Solvency Capital Requirements is shown in Figure 2.

Figure 2: Classification of risks in Solvency II



Adapted from EIOPA (2014).

2.2 The second pillar – risk management and internal governance

As reported by Dreher (2015), the second pillar of the Directive reviews risk management and system of governance. Firstly, as part of the risk management and governance system, each insurance undertaking has to perform its Own Risk and Solvency Assessment (hereinafter ORSA) report. Even though ORSA would formally be linked to the second pillar, it is also very closely related to the first and the third pillar. For example, all the quantitative requirements defined in the first pillar are also addressed in ORSA, in which solvency requirements are presented both – quantitatively and qualitatively. Moreover, as a matter of documentation, ORSA is also being communicated and reported and it is linked to the third pillar. ORSA reporting has a purpose to improve the self-assessment of overall solvency needs (in the short and long term), taking in consideration the risk profile of the insurance undertaking. Moreover, it adds additional value to the information that the supervisory authorities have for evaluating the solvency of the undertaking. All the Solvency II principles also apply for ORSA. Taking the materiality principle, for example, it would mean that only the risks that are material would be included in the analysis, and the decision on which risks are material is left on the insurance undertakings. However, regular review is being done on the criteria the undertakings determine for the significance of the risks. The proportionality principle would mean that the undertakings that have simple business models would create a simple ORSA, while the ones with complex business models would have to conduct more comprehensive ORSA. ORSA's content and results have to be in line with the business strategy of the undertaking and they should be considered when making strategic decisions.

As Dreher (2015) continues, the ORSA has a purpose to provide information to the insurance undertaking whether the standard formula of Solvency II is adequate and whether it can guarantee that the undertaking is solvent. If there is a dilemma about the solvency of the undertaking, according to EIOPA, the undertaking should consider developing an internal model. If the internal model already exists in the evaluation, the ORSA should assess whether the model is adequate (for example, review would be done on whether the assumptions used are appropriate or whether the risks considered truly reflect the risk profile of the undertaking). After all, the supervisory regime demands calculating regulatory capital with the standard formula, while at the same time (in order to ensure adequacy of the risk management system) stimulating the management to question the assessment of the standard formula and strive for improved evaluation of the undertaking's solvency.

Another important issue for economics agents is also whether Enterprise Risk Management (hereinafter ERM) improves the financial vulnerability of insurance companies and the main arguments in favor of ERM is its contribution in handling changes in the regulatory frameworks (such as Solvency II), in managing risks and in increasing insurers' resilience to uncertainty in the macroeconomic environment (Nguyena & Voa, 2020).

The main goals of having a risk management system in the insurance companies are reducing the insurer's risks, identifying the optimal capital structure and contributing to increasing the long-term profitability (Mulvey, Pauling, Britt, Morin & Perrin-Tillinghast, 2008).

2.3 The third pillar – reporting and disclosure

Regarding the third pillar, the goal is to increase the transparency in the insurance market, so there would be no informational imbalances. Since economic decisions are being made based on information, the insurance and reinsurance undertakings should publicly disclose current, reliable information regarding the financial condition, solvency and corporate governance. This way, adequate protection of policyholders and beneficiaries is established, but it also helps to maintain financial stability and fair and stable markets (which is a secondary objective), i.e. reinforcing market discipline. The primary addressees of the public disclosure are policyholders and beneficiaries, while the secondary addresses are shareholders, competitors, insurance brokers, rating agencies, press etc. (Dreher, 2015).

The third pillar is linked with the first two pillars, as all the quantitative solvency requirements that need to be calculated and how the risk is managed considering all the requirements, need to be communicated and reported to the supervisory authorities and to the public. As stated by Dreher (2015), reporting about ORSA implementation is a part of the regular reporting to the supervisory authority, so the authority could assess whether the insurance undertaking is able to assess its own risks and solvency criteria. The public, on the other hand, gets informed about ORSA results through the Solvency and Financial Condition Report (hereinafter SFCR). This obligation of the undertakings for public disclosure with regards to ORSA is mainly directed towards the organizational integration into the risk management system, which is a matter that is not discussed in other publications, including the management report.

Apart from SFCR reporting, the third pillar also defines the following reporting requirements: the Regular Supervisory Report (hereinafter RSR) and the Quantitative Reporting Templates (hereinafter QRT). The reporting requirements comprise a combination of quantitative and qualitative elements. The SFCR and RSR reports contain both quantitative and qualitative elements, whereas the structure of QRT is only quantitative. Unlike the SFCR report that is publicly disclosed, the RSR report is available to the supervisor only. All QRT are for the supervisor, while some of their elements are also for the public. Regarding the frequency of the reporting, the QRT are reported quarterly, the SFCR is reported annually and the RSR is reported once every three years or when requested by the supervisor (Burckbuchler & Irwin, 2011).

As Burckbuchler and Irwin (2011) continue, the content of the QRT is quantitative and these templates should consist of information about the SCR, the MCR, the technical provisions, the assets and the own funds. The content of the SFCR and RSR reports is practically the

same and it should provide information on the business and the performance of the insurers, their governance system, their risk profile, valuation and capital management.

In the SFCR report, insurers include a description of their activities and operations, their risk profile, their technical provisions and other liabilities, they reveal the principles used when valuing their assets, as well as their results and capital management. Apart from the annual report, insurers are also obliged to disclose information in the interim, when specific circumstances that affect their business occur (De Nederlandsche Bank, 2022).

According to the guidelines of EIOPA (2015), insurers' SFCR report should consist of 5 sections: business and performance, system of governance, risk profile, valuation for solvency purposes and capital management. In the section of business and performance, insurers should provide information about the legal or the natural persons that are holders of qualifying holdings in the undertaking, the proportion of ownership interest held and the proportion of voting rights held, as well as a simplified group structure. In the section of system of governance, insurers should reveal information about how key functions in the company operate, how their authority is ensured and the way they report to the administrative, management and supervisory body of the company. This section should also consist of information about how the risk management system functions in undertakings that use partial or full internal models to calculate the SCR.

As outlined by EIOPA (2015), the risk profile section of SFCR should reveal the risks identified by the undertaking, how they are assessed, monitored and managed, but also, this section should provide information about how the risk are transferred to SPV, if they are used. In the section of valuation for solvency purposes, insurers should report about valuation of their assets and liabilities. More specifically, they need to describe the valuation basis that has been applied to the assets, including methods and inputs used, but also assumptions and judgements used in the process. Moreover, insurers need to describe the significant simplified methods used for calculation of the technical provisions, including the methods used for calculation of the risk margin. Insurers need to also include information about the valuation basis that has been applied to the other liabilities apart from the technical provisions, including the methods, assumptions and judgements used in the process. In the final section of capital management, insurers should provide information about any additional potential solvency ratios that are calculated. In this section they also need to provide information on the structure, amount, quality and eligibility of own funds, as well as on the differences between the standard formula and the internal models used.

3 IMPLEMENTATION OF SOLVENCY II DIRECTIVE

The main purpose of the thesis is clarification of the SCR, explanation of its calculation, understanding what affects the SCR, understanding the meaning of the assumption used in the calculation process and whether these assumptions would lead to real reflection of the

solvency position of an insurer. Moreover, it will be analyzed how changing these assumptions would reflect the capital adequacy of an insurance company.

The Solvency II framework is centered on risk-based capital requirements, in combination with market-based valuation of assets and liabilities in the balance sheet. The goal of the solvency capital requirements is to test whether the insurance company has sufficient funds to cover losses over a 1-year horizon with 99,5% probability (Kouwenberg, 2018).

The first step of calculating capital adequacy based on Solvency II is defining the assessment principles of the assets, liabilities, technical provisions and own funds of the insurer. By defining the assessment principles, differences and similarities are identified among the accounting principles\standards, actuarial principles and solvency-related principles. Additionally, the risks linked to the SCR estimation are clarified and the role of risk mitigation techniques is explained. This mainly refers to the underwriting risks for life, non-life and health businesses. Finally, the economic capital is analyzed in comparison with the SCR, where the economic capital is related to the interests of the stakeholders included in the insurance processes, and the SCR is related to the interests of the policyholders and beneficiaries (Starita & Malafronte, 2014).

The starting point of the assessment is identifying the main balance sheet components, then identifying the assessment principles for SCR calculation and identifying the eligibility principles of the financial resources to cover the SCR. The main components of the balance sheet are shown in Table 3.

Table 3: Main components of an insurer's balance sheet

ASSETS	LIABILITIES
Reinsurance	Own funds
Investments	Technical provisions
Other assets	Other liabilities

Source: Starita &Malafronte (2014).

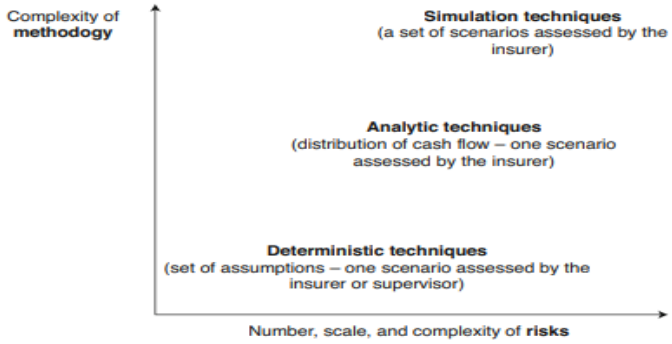
There are three different methodologies for assessing the capital requirements, and they are shown in Figure 3, together with their relation to the number, scale and complexity of risks (Starita & Malafronte, 2014).

Different methodology is used for different evaluation aims. The deterministic technique is used when the insurer itself or the supervisor defines assumption (i.e. scenario) for revaluing the components, not taking any specificities of the insurer into account. The analytic technique is used when the insurer revalues the components based on their distribution of future cash flows. And the simulation technique is used when the revaluation is done based on a set of scenarios (Starita & Malafronte, 2014).

The purpose of Solvency II assessment is to define a capital requirement that would be capable of coping with all the risks. To be able to manage all the risks, the insurers must

choose a set of methodologies that would be most suitable with respect to the nature, scale and complexity of their risks (Starita & Malafronte, 2014).

Figure 3: The relation between the methodologies for capital requirements assessment and the risks underlying the insurance business



Source: Starita & Malafronte (2014).

As shown in Figure 3, if the number and the complexity of risks the insurer is exposed to is lower, the deterministic techniques for capital requirement assessment are the most appropriate, and they require a set of assumptions that form one scenario. As the number and complexity of risks increase, the analytic techniques would be more suitable as they require estimation of cash flows for the main items of the balance sheet based on a set of assumptions. Lastly, simulation techniques should be used when the number and complexity of risks that the insurer is exposed to is high. These techniques require a set of scenarios, and for each scenario there has to be a cash flow estimation for the main items of the balance sheet (Starita & Malafronte, 2014).

When it comes to valuation of assets and liabilities, as components of the insurers' balance sheet, Solvency II bases on the principle that these items should be valued according to their economic value. The difference between the value of assets and the value of liabilities is the starting point for determining the insurers' available own funds (De Nederlandsche Bank, 2014). Considering that Solvency II regulatory regime pushes insurance companies to engage into market consistence evaluation of their balance sheet, the robustness of these valuations is very significant for producing sound estimates and good risk management strategies (Gambaro, Casalini & Fusai, 2019).

When it comes to technical provisions, they are usually the largest item in the insurers' balance sheet, and this is no different under the Solvency II regime. The Directive actually confirms that the calculation of technical provisions remains an essential component in the balance sheet construction (Dreksler et al, 2015). The Directive provides a specific mark-to-model technique according to which technical provisions should be equal to the sum of the "best estimate" and "risk margin" specific to each homogeneous risk group. The homogeneous risk groups are not only divided on life and non-life contracts, but the segmentation needs to be done on a more detailed basis. That is why the homogeneous risk

group should consist of contracts that have similar risk profiles from the perspective of the policyholders, similar claims settlement pattern, underwriting policies etc. The minimum level on which the segmentation should be done is on a line of business (Starita & Malafronte, 2014).

When calculating the best estimates, i.e. the present value of the cash flows, in case of life business – discounted cash flow model is used (Olivieri & Pitacco, 2011). This calculation is done on a policy-by-policy basis, including the specific risk factors, such as mortality, survival or changes in the health state of the insured. It is also possible to group policies if the risks underlying them are identical in terms of nature and scope. However, the profit-sharing life business should always be separated from life business without profit sharing and index-linked and unit-linked contracts should be separated from the rest of the contracts. When it comes to non-life business, run off triangles are used, which are obtained by combining the accident year and the length of processing time in years, the frequency/severity model and/or expected loss ratio. The best estimate is calculated as an average of the results/outcomes coming from many possible scenarios weighted by their respective probability, considering the time value of money. The best estimates should be the gross of recoverables from reinsurance contracts and SPV. The best estimate calculation for non-life business implies separating the premium provisions and claims provisions. Premium provisions are estimated with regards to the claim events, including the claim handling costs, while the claim provisions are estimated with regards to the incurred and reported or not reported claims. The best estimates for health business which are similar to non-life should be calculated in the same manner non-life best estimates are calculated, and those similar to life – in the manner of life best estimates are calculated (Starita & Malafronte, 2014).

The second component of the technical provisions is the risk margin. The risk margin should be calculated in a way to ensure that the value of the technical provisions is equal to the amount that the undertaking would be expected to require in order to meet its insurance obligations. According to the cost of capital approach, the risk margin should be calculated "by determining the cost of providing an amount of eligible own funds equal to the SCR necessary to support the obligations over their lifetime" (Dreksler et al, 2015). The SCR can be calculated based on the standard formula or based on an approved internal model used by the insurer. The final step before the capital adequacy assessment is analyzing the own funds, i.e. the sources available to cover the requirement. According to Articles 69 to 79 of the Delegated regulation (EU) 2015/35 (hereinafter the Regulation), based on Solvency II, own funds are classified in three tiers: Tier 1, which consists only of BOF, Tier 2 which consists of BOF and AOF, and Tier 3, which consists of BOF and AOF. The classification of own-fund items in the three tiers depends on whether they are basic on ancillary own funds, whether they are permanently available and on their subordination. The excess of assets over liabilities and the subordinated liabilities comprise the BOF, while items other than BOF that can be called up to absorb losses are AOF. Own-fund items that are classified in Tier 1 would be the highest-grade capital, for e.g. the paid-in ordinary capital, while the unpaid share

capital, letter of credit and guarantees would be AOF (De Nederlandsche Bank, 2014a). Regarding the limits applicable to the three tiers of own-funds, according to Article 82 of the Regulation, "the eligible amount of Tier 1 items shall be at least one half of the SCR, the eligible amount of Tier 3 items shall be less than 15% of the SCR and the sum of the eligible amounts of Tier 2 and Tier 3 items shall not exceed 50% of the SCR". Article 82 of the Regulation also defines the restrictions of own-funds regarding the MCR: "the eligible amount of Tier 1 items shall be at least 80% of the MCR and the eligible amount of Tier 2 items shall not exceed 20% of the MCR".

3.1 Implementation in the EU countries

As an EU legislation, the Solvency II Framework Directive was adopted by the Council of the EU in April 2014 and entered into force on 22 May, after publication in the Official Journal of the EU. The Solvency II Directive replaced the existing insurance and reinsurance directives. The detailed requirements that the insurers had to meet, i.e. implementing measures were part of the Regulation. They had direct effect in all the 28 EU member states at the time, meaning that it did not have to be transposed into national law. EIOPA also designed Guidelines and Recommendations on how to apply Solvency II requirements in order to help national supervisors with its implementation. After the implementation, the European Commission has the responsibility to make sure that the EU member states are complying with the legislation (Lloyd's, n.d.).

3.2 Implementation in the third countries

The European Commission adopted its first third country equivalence decisions under Solvency II in June, 2015 (European Commission, 2015). Considering that insurance is a global industry, the Solvency II regime included the certain provisions regarding the recognition of third country jurisdictions in order to offer an equivalent level of supervision. There are three areas of equivalence evaluation of third countries under Solvency II: group solvency calculation, group supervision and reinsurance. The first area refers to the insurance companies based in the EU that have subsidiaries in third countries. If the country receives equivalent decision, then the insurance group would be allowed to calculate capital requirements for its branch based on the local solvency rules. The second area refers to insurance companies headquartered in third countries that have subsidiaries in the EU. In this case, the home supervisor would be responsible for supervising that insurance group, in order to avoid double supervision. In fact, group supervision represented an important step change in the financial services regulation (Elderfield, 2009). And the third area refers to reinsurance contracts between an EU (re)insurer and a non-EU insurer. If equivalence is granted for the non-EU jurisdiction, the contract would be considered as a full EU reinsurance contract (FERMA, 2017).

Assuming that the insurance group is headquartered in the EU, thus is obliged to report under Solvency II regime, and it has subsidiaries in a third country, it would have to calculate group SCR by assessing the capital requirements and eligible own funds for the non-EU subsidiaries too and that is the first area of the equivalence evaluation. The European Commission should determine whether the solvency regime in that third country is equivalent to the one under Solvency II. If equivalence decision is granted, then the group solvency capital requirement and eligible own funds would be calculated taking into the account the capital requirements and eligible own funds of the non-EU subsidiary based on its local requirements (Norton Rose Fulbright, 2015). If the third country is found not to be equivalent, the subsidiary's capital requirements and eligible own funds would be calculated based on Solvency II directive (even though it is not mandatory for them according to their local requirements) and that might potentially impose stricter capital requirements than those under the local rules (Sidley Austin LLP, 2010).

If an equivalence decision is not granted on a country, insurers are allowed to apply for a decision with the group supervisor. The group supervisor then can make decisions in consultation with EIOPA and other EU member states concerned (De Nederlandsche Bank, 2015).

Regarding Serbia, the Executive Board of the National Bank of Serbia (hereinafter NBS) adopted the Strategy for Implementation of Solvency II in Serbia in 2017. As proposed in the first stage of the Strategy, the NBS completed an in-depth legislative gap analysis, as well as an analysis of the potential exemption of small undertakings from the Solvency II scope and also, an analysis of the capacity and readiness of undertakings for Solvency II implementation. The NBS adopted the latest amendments and supplements to the Strategy in 2021 (NBS, n.d).

Considering the importance and complexity of the implementation process, the NBS will review the Strategy every year and update it according to the new circumstances and challenges, especially in the light of accession process of Serbia to the EU, considering the recommendations issued by the European Commission (NBS, 2021).

Based on the IMF (2022) country report for Serbia, the process of strengthening the financial sector regulatory and supervisory frameworks continues. The framework for insurance companies continues to be enhanced in order to align with international standards and EU requirements.

However, until this date, Solvency II is still not implemented in the legislative in Serbia, thus insurance companies in Serbia are not obliged to calculate and report their capital adequacy under the Solvency II regime to their local authority. The in-force legislative regarding solvency in insurance companies is still Solvency I. The solvency of insurance companies largely depends on the sufficiency of technical provisions for undertaken obligations and on meeting the conditions related to capital adequacy, which are determined as the ratio of the

required and available solvency margin (RS Official Gazette, No 51/2015). The required solvency margin is predetermined and set in the Serbian Insurance Law, separately for non-life and life insurance companies. The available solvency margin refers to the capital of the company taken into account according to the requirements. The detailed requirements are given in Appendices 2 and 3.

Before the actual simulation for capital adequacy calculation in Slovenia and Serbia, an analysis of the insurance market in Slovenia and Serbia is made, in terms of the insurance premium volume, which is shown in Table 4. A few more markets from Western Balkan are taken in the analysis to widen the overall picture of the insurance market development in Western Balkan compared to the Slovenian market.

Table 4: Gross written premiums in Slovenia and certain Western Balkan countries in 2021

Country	GWP (in EUR million)
Slovenia	2,404
Serbia	1,020
Federation of Bosnia and Herzegovina	286
North Macedonia	188
Republika Srpska	131
Montenegro	98

Adapted from Agencija za zavarovalni nadzor (n.d.); Narodna banka Srbije (n.d.); Agencija za nadzor osiguranja Federacije Bosne i Hercegovine (n.d.); Agencija za supervizija na osiguruvanje na Republika Severna Makedonija (n.d.); Agencija za osiguranje Republike Srpske (n.d.) and Agencija za nadzor osiguranja Crne Gore (n.d.).

As in can be seen in Table 4, the gross written premium in Slovenia in higher than the sum of gross written premiums in Serbia, Bosnia and Herzegovina (Federation and Republika Srpska), Macedonia and Montenegro.

In order to get a more detailed overview of the insurance presence in Slovenia and Serbia, as the following simulations are done for those two countries, an analysis of the gross written premium by insurance classes was done.

In 2021 in Slovenia, the largest share of gross written premium was represented by voluntary health insurance (26.3%), followed by life insurance (23.8%) and land motor vehicle insurance (14.0%) (Republic of Slovenia Statistical Office, 2022).

In 2021 in Serbia, the largest share of gross written premium was represented by motor vehicle liability insurance (30.9%), life insurance (22.7%) and property insurance (19.9%) (NBS, 2022).

Even though the share of premium in life insurance is approximately the same in both countries, still there is a significant difference in the structure of the most present insurance classes, measured by the gross premium underwritten.

In the next chapter the simulation of capital adequacy calculations for both countries is done.

4 SIMULATION: CAPITAL ADEQUACY CALCULATION

For the purpose of the simulation, I have assumed that the Slovene insurance company has a subsidiary in Serbia, thus Solvency II regime is applied to the Serbian insurance company as well (as Solvency II is still not a local regulatory requirement in Serbia and Solvency II evaluation has to be done for the purpose of group SCR calculation).

I assumed that neither of the companies has intangibles, thus they do not calculate capital requirements for that risk. This means that I calculated capital requirement for all other risks defined under Solvency II: market risk, counterparty default risk, life, health and non-life underwriting risk and operational risk. For the calculation of the loss-absorbing capacity of deferred taxes (hereinafter LACDT) I used the current corporate income tax (hereinafter CIT) rates in Slovenia and Serbia. I assumed that there is no adjustment for the loss-absorbing capacity of technical provisions.

Both simulations (for the Slovenian and the Serbian insurance company) are my own calculations of the solvency capital requirements. The data used for both entities is not real data taken from existing insurance companies, but it is made up. However, while producing the input data, I considered the real state of the insurance industry in these regions, in order to have more realistic results.

All the formulas given in this chapter are taken from Commission Delegated Regulation (EU) 2015/35 published in the Official Journal of the European Union, 2015. The explanations of the formulas are taken from this Regulation as well.

In all the tables shown in this chapter, where there is a presented share of risks in SCR, the share of a separate risk module is calculated in the undiversified sum of capital requirement of all the risk modules that are considered in the calculation of the basic solvency capital requirement (hereinafter BSCR). For example, the share of market risk is calculated as share of capital requirement for market risk in the undiversified sum of capital requirements for market risk, counterparty default risk, life, health and non-life underwriting risk. Similarly, the share of sub-modules of market risk in total capital requirement for market risk is calculated as share of capital requirement for a certain market risk sub-module in the undiversified sum of capital requirements of all risk sub-modules of market risk. For example, the share of interest rate risk sub-module is calculated as a share of capital requirement for interest rate risk in the undiversified sum of capital requirements for interest rate risk, equity risk, property risk, market risk concentrations, spread risk and currency risk.

4.1 Simulation: capital adequacy calculation in Slovenia

The simulation for the Slovenian insurance company is done based on the standard formula provided in the Commission Delegated Regulation (EU) 2015/35.

For the calculation of capital requirement for premium and reserve risk of non-life and health underwriting risk, I have used assumed values of net earned premium and net claims outstanding. For lapse risk sub-module of non-life and health underwriting risk, I have used assumed values of assets and liabilities before and after the lapse shock. For catastrophe sub-module of non-life and health underwriting risk I have used assumed capital requirements for each sub-module of the catastrophe risk.

For life underwriting risk, I have used assumed values of assets and liabilities before and after the shocks applied for each life sub-module. It is assumed that the company does not have health contracts that would be valued based on similar-to-life-technique (hereinafter SLT) approach.

For market risk module I have used assumed values of assets and liabilities before and after shocks applied for each market sub-module.

For counterparty default risk I have used assumed capital requirements for risk mitigation contracts, financial contracts and type 2 exposures. Regarding counterparty default risk, it is assumed that the risk mitigation contracts refer to reinsurance, financial contracts refer to cash in banks and that the company has only receivables from policyholders regarding the type 2 exposures.

For the operational risk calculation, I have used assumed values of gross earned premium in the last and the previous 12 months, as well as assumed values of technical provisions.

The assumed values were the basis for my calculations of capital requirements of each risk module. The final results are shown in Table 5 and the detailed data and calculations are given later in this chapter.

Table 5: Solvency capital requirements for the Slovenian insurance company

	SCR (in EUR)	Share of risks in own funds (in %)	Share of risks in SCR (in %)
Market risk	265,385,952	22	49
Counterparty default risk	45,258,562	4	8
Life	57,137,885	5	11
Health	31,571,170	3	6
Non-life	143,756,522	12	26
Diversification	-164,067,760	-	-
BSCR	379,042,331	-	-
Operational risk	25,964,810	2	-

(table continues)

Table 5: Solvency capital requirements for the Slovenian insurance company (continued)

	SCR (in EUR)	Share of risks in own funds (in %)	Share of risks in SCR (in %)
LACDT	-33,556,626	-	-
Own funds	1,209,582,665	-	-
Solvency capital requirement	371,450,514	-	-

Source: Own work

4.1.1 Underwriting risks

Based on the Regulation, the capital requirement for underwriting risk is calculated separately for non-life, life and health portfolio. According to Article 114 of the Regulation, the capital requirement for non-life underwriting risk is linked to the exposure to premium and reserves, exposure to possibility that that the insured would cancel their insurance before the end of the contract and exposure to catastrophe events.

Therefore, the non-life underwriting risk module consists of three sub-modules which are connected to the exposures previously outlined: premium and reserve risk, lapse risk and catastrophe risk.

The formula for calculating capital requirement for non-life underwriting risk is:

$$SCR_{non-life} = \sqrt{\sum_{i,j} CorrNL_{(i,j)} * SCR_i * SCR_j} \quad (1)$$

where the correlation parameter for non-life underwriting risk for sub-modules *i* and *j* $CorrNL_{(i,j)}$ is considered, summing up all possible combinations (i,j) of the sub-modules and where SCR_i and SCR_j represent the capital requirements for sub-modules *i* and *j*, respectively. The correlation matrix is shown in Appendix 4.

As outlined in Article 115 of the Regulation, if analyzed separately (by sub-modules), the capital requirement for non-life premium and reserve risk is calculated based on the following formula:

$$SCR_{nl\ prem\ res} = 3 * \sigma_{nl} * V_{nl} \quad (2)$$

where σ_{nl} refers to the standard deviation for non-life premium and reserve risk and V_{nl} refers to the volume measure for non-life premium and reserve risk. According to Article 116 of the Regulation, the volume measure for non-life premium and reserve risk shall be equal to the sum of the volume measures for premium and reserve risk of the segments:

$$V_s = \left(V_{(prem,s)} * V_{(res,s)}\right) * (0.75 + 0.25 * DIV_s) \quad (3)$$

where $V_{(prem,s)}$ and $V_{(res,s)}$ refer to the volume measure for premium risk and volume measure for reserve risk of segment *s*, respectively, and DIV_s denotes the factor for geographical diversification of segment *s*.

The volume measure for premium risk of a particular segment shall be equal to the following:

$$V_{(prem,s)} = max\left[P_s; P_{(last,s)}\right] + FP_{(existing,s)} + FP_{(future,s)} \quad (4)$$

where P_s and $P_{(last,s)}$ respectively denote the estimate of earned premium by the (re)insurance undertaking in the following 12 months and the earned premium by the (re)insurance undertaking in the last 12 months in the segment *s*. On the other hand, $FP_{(existing,s)}$ and $FP_{(future,s)}$ respectively denote the expected present value of premium to be earned by the (re)insurance undertaking after the following 12 months for existing contracts in the segment *s* and expected present value of premium to be earned by the (re)insurance undertaking in the following 12 months for future contracts in the segment *s*.

For the purpose of the simulation, the assumed premium volumes of the Slovenian insurance company that refer to the non-life lines of business are shown in Table 6. The lines of business as defined in Annex II of the Regulation are Motor vehicle liability insurance (hereinafter MTPL), other motor insurance (hereinafter MO), Marine, aviation and transport insurance (hereinafter MAT), Fire and other damage to property insurance (hereinafter Fire), General liability insurance (hereinafter GL), Credit and suretyship insurance (hereinafter CS), Legal expenses insurance (hereinafter LE), Assistance (hereinafter AS) and Miscellaneous financial loss insurance (hereinafter Misc).

Table 6: Premium volume by line of business of the Slovenian insurance company (non-life)

Line of business	Premium volume (in EUR)
MTPL	115,965,281
MO	149,702,492
MAT	14,071,452
Fire	129,130,660
GL	35,561,525
CS	60,479,996
LE	657,694
AS	21,447,607
Misc	1,297,267

Source: Own work

As explained in the Article 116 of the regulation, the volume measure for reserve risk of a particular segment $V_{(res,s)}$ should be equal to the amount of the best estimate of the provisions for claims outstanding after deducting the mitigation part of the best estimate, i.e. the amount recoverable from reinsurance contracts.

The assumed reserve volumes of the Slovenian insurance company by non-life lines of business are shown in Table 7.

Table 7: Reserve volume by line of business of the Slovenian insurance company (non-life)

Line of business	Reserve volume (in EUR)
MTPL	89,958,637
MO	15,219,149
MAT	6,250,653
Fire	29,228,514
GL	40,734,389
CS	1,156,288
LE	300,557
AS	1,812,554
Misc	1,498,653

Source: Own work

For calculating the total volume measure for non-life business, i.e. premium volume and reserve volume of the Slovenian insurance company, the factor for geographical diversification DIV_s needs to be calculated. Based on Annex III of the Regulation, the factor for geographical diversification is calculated with the formula:

$$DIV_s = \frac{\sum_r (V_{(prem,r,s)} - V_{(res,r,s)})^2}{(\sum_r (V_{(prem,r,s)} - V_{(res,r,s)})^2} \quad (5)$$

where premium and reserve volumes for each segment and region are considered, as categorized in Annex III of the Regulation. For the simulation, it is assumed that this factor is 100% for all lines of business.

The calculation and results for total volume measure of the Slovenian insurance company by non-life lines of business is shown in Table 8.

Table 8: Total volume measure of the Slovenian insurance company by line of business (non-life)

Line of business	Premium volume in EUR (1)	Reserve volume in EUR (2)	DIV factor in % (3)	Total volume measure in EUR (4) ((4)=(1)+(2))*(0.75+0.25*(3))
MTPL	115,965,281	89,958,637	100	205,923,918
MO	149,702,492	15,219,149	100	164,921,641
MAT	14,071,452	6,250,653	100	20,322,105
Fire	129,130,660	29,228,514	100	158,359,174
GL	35,561,525	40,734,389	100	76,295,915
CS	60,479,996	1,156,288	100	61,636,284
LE	657,694	300,557	100	958,251
AS	21,447,607	1,812,554	100	23,260,161
Misc	1,297,267	1,498,653	100	2,795,920

Source: Own work

Article 117 of the Regulation defines the calculation of the standard deviation for non-life premium and reserve risk with the following formula:

$$\sigma_{nl} = \frac{1}{V_{nl}} * \sqrt{\sum_{s,t} CorrS_{(s,t)} * \sigma_s * V_s * \sigma_t * V_t} \quad (6)$$

where the correlation parameter for non-life premium and reserve risk for segment *s* and *t*, $CorrS_{(s,t)}$, is considered, summing up all possible combinations of the segments *s* and *t*, where V_{nl} refers to the volume measure for non-life premium and reserve risk, σ_s and σ_t refer to the standard deviations for non-life premium and reserve risk of segments *s* and *t* respectively and V_s and V_t denote volume measures for premium and reserve risk of segments *s* and *t*.

The standard deviation for non-life premium and reserve risk of a particular segment *s* shall be equal to the following:

$$\sigma_s = \frac{\sqrt{\sigma^2_{(prem,s)} * V^2_{(prem,s)} + \sigma_{(prem,s)} * V_{(prem,s)} * \sigma_{(res,s)} * V_{(res,s)} + \sigma^2_{(res,s)} * V^2_{(res,s)}}}{V_{(prem,s)} + V_{(res,s)}} \quad (7)$$

where $\sigma_{(prem,s)}$ and , $\sigma_{(res,s)}$ refer to the standard deviation for non-life premium and reserve risk of segment s, and $V_{(prem,s)}$ and $V_{(res,s)}$ refer to the volume measure for premium and reserve risk of segment *s*. The standard deviations for premium and reserve risk by segments are given in Annex II of the Regulation.

The calculation and final results of the non-life premium and reserve risk are shown in Table 9 and Table 10.

Table 9: Volume measure, standard deviation and total risk by line of business of the Slovenian insurance company (non-life)

Line of business	Total volume measure V in EUR (1)	Standard deviation σ in % (2)	Total risk by line of business in EUR (3) ((3)=(1)*(2))
MTPL	205,923,918	7	15,057,474
MO	164,921,641	8	12,629,059
MAT	20,322,105	12	2,525,699
Fire	158,359,174	6	10,049,788
GL	76,295,915	10	7,333,983
CS	61,636,284	19	11,591,920
LE	958,251	7	64,464
AS	23,260,161	7	1,609,512
Misc	2,795,920	15	410,886

Source: Own work

Table 10: Capital requirement for premium and reserve risk of the Slovenian insurance company (non-life)

SCR for premium and reserve risk (1) ((1)=3*(2)*(3))	123,623,609 EUR
Combined standard deviation (2) ((2)=(4)/(3))	5.77%
Total Volume measure (3)	714,473,369 EUR
Total risk (4) (4)= $\sqrt{\sum \mathrm{Corr}S_{(s,t)} * V_s * \sigma_S * V_t * \sigma_t}$	41,207,869 EUR
Diversification (5) ((5)=(4)-(6))	-20,064,916 EUR
Sum of risks by line of business (6)	61,272,785 EUR

Source: Own work

Regarding the second sub-module of non-life underwriting risk, i.e. non-life lapse risk sub-module, as outlined in Article 118 of the Regulation, the capital requirement for it should be equal to the loss in basic own funds of the insurance or reinsurance undertaking as a consequence from a combination of the following events: the discontinuance of 40 % of the insurance policies which would result in an increase of technical provisions without the risk margin and the decrease of 40 % of the number of the future insurance or reinsurance contracts that were considered in the calculation of technical provisions (where reinsurance contracts cover insurance or reinsurance contracts that will be written in the future).

For the purpose of the simulation, I have assumed the values of technical provision without the risk margin and the reinsurance recoverables before the lapse shock, as well as their values after the lapse shock is applied. Based on those inputs, I have calculated the capital requirement for the lapse sub-module. The results are shown in Table 11.

Table 11: Capital requirement for lapse risk of the Slovenian insurance company (non-life)

Initial values before lapse shock in EUR		Values after lapse shock in EUR		SCR in EUR
Assets (1)	Liabilities (2)	Assets (3)	Liabilities (4)	(1)-(2)-((3)-(4))
-5,982,723	133,853,411	-12,619,461	160,429,731	33,213,058

Source: Own work

The third sub-module of non-life underwriting risk, which is non-life catastrophe risk consists of four sub-modules (as explained in Article 119 of the Regulation): the natural catastrophe risk sub-module, the sub-module for catastrophe risk of non-proportional property reinsurance, the man-made catastrophe risk sub-module and the sub-module for other non-life catastrophe risk.

The capital requirement for the non-life catastrophe underwriting risk should be calculated based on the following formula:

$$SCR_{nlCAT} = \sqrt{\left(SCR_{natCAT} + SCR_{npproperty}\right)^2 + SCR_{mmCAT}^2 + SCR_{CATother}^2} \qquad (8)$$

where the solvency capital requirements refer to the separate sub-modules of risk, i.e. natural catastrophe risk, catastrophe risk for non-proportional property reinsurances, man-made catastrophe risk and other non-life catastrophe risk. In this simulation, it is assumed that the insurance company is not exposed to non-proportional property reinsurance catastrophe risk, so the capital requirement for catastrophe risk is based on the other three sub-modules mentioned.

In the following part, the four sub-modules are described and formulas for capital requirement calculation are shown.

As indicated in Article 120 of the Regulation, the natural catastrophe risk sub-module itself consists of five sub-modules: the windstorm risk sub-module, the earthquake risk sub-module, the flood risk sub-module, the hail risk sub-module and the subsidence risk sub-module. The capital requirement for natural catastrophe risk shall be equal to the following:

$$SCR_{natCAT} = \sqrt{\sum_i SCR_i^2} \tag{9}$$

where the sum includes all possible combinations of the sub-modules *i* and SCR_i denotes the capital requirement for sub-module *i*.

As shown in Article 128 of the Regulation, the man-made catastrophe risk sub-module consists of six sub-modules: the motor vehicle liability risk sub-module, the marine risk sub-module, the aviation risk sub-module, the fire risk sub-module, the liability risk sub-module and the credit and suretyship risk sub-module.

The capital requirement for the man-made catastrophe risk shall be calculated with the following formula:

$$SCR_{mmCAT=}\sqrt{\sum_i SCR_i^2} \tag{10}$$

where the sum of solvency capital requirements of each module mentioned above is considered.

In Article 135 of the Regulation, the last sub-module of non-life catastrophe underwriting risk is defined, i.e. the sub-module for other non-life catastrophe risk. The capital requirement for other non-life catastrophe risk shall be equal to the loss in basic own funds of insurance and reinsurance undertakings that would result from an loss, without deducting the amounts recoverable from reinsurance contracts and SPV, which is calculated with the following formula:

$$L_{other} = \sqrt{(c_1 * P_1 + c_2 * P_2)^2 + (c_3 * P_3)^2 + (c_4 * P_4)^2 + (c_5 * P_5)^2} \tag{11}$$

where P_1, P_2, P_3, P_4 and P_5 refer to estimates of the gross premium, without deducting the amounts recoverable from reinsurance contracts, expected to be earned by the insurance or reinsurance undertaking during the following 12 months in relation to the groups of insurance and reinsurance obligations 1 to 5 as specified in Annex XII of the Regulation and c_1, c_2, c_3, c_4 and c_5 denote the risk factors for the groups of insurance and reinsurance obligations 1 to 5.

In the simulation, I have assumed exposures, i.e. capital requirement for each sub-module of the catastrophe risk and I calculated the separate capital requirement for natural catastrophe risk, man-made risk and other non-life catastrophe risk, as well as the total capital requirement for non-life catastrophe risk. The input data and the calculation of the capital requirements are shown in Table 12.

Table 12: Capital requirement for non-life catastrophe risk of the Slovenian insurance company

Risk module/sub-module	Capital requirement in EUR
Windstorm	16,821,435
Earthquake	10,166,533
Flood	18,644,595
Hail	17,043,399
Subsidence	0
Natural catastrophe risk $SCR_{natCAT} = \sqrt{\sum_i SCR_i^2}$	32,006,522
Man-made risk Fire	9,375,000
Man-made risk Motor	1,187,500
Man-made risk Marine	1,875,000
Man-made risk Credit and suretyship	24,178,435
Man-made risk Liability	3,180,144
Man-made risk Aviation	1,226,001
Man-made catastrophe risk $SCR_{mmCAT=}\sqrt{\sum_i SCR_i^2}$	26,249,372
Other non-life catastrophe risk	2,135,211
Total catastrophe risk $SCR_{nlCAT} = \sqrt{(SCR_{natCAT} + SCR_{npproperty})^2 + SCR_{mmCAT}^2 + SCR_{CATother}^2}$	41,448,837

Source: Own work

The results of capital requirement for non-life underwriting risk and its sub-modules are shown separately in Table 13.

Table 13: Capital requirement for non-life underwriting risk and its sub-modules of the Slovenian insurance company

Non-life underwriting risk	Value in EUR	Share in own funds in %
Exposure to premium risk	528,313,973	44

(table continues)

Table 13: Capital requirement for non-life underwriting risk and its sub-modules of the Slovenian insurance company (continued)

Non-life underwriting risk	Value in EUR	Share in own funds in %
Exposure to reserve risk	186,159,395	15
SCR for premium and reserve risk	123,623,609	10
SCR for lapse risk	33,213,058	3
SCR for CAT risk	41,448,837	3
Total SCR for non-life underwriting risk	143,756,522	12

Source: Own work

According to Article 144 of the Regulation, the health underwriting risk module, consists of three sub-modules: the non-similar-to-life-technique (hereinafter NSLT) health insurance underwriting risk sub-module, the SLT health insurance underwriting risk sub-module and health catastrophe risk sub-module.

The capital requirement for health underwriting risk shall be equal to the following:

$$SCR_{health} = \sqrt{\sum_{i,j} CorrH_{(i,j)} * SCR_i * SCR_j} \quad (12)$$

where the correlation parameter for health underwriting risk for sub-modules *i* and *j* $CorrH_{(i,j)}$ is considered, summing up all possible combinations (i, j) of the sub-modules and SCR_i and SCR_j refer to the capital requirements for the sub-modules *i* and *j*, respectively. The correlation matrix is shown in Appendix 5.

As underlined in Article 145 of the Regulation, the NSLT health underwriting risk sub-module consists of two sub-modules: the NSLT health premium and reserve risk sub-module and the NSLT health lapse risk sub-module.

The capital requirement for NSLT health underwriting risk is calculated based on the following formula:

$$SCR_{NSLTh} = \sqrt{SCR^2_{(NSLT,pr)} + SCR^2_{(NSLTh,lapse)}} \quad (13)$$

where $SCR_{(NSLTh,pr)}$ is the capital requirement for NSLT health premium and reserve risk and $SCR_{(NSLTh,lapse)}$ is the capital requirement for NSLT health lapse risk.

The formulas for capital requirement for premium and reserve risk (including formulas for standard deviation for premium and reserve risk, volume measure for premium and reserve risk) and for lapse risk are the same as in the non-life underwriting risk module, with the segments on which these formulas apply being the only ones that differ.

As pointed out in Article 151 of the Regulation, the formula for capital requirement for SLT health underwriting risk sub-module is the same as for life underwriting risk, which is explained in detail in the following part.

The correlation matrix for SLT health underwriting risk sub-module is shown in Appendix 6. For simplification, we assume that there are no SLT health insurance policies in the undertaking, and for that reason the capital requirement for health underwriting risk sub-module is calculated only for the NSLT sub-module.

For the purpose of the simulation, the assumed premium volumes of the Slovenian insurance company that refer to the health segments are shown in Table 14.

Table 14: Premium volume by line of business of the Slovenian insurance company (health)

Line of business	Premium volume (in EUR)
ME	717,419
IP	77,724,361

Source: Own work

The assumed reserve volumes of the Slovenian insurance company by health line of business are shown in Table 15.

Table 15: Reserve volume by line of business of the Slovenian insurance company (health)

Line of business	Reserve volume (in EUR)
ME	5,436
IP	33,559,151

Source: Own work

For the simulation, it is assumed that the factor for geographical diversification is 100% for all lines of business regarding health portfolio.

The calculation and results for total volume measure of the Slovenian insurance company by line of business is shown in Table 16.

Table 16: Total volume measure of the Slovenian insurance company by line of business (health)

Line of business	Premium volume in EUR (1)	Reserve volume in EUR (2)	DIV factor in % (3)	Total volume measure in EUR (4) ((4)=(1)+(2))*(0.75+0.25*(3))
ME	717,419	5,436	100	722,855
IP	77,724,361	33,559,151	100	111,283,512

Source: Own work

The calculation and final results of the health premium and reserve risk are shown in Table 17 and Table 18.

Table 17: Volume measure, standard deviation and total risk by line of business of the Slovenian insurance company (health)

Line of business	Total volume measure V in EUR (1)	Standard deviation σ in % (2)	Total risk by line of business in EUR (3) ((3)=(1)*(2))
ME	722,855	5	36,027
IP	111,283,512	9	9,836,674

Source: Own work

Table 18: Capital requirement for premium and reserve risk of the Slovenian insurance company (health)

SCR for premium and reserve risk (1) ((1)=3*(2)*(3))	29,564,210 EUR
Combined standard deviation (2) ((2)=(4)/(3))	8.80%
Total Volume measure (3)	112,006,367 EUR
Total risk (4) (4)= $\sqrt{\sum \mathrm{Corr}_{(s,t)} * V_s * \sigma_S * V_t * \sigma_t}$	9,854,736 EUR
Diversification (5) ((5)=(4)-(6))	-17,964 EUR
Sum of risks by line of business (6)	9,872,701 EUR

Source: Own work

For the purpose of the simulation, I have assumed the values of technical provision without the risk margin and the reinsurance recoverables before the lapse shock, as well as their values after the lapse shock is applied. Based on those inputs, I have calculated the capital requirement for the lapse sub-module. The results are shown in Table 19.

Table 19: Capital requirement for lapse risk of the Slovenian insurance company (health)

Initial values before lapse shock in EUR		Values after lapse shock in EUR		SCR in EUR
Assets (1)	Liabilities (2)	Assets (3)	Liabilities (4)	(1)-(2)-((3)-(4))
-913,687	-14,099,763	-945,919	-6,015,835	8,116,160

Source: Own work

According to Article 160, the capital requirement for health catastrophe risk should be calculated based on the following formula:

$$SCR_{healthCAT} = \sqrt{SCR_{ma}^2 + SCR_{ac}^2 + SCR_p^2} \quad (14)$$

where the capital requirements for mass accident, accident concentration and pandemic risk sub-module are considered. I assumed the capital requirements for the separate risk sub-modules and calculated the total health catastrophe risk. The results are shown in Table 20.

Table 20: Capital requirement for health catastrophe risk of the Slovenian insurance company

(table continues)

Table 20: Capital requirement for health catastrophe risk of the Slovenian insurance company (continued)

Risk module	SCR in EUR
Mass accident risk	2,906,773
Accident concentration risk	485,000
Pandemic risk	915,180
Total health catastrophe risk	3,085,791

Source: Own work

The final results regarding NSLT health risk sub-module are shown in Table 21.

Table 21: Capital requirement for health underwriting risk and its sub-modules of the Slovenian insurance company

Health underwriting risk	Value in EUR	Share in own funds in %
Exposure to premium risk	78,441,780	6
Exposure to reserve risk	33,564,587	3
Premium and reserve risk	29,564,210	2
Lapse risk	8,116,160	1
CAT	3,085,791	0
Total SCR for health underwriting risk	31,571,170	3

Source: Own work

As explained in Article 136 of the Regulation, the life underwriting risk module consists of seven sub-modules: the mortality risk sub-module, the longevity risk sub-module, the disability-morbidity sub-module, the life-expense risk sub-module, the revision risk sub-module, the lapse risk sub-module and the life-catastrophe risk sub-module.

The capital requirement for life underwriting risk shall be equal to the following:

$$SCR_{life} = \sqrt{\sum_{i,j} CorrNL_{(i,j)} * SCR_i * SCR_j} \qquad (15)$$

where the correlation parameter for life underwriting risk sub-modules *i* and *j*, $CorrNL_{(I,j)}$, is considered, summing up all the possible combinations (i,j) of the sub-modules, and SCR_i and SCR_j refer to the capital requirements for risk sub-module *i* and *j*, respectively. The correlation matrix for life underwriting risk is shown in Appendix 7.

Article 137 of the Regulation defines the capital requirement for mortality risk, which should be equal to the loss in basic own funds of that would result from a permanent increase of 15% in the mortality rates used for the calculation of technical provisions.

Similarly, in Article 138 of the Regulation, the capital requirement for longevity risk is defined as the loss in basic own funds that would result from a permanent decrease of 20% in the mortality rates used for the calculation of technical provisions.

The capital requirement for disability-morbidity risk is defined in Article 139 of the Regulation, as a loss in basic own funds that would result from changes in the assumed disability and morbidity rates for calculation of the technical provisions. Precisely, for the calculation of the capital requirement for disability-morbidity risk, we assume an increase of 35% of the rates in the following 12 months, increase of 25% of the rates for all months after the following 12 months and decrease of 20% of recovery rates for the following 12 months and for all years thereafter.

In Article 140 of the Regulation, the capital requirement for life-expense risk is defined as a loss in basic own funds that would result from changes in the assumed expenses for calculation of technical provisions. Precisely, we assume an increase of 10% in the amount of expenses and an increase of 1 p.p. to the expense inflation rate.

In Article 141 of the Regulation the capital requirement for revision risk is defined as a loss in basic own funds that would result from an increase of 3% in the amount of annuity benefits for those contracts where an increase of the benefit payable is possible only as a result of changes in the legal environment or in the state of health of the person insured.

Article 142 of the Regulation defines the capital requirement for lapse as the maximum of the following capital requirements: the capital requirement for the risk of a permanent increase in lapse rates, the capital requirement for the risk of a permanent decrease in lapse rates and the capital requirement for mass lapse risk.

In Article 143 of the Regulation, the capital requirement for life-catastrophe is defined as a loss in basic own funds that would result from an increase of 0.15 percentage points to the mortality rates (expressed as percentages) which are used in the calculation of technical provisions to reflect the mortality experience in the following 12 months.

For the purpose of the simulation, I have assumed the value of assets and liabilities that refer to each sub-module of life underwriting risk and their values after the shocks would be applied. Based on those assumed values, I have calculated the capital requirement for each sub-module and the total capital requirement, as well as diversification. The results are shown in Table 22 and 23.

Table 22: Initial values and values after shocks of assets and liabilities for each life sub-module of the Slovenian insurance company

Risk module	Initial values before shock in EUR		Values after shock in EUR		SCR in EUR
	Assets (1)	Liabilities (2)	Assets (3)	Liabilities (4)	(5) ((5)=(1)-(2)-((3)-(4))
Mortality risk		1,584,183,919		1,591,296,922	7,113,003
Longevity risk	25,514,454	1,672,653,767	26,347,095	1,692,936,846	19,450,439
Disability-morbidity risk	-	20,791,089	-	21,088,816	297,728

(table continues)

Table 22: Initial values and values after shocks of assets and liabilities for each life sub-module of the Slovenian insurance company (continued)

Risk module	Initial values before shock in EUR		Values after shock in EUR		SCR in EUR
	Assets (1)	Liabilities (2)	Assets (3)	Liabilities (4)	(5) ((5)=(1)-(2)-((3)-(4))
Lapse risk					28,039,620
risk of increase in lapse rates	-	1,437,924,421	-	1,450,925,387	13,000,966
risk of decrease in lapse rates	-	1,437,925,086	-	1,456,934,612	19,009,527
mass lapse risk	-	1,438,018,654	-	1,466,058,275	28,039,620
Life expense risk	25,514,454	1,678,101,246	25,605,109	1,702,469,702	24,277,801
Revision risk	25,514,454	88,468,881	26,199,293	90,843,493	1,689,773
Life catastrophe risk	-	1,440,513,378	-	1,445,774,450	5,261,072
Diversification (Total SCR life-sum of separate SCR of sub-modules)					-28,991,551
Total life underwriting risk					57,137,885

Source: Own work

The results of capital requirement for life underwriting risk and its sub-modules are shown separately in Table 23.

Table 23: Capital requirement for life underwriting risk and its sub-modules of the Slovenian insurance company

Life underwriting risk	Value in EUR	Share in own funds in %
Mortality risk	7,113,003	1
Longevity risk	19,450,439	2
Disability-morbidity risk	297,728	0
Lapse risk	28,039,620	2
Life expense risk	24,277,801	2
Revision risk	1,689,773	0
Life catastrophe risk	5,261,072	0
SCR for life underwriting risk	57,137,885	5

Source: Own work

4.1.2 Market risk

Market risk refers to the level of volatility of market prices of financial instruments. The actual exposure to market risk is measured by the impact of changes in stock prices, interest rates, immovable property and exchange rates to the value of the insurers' assets and liabilities whose value is sensitive to those changes (Corlosquet-Habart, Gehin, Jansen & Manca 2015). The mitigation of these sources of risk is a major task for risk managers and

asset liability management in terms of integrated consideration and optimization of assets and liabilities (Gonzalez, Kunze, Schwarzbach & Dieng, 2017).

Generally, with introducing the Solvency II regime, the importance of the risk of a mismatch between assets and liabilities has been increased, especially regarding the long-term business that the insurance companies are exposed to. Being liability-driven financial intermediaries, insurance companies need to have investment activities that would ensure that the claims will be met when they are due. It can be concluded that the liability structure of an insurance company is the benchmark of its successful asset liability management (Albrecher et al, 2018). Asset liability management handles creation, implementation, monitoring and revision of strategies related to assets and liabilities, so the financial objectives of the insurance companies are met, for a given set of risk tolerances and constraints (Corsaro, Angelis, Marino, Perla & Zanetti, 2009).

According to Article 164 of the Regulation, the market risk module consists of six sub-modules: the interest-rate risk sub-module, the equity risk sub-module, the property risk sub-module, the spread risk sub-module, the currency risk sub-module and the market risk concentrations sub-module.

The capital requirements for each market risk sub-module are derived from scenarios, i.e. each scenario represents the effects of exogenous capital market shocks on the insurers' basic own funds (Braun, Schmeiser & Schreiber, 2018).

As explained in Article 164 of the Regulation, the capital requirement for market risk module is calculated using the following formula:

$$SCR_{market} \sqrt{\sum_{i,j} Corr_{(i,j)} * SCR_i * SCR_j} \qquad (16)$$

where the correlation parameter for market risk for sub-modules *i* and *j*, $Corr_{(I,j)}$, is considered, summing up all the possible combinations (i,j) of sub-modules and SCR_i and SCR_j refer to the capital requirements for sub-modules *i* and *j*, respectively. The correlation matrix for market risk is shown in Appendix 8.

In Article 165 of the Regulation, in order to calculate the capital requirement for the interest rate risk sub-module, we should calculate the capital requirement for the risk of an increase in the term structure of interest rate and calculate the capital requirement for the risk of a decrease in the term structure of interest rate. The larger requirement of those two should be the capital requirement for interest rate risk.

Article 168 of the Regulation states that the equity risk sub-module should include a risk sub-module for type 1 equities and a risk sub-module for type 2 equities. All equities listed in member countries of the European Economic Area (hereinafter the EEA) or the Organization for Economic Co-operation and Development (hereinafter the OECD) are

considered type 1 equities. Equities listed in stock exchanges in countries which are not members of the EEA or the OECD, equities which are not listed and commodities and other alternative investments are considered type 2 equities. The capital requirement for equity risk shall be calculated with the following formula:

$$SCR_{equity} = \sqrt{SCR_{type1equities}^2 + 2 * 0.75 * SCR_{type1equities} * SCR_{type2equities} + SCR_{type2equities}^2} \quad (17)$$

where the separate solvency capital requirement for type 1 and type 2 equities are considered. Type 1 and type 2 equities can be divided in more detailed sub-modules: standard equity risk sub-module, duration-based sub-module and strategic equity investments. The calculation for this simulation is done for an undertaking that has only standard equity regarding type 1 equities, and standard equity and strategic equity investments regarding type 2 equities.

Article 174 of the Regulation defines the capital requirement for property risk sub-module as a loss in the basic own funds that would result from an instantaneous decrease of 25% in the value of immovable property.

According to Article 175 of the Regulation, the capital requirement for spread risk sub-module shall be calculated based on the following formula:

$$SCR_{spread} = SCR_{bonds} + SCR_{securitisation} + SCR_{cd} \quad (18)$$

where the solvency capital requirements for bond and loans, securitization positions and credit derivatives are considered.

One of the main topics of the analysis shown in this paper is the spread risk, more specifically, the capital requirement that refers to bonds and loans, since different stress factors are applied to bonds of countries that are member states of the EU and bonds of countries outside of the EU. The spread risk is explained in detail in chapter 4.2.

Article 183 of the Regulation states that the capital requirement for market risk concentrations sub-module should be calculated on the basis of single name exposures (hereinafter SNE). This means that exposures to undertakings which belong to the same corporate group shall be treated as a SNE. The exposure at default to a SNE should be calculated, which is the sum of the exposures at default to all counterparties that belong to the SNE. Finally, the weighted average credit quality step on a SNE shall be equal to the rounded-up average of the credit quality steps of all exposures to all counterparties that belong to the SNE, weighted by the value of each exposure.

The capital requirement for market risk concentrations should be calculated with the following formula:

$$SCR_{conc} = \sqrt{\sum_i Conc_i^2} \quad (19)$$

where the sum covers all SNE *i* and $Conc_i$ refers to the capital requirement for market risk concentrations on a SNE *i*. The calculation process for market risk concentrations sub-module is explained in detail in chapter 4.2, as it is one of the main purposes of the simulation.

Finally, as underlined in Article 188 of the Regulation, the capital requirement for currency risk sub-module should be calculated as the sum of the capital requirements for currency risk for each foreign currency. Firstly, we have to calculate the capital requirement for each foreign currency for the risk of an increase (of 25%) and for the risk of a decrease (of 25%) in the value of the foreign currency against the local currency. The final capital requirement for currency risk should be the larger of those two capital requirements.

Regarding the market risk, it can generally be concluded that the standard formula provides one-dimensional design that is centered around stress factors for different asset classes. The standard formula only evaluates portfolios based on their riskiness as judged by the regulator, and this approach does not distinguish investments on the basis of risk-return and correlation profiles (Braun, Schemiser & Schreiber, 2013).

The assumed initial values of assets and liabilities that are sensitive to each market risk sub-modules, as well as their assumed values after shocks, are shown in Table 24 with the calculations of capital requirement for market risk sub-modules and total market risk, as well as diversification.

Table 24: Initial values and values after shocks for each market risk sub-module of the Slovenian insurance company

Risk module	Initial values before shock in EUR		Values after shock in EUR		SCR in EUR
	Assets	Liabilities	Assets	Liabilities	
Interest rate risk					22,440,934
interest rate down shock	2,340,206,617	2,153,913,746	2,344,750,624	2,167,782,437	9,324,683
interest rate up shock	2,340,206,617	2,153,913,746	2,177,220,012	2,013,368,075	22,440,934
Equity risk					168,021,734
type 1 equities	453,667,918	474,004,299	288,738,778	342,788,479	33,713,319
type 2 equities	611,699,822	474,004,293	441,119,168	444,674,069	141,250,429
Property risk	175,969,841	4,594,753	131,703,474	3,446,065	43,117,678
Spread risk	2,234,840,555	474,004,280	2,156,571,830	468,471,705	72,736,150
Market risk concentrations	2,514,455,901	-	-	-	29,133,919
Currency risk					8,424,078

(table continues)

Table 24: Initial values and values after shocks for each market risk sub-module of the Slovenian insurance company (continued)

Risk module	Initial values before shock in EUR		Values after shock in EUR		SCR in EUR
	Assets	Liabilities	Assets	Liabilities	
increase in the value of foreign currency	364,285,559	343,261,397	454,627,222	424,899,588	0
decrease of the value of foreign currency	364,285,559	343,261,397	273.943.897	261.343.813	8.424.078
Diversification					-78,488,542
Total market risk					265,385,952

Source: Own work

The results of capital requirement for market risk and its sub-modules are shown separately in Table 25.

Table 25: Capital requirement for market risk and its sub-modules of the Slovenian insurance company

Market risk	Capital requirement in EUR	Share in own funds in %	Share of risk sub-modules in market risk in %
Interest rate risk	22,440,934	2	7
Equity risk	168,021,734	14	49
Property risk	43,117,678	4	13
Spread risk	72,736,150	6	21
Market risk concentrations	29,133,920	2	8
Currency risk	8,424,079	1	2
Total market risk	265,385,952	22	-

Source: Own work

For obtaining a wider picture about the asset type allocation in EU insurance companies in 2021, it is important to also consider that 53.5% of the portfolio is consisted of government and corporate bonds, 12.2% refers to equity, 20.7% refer to investment funds, collective investment undertakings, 1.1% refers to structured notes, 0.6% to collateralized securities, 4.3% to cash and deposits, 5.5% to mortgages and loans, 1.8% to property and 0.2% refers to other investments (EIOPA, 2021).

4.1.3 Counterparty default risk

During and after the financial crisis, the credit environment became even more significant and a crucial area that needs to be considered in all financial institutions, including insurance

companies. The strong impact of the crisis on the economic and financial system actually redrew the boundaries of the credit environment (Modina, 2015).

Regarding Solvency II regime, credit environment is important so the risk of defaulting of all the counterparties with whom the insurer has transactions, can be considered. According to Article 189 of the Regulation, the capital requirement for counterparty default risk should be calculated with the following formula:

$$SCR_{def} = \sqrt{SCR_{(def,1)}^2 + 1{,}5 * SCR_{(def,1)} * SCR_{(def,2)} + SCR_{(def,2)}^2} \qquad (20)$$

where separate capital requirements are considered for type 1 exposures and type 2 exposures.

As explained in Article 189 of the Regulation, type 1 exposures refer to risk mitigation contracts, cash at banks, deposits with ceding undertakings (where the number of SNE does not exceed 15), commitments received by insurance on reinsurance undertaking which have been called up but are unpaid (where the number of SNE does not exceed 15) and legally binding commitments which the undertaking has provided or arranged and which may create payment obligations.

Type 2 exposures refer to all credit exposures which are not covered in the spread risk sub-module or type 1 exposures of counterparty default risk, for example receivables from intermediaries, policyholder debtors, mortgage loans, etc.

The other main point (besides the market risk) of the analysis shown in this paper is the capital requirement for counterparty default risk, since the formula for calculation of loss-given default (which is the basis for calculating the capital requirement) implies different risk depending on whether the exposure is towards an entity that has or has not a credit assessment. The spread risk is explained in detail in chapter 4.2.

For the Slovenian insurance company, I have assumed the capital requirements for the risk mitigation contracts and financial contracts defined as type 1 and I calculated the capital requirement for type 1 exposures. I also assumed the exposures defined as type 2 exposures and I calculated the capital requirement for type 2 exposures, as well as the final capital requirement for counterparty default risk. More detailed assumptions and calculations are done in chapter 4.2 for the Serbian insurance company, as it is the main subject of the analysis.

The results of the capital requirement for counterparty default risk are shown in Table 26.

Table 26: Capital requirement for counterparty default risk of the Slovenian insurance company

(table continues)

Table 26: Capital requirement for counterparty default risk of the Slovenian insurance company (continued)

Counterparty default risk	Capital requirement in EUR	Share in own funds in %
Capital requirement for Type 1 exposures	39,494,616	3
Risk mitigation contracts	34,577,243	3
Financial contracts (cash)	20,204,388	2
Capital requirement for Type 2 exposures	7,337,314	1
Receivables from intermediaries due more than 90 days	0	0
Other receivables	48,915,426	4
Financial contracts (mortgage loans)	0	0
Capital requirement for counterparty default risk	45,258,562	4

Source: Own work

4.1.4 Operational risk

According to Article 204 of the Regulation, the capital requirement for operational risk should be calculated with the following formula:

$$SCR_{Operational} = min(0.3 * BSCR; Op) + 0.25 * Exp_{ul} \quad (21)$$

where BSCR refers to the basic solvency capital requirement, Op refers to the basic capital requirement for operational risk charge and Exp_{ul} refers to the amount of expenses incurred during the previous 12 months in respect of life insurance contracts where the investment risk is carried by policyholders.

As explained in Article 204 of the Regulation, the basic capital requirement for operational risk should be the maximum of the capital requirement for operational risk calculated based on earned premiums and the capital requirement for operational risk calculated based on technical provisions:

$$Op = ma\,x\left(Op_{premiums}; Op_{provisions}\right) \quad (22)$$

The capital requirement for operational risk based on earned premiums should be calculated with the following formula:

$$Op_{premiums} = \begin{cases} 0.04 * \left(Earn_{life} - Earn_{life-ul}\right) + 0.03 * Earn_{non-life} \\ +max\left(0; 0.04 * \left(Earn_{life} - 1.2 * pEarn_{life} - \left(Earn_{life-ul} - 1.2 * pEarn_{life-ul}\right)\right)\right) \\ +max\left(0; 0.03 * \left(Earn_{non-life} - 1.2 * pEarn_{non-life}\right)\right) \end{cases} \quad (23)$$

The capital requirement for operational risk based on technical provisions should be calculated with the following formula:

$$Op_{provisions} = 0.0045 * max\left(0; TP_{life} - TP_{life-ul}\right) + 0.03 * max\left(0; TP_{non-life}\right) \quad (24)$$

where *life*, *life-ul* and *non-life* refer to premiums earned/technical provisions for life insurance and reinsurance obligations, for life insurance and reinsurance obligations where the investment risk is borne by the policyholder and non-life insurance and reinsurance obligations, respectively.

For the purpose of the simulation, I took assumed amount of earned gross premiums for the last and the previous 12 months and I took assumed gross technical provisions for non-life and life segment. Based on those assumptions, I have calculated the capital requirement for operational risk based on earned premiums and capital requirement for operational risk based on technical provisions. The results of capital requirement for operational risk are shown in Table 27.

Table 27: Capital requirements for operational risk of the Slovenian insurance company

Operational risk	Value in EUR	Share in own funds in %
Capital requirement based on premium	24,101,858	2
Capital requirement based on technical provisions	17,843,603	1
Earned gross premium (in the last 12 months)	865,196,419	-
Earned gross premium (in the previous 12 months)	826,692,443	-
Gross technical provisions - non-life	406,993,829	-
Gross technical provisions - life	1,251,952,839	-

Source: Own work

4.1.5 Capital adequacy

Lastly, the final calculation of the capital requirement takes into account the BSCR, the operational risk and the LACDT.

As shown in Article 87 of the Regulation, the basic solvency capital requirement is calculated by considering the correlation parameter of the risk modules shown in Appendix 8, summing up all the possible combinations of risk modules *i* and *j*, where SCR_i and SCR_j refer to the capital requirement for the risk modules *i* and *j*, respectively. Also, the SCR for intangibles is added, but in these simulations, we assume that the companies do not have intangibles, thus capital requirement for intangibles is not calculated. Basic solvency capital requirement is calculated with the following formula:

$$BasicSCR = \sqrt{\sum_{i,j} Corr_{i,j} * SCR_i * SCR_j} + SCR_{intangibles} \quad (25)$$

According to Article 207 of the Regulation, the LACDT takes into account two calculations: the difference between deferred tax liabilities and deferred tax assets on one side, and on the other side the sum of BSCR and operational risk multiplied by the CIT rate. LACDT is actually the lower number of those two calculations. However, if the difference between deferred tax liabilities and deferred tax assets is negative, i.e. the deferred tax assets are higher than the deferred tax liabilities, we take the difference as equal to zero and as it follows, the LACDT would also be equal to zero.

Finally, the SCR is calculated as a sum of the BSCR, the capital requirement for operational risk and the LACDT.

By simply dividing the own funds with the SCR, we get the solvency ratio, which shows us how solvent the undertaking is.

The final results are shown in Table 28.

Table 28: Capital adequacy calculation of the Slovenian insurance company

BSCR	379,042,331 EUR
Operational risk	25,964,810 EUR
Loss-absorbing capacity of deferred taxes	-33,556,626 EUR
Solvency capital requirement	371,450,514 EUR
Own funds	1,209,582,665 EUR
Solvency ratio	326%

Source: Own work

4.2 Simulation: capital adequacy calculation in Serbia

The simulation for the Serbian insurance company is also done based on the standard formula provided in the Regulation.

For the calculation of capital requirement for premium and reserve risk of non-life and health underwriting risk, I have used assumed the values of net earned premium and net claims outstanding. For lapse risk sub-module of non-life and health underwriting risk, I have used assumed values of assets and liabilities before and after the lapse shock. For catastrophe sub-module of non-life and health underwriting risk I have used assumed capital requirements for each sub-module of the catastrophe risk.

For life underwriting risk, I have used assumed values of assets and liabilities before and after the shocks applied for each life sub-module. It is assumed that the company does not have health contracts that would be valued based on SLT approach.

For the market risk module, I have used assumed values of assets and liabilities before and after shocks applied for each market sub-module. This simulation of the Serbian insurance company contains a more detailed analysis of the calculation of the capital requirement for spread risk and market risk concentrations modules of market risk, as the assumptions used

in these modules are the main focus of the analysis. In particular, assessment is being done considering the assumptions given in the Regulation, i.e. that exposures to Serbian government bonds are risky, since Serbia is not an EU member state and does not have legislative that is equivalent to Solvency II.

For counterparty default risk I have used assumed capital requirements for risk mitigation contracts, financial contracts and type 2 exposures. There are also more detailed analysis and assumptions used in this risk module, as the assumptions used significantly differ depending on whether the exposures have or do not have a credit assessment. Regarding type 1 exposures of counterparty default risk, it is assumed that the risk mitigation contracts refer to reinsurance, while financial contracts refer to cash in banks. Regarding reinsurance exposure, it is assumed that the company is exposed to 15 reinsurers, out of which only one has a credit rating 3, all the rest have a credit rating 6. Regarding exposures in banks, it is assumed that the company is exposed to 11 banks, out of which only one has a credit rating 3, all the rest have a credit rating 6.

For the operational risk calculation, I have used assumed values of gross earned premium in the last and the previous 12 months, as well as assumed values of technical provisions.

The assumed values were the basis for my calculations of capital requirements of each risk module.

4.2.1 Solvency capital requirements and capital adequacy calculation (based on standard formula)

All the assumptions pointed out in 4.2 are used in the first simulation, which is based on the standard formula. The final results are shown in Table 29, the detailed data and calculations are shown later in this chapter. As expressed in Table 29, the most significant potential losses of the undertaking's own funds are the capital requirements for counterparty default risk (15,798,902 EUR), market risk (14,669,460 EUR) and non-life underwriting risk (14,386,031 EUR). What is noticeable is that the rest of the capital requirements – for life underwriting, health underwriting and operational risk, are much lower, compared with the previous ones. The conclusions are identical when assessing the shares in the total solvency capital requirement. This means that the undertaking is mostly exposed to counterparty default risk (33%), market risk (30%) and non-life underwriting risk (30%).

Table 29: Solvency capital requirements for the Serbian insurance company

	Gross SCR in EUR	Share in own funds in %	Share of risks in SCR in %
Market risk	14,669,460	48	30
Counterparty default risk	15,798,902	52	33
Life underwriting risk	1,604,775	5	3
Health underwriting risk	1,659,897	5	3

(table continues)

Table 29: Solvency capital requirements for the Serbian insurance company (continued)

	Gross SCR in EUR	Share in own funds in %	Share of risks in SCR in %
Non-life underwriting risk	14,386,031	47	30
Diversification	-13,281,668	-	-
BSCR	34,305,031	-	-
Operational risk	2,417,770	8	-
Loss-absorbing capacity of deferred taxes	-21,374	-	-
Own funds	30,355,267	-	-
Solvency capital requirement	36,701,427	-	-

Source: Own work

In addition, a more detailed overview of the capital requirements for each risk module is shown.

4.2.1.1 Underwriting risks

The same as for the Slovenian insurance company, underwriting risks are analyzed separately for non-life, health and life segment.

The assumed premium volumes of the Serbian insurance company that refer to the non-life lines of business are shown in Table 30.

Table 30: Premium volume of the Serbian insurance company by line of business (non-life)

Line of business	Premium volume (in EUR)
MTPL	28,979,464
MO	8,583,173
MAT	327,536
Fire	8,909,035
GL	1,695,500
CS	1,003,167
LE	0
AS	1,695,608
Misc	215,829

Source: Own work

The assumed reserve volumes by non-life lines of business of the Serbian insurance company are shown in Table 31.

Table 31: Reserve volume of the Serbian insurance company by line of business (non-life)

Line of business	Reserve volume (in EUR)

(table continues)

Table 31: Reserve volume of the Serbian insurance company by line of business (non-life) (continued)

Line of business	Reserve volume (in EUR)
MTPL	16,492,281
MO	2,240,306
MAT	122,903
Fire	1,121,050
GL	589,661
CS	187,366
LE	0
AS	54,214
Misc	38,175

Source: Own work

Based on these assumptions, the total volume measure of the Serbian insurance company is calculated. It is assumed that the factor for geographical diversification is 100% for all lines of business. The calculation and results for the total volume measure of the Serbian insurance company by non-life line of business is shown in Table 32.

Table 32: Total volume measure of the Serbian insurance company by line of business (non-life)

Line of business	Premium volume in EUR (1)	Reserve volume in EUR (2)	DIV factor in % (3)	Total volume measure in EUR (4) ((4)=(1)+(2))*(0.75+0.25*(3))
MTPL	28,979,464	16,492,281	100	45,471,745
MO	8,583,173	2,240,306	100	10,823,478
MAT	327,536	122,903	100	450,439
Fire	8,909,035	1,121,050	100	10,030,085
GL	1,695,500	589,661	100	2,285,161
CS	1,003,167	187,366	100	1,190,533
LE	0	0	100	0
AS	1,695,608	54,214	100	1,749,822
Misc	215,829	38,175	100	254,003

Source: Own work

After calculating the standard deviations by lines of business in the same manner as for the Slovenian insurance company, the total risk in terms of premiums and reserves by line of business was calculated. The results are shown in Table 33.

Table 33: Total risk of the Serbian insurance company by line of business (non-life)

Line of business	Total volume measure V in EUR (1)	Standard deviation σ in % (2)	Total risk by line of business in EUR (3) ((3)=(1)*(2))
MTPL	45,471,745	7	3,319,502
MO	10,823,478	7	791,631
MAT	450,439	13	57,103
Fire	10,030,085	6	633,712

(table continues)

Table 33: Total risk of the Serbian insurance company by line of business (non-life) (continued)

Line of business	Total volume measure V in EUR (1)	Standard deviation σ in % (2)	Total risk by line of business in EUR (3) ((3)=(1)*(2))
GL	2,285,161	10	229,314
CS	1,190,533	18	208,591
LE	0	0	0
AS	1,749,822	7	114,947
Misc	254,003	13	32,554

Source: Own work

The final results for premium and reserve risk of the Serbian insurance company are shown in Table 34.

Table 34: Capital requirement for premium and reserve risk of the Serbian insurance company (non-life)

SCR for premium and reserve risk (1) ((1)=3*(2)*(3))	12,855,344 EUR
Combined standard deviation (2) ((2)=(4)/(3))	5.93%
Total Volume measure (3)	72,255,267 EUR
Total risk (4) (4)= $\sqrt{\sum \mathrm{Corr}_{(s,t)} * V_s * \sigma_S * V_t * \sigma_t}$	4,285,115 EUR
Diversification (5) ((5)=(4)-(6))	-1,102,239 EUR
Sum of risks by line of business (6)	5,387,354 EUR

Source: Own work

Continuing with the lapse risk sub-module, the assumed values of assets and liabilities before and after lapse shocks are shown in Table 35, together with the calculation of the capital requirement.

Table 35: Capital requirement for lapse risk of the Serbian insurance company (non-life)

Initial values before lapse shock in EUR		Values after lapse shock in EUR		SCR in EUR
Assets (1)	Liabilities (2)	Assets (3)	Liabilities (4)	(1)-(2)-((3)-(4))
-395,204	11,475,074	-1,292,393	15,936,763	5,358,877

Source: Own work

The assumed capital requirements for each catastrophe sub-module, as well as the calculation of the total capital requirement for catastrophe risk is shown in Table 36.

Table 36: Capital requirement for catastrophe risk of the Serbian insurance company (non-life)

Risk module/sub-module	Capital requirement in EUR

(table continues)

Table 36: Capital requirement for catastrophe risk of the Serbian insurance company (non-life) (continued)

Risk module/sub-module	Capital requirement in EUR
Windstorm	377,257
Earthquake	172,268
Flood	374,483
Hail	335,615
Subsidence	0
Natural catastrophe risk $SCR_{natCAT} = \sqrt{\sum_i SCR_i^2}$	651,823
Man-made risk Fire	500,553
Man-made risk Motor	375,384
Man-made risk Marine	187,191
Man-made risk Credit and suretyship	742,010
Man-made risk Liability	1,080,716
Man-made risk Aviation	0
Man-made catastrophe risk $SCR_{mmCAT=}\sqrt{\sum_i SCR_i^2}$	1,464,593
Other non-life catastrophe risk	171,960
Total catastrophe risk $SCR_{nlCAT} = \sqrt{(SCR_{natCAT} + SCR_{npproperty})^2 + SCR_{mmCAT}^2 + SCR_{CATother}^2}$	1,612,289

Source: Own work

Finally, I calculated the total capital requirement for non-life underwriting risk based on the data for premium and reserve risk, lapse risk and catastrophe risk. In terms of materiality, non-life underwriting risk is one of the most significant risk modules. The capital requirement for this risk module is 14,386,031 EUR and it represents 47% of the own funds. As it can be seen in Table 37, the largest part of the capital requirements in this module come from the premium and reserve risk – in the amount of 12,855,344 EUR. The exposure to the premium risk, measured by the volume of net earned premium is 51,409,312 EUR and the exposure to the reserve risk, measured by the volume of net claims outstanding is 20,845,955 EUR. Capital requirements for lapse and catastrophe risk are significantly lower.

Table 37: Capital requirement for non-life underwriting risk and its sub-modules of the Serbian insurance company

Non-life underwriting risk	Value in EUR	Share in own funds in %
Exposure to premium risk	51,409,312	169
Exposure to reserve risk	20,845,955	69
Premium and reserve risk	12,855,344	42
Lapse risk	5,360,529	18
CAT	1,612,289	5
Total SCR for non-life underwriting risk	14,386,031	47

Source: Own work

As mentioned before, the capital requirements for health underwriting risk are valued on the same principles as the non-life business is valued, so the same calculations were obtained

for this module. The assumed premium volumes and reserve volumes of the Serbian insurance company by line of business are shown in Table 38 and Table 39.

Table 38: Premium volume by line of business of the Serbian insurance company (health)

Line of business	Premium volume (in EUR)
ME	3,913,824
IP	1,978,776

Source: Own work

Table 39: Reserve volume by line of business of the Serbian insurance company (health)

Line of business	Reserve volume (in EUR)
ME	509,478
IP	287,921

Source: Own work

For the health module it is also assumed that the factor for geographical diversification is 100% for all lines of business. Based on these assumptions, the total volume measure is calculated, as shown in Table 40.

Table 40: Total volume measure of the Serbian insurance company by line of business (health)

Line of business	Premium volume in EUR (1)	Reserve volume in EUR (2)	DIV factor in % (3)	Total volume measure in EUR (4) ((4)=(1)+(2))*(0.75+0.25*(3))
ME	3,913,824	509,478	100	4,423,302
IP	1,978,776	287,921	100	2,266,697

Source: Own work

The standard deviations of both lines of business were calculated in the same manner as for the non-life business, and the total risk measure regarding premium and reserve was calculated. The results are shown in Table 41 and Table 42.

Table 41: Volume measure, standard deviation and total risk by line of business of the Serbian insurance company (health)

Line of business	Total volume measure V in EUR (1)	Standard deviation σ in % (2)	Total risk by line of business in EUR (3) ((3)=(1)*(2))
ME	4,423,302	5	211,710
IP	2,266,697	8	191,558

Source: Own work

Table 42: Capital requirement for premium and reserve risk of the Serbian insurance company (health)

(table continues)

Table 42: Capital requirement for premium and reserve risk of the Serbian insurance company (health) (continued)

SCR for premium and reserve risk (1) ((1)=3*(2)*(3))	1,048,158 EUR
Combined standard deviation (2) ((2)=(4)/(3))	5.22%
Total Volume measure (3)	6,689,999 EUR
Total risk (4) $(4)=\sqrt{\sum \mathrm{CorrS}_{(s,t)} * \mathrm{V_s} * \sigma_S * \mathrm{V_t} * \sigma_t}$	349,386 EUR
Diversification (5) ((5)=(4)-(6))	-53,882 EUR
Sum of risks by line of business (6)	403,269 EUR

Source: Own work

The capital requirement for lapse risk was calculated in the same manner as for non-life business, i.e. values of assets and liabilities before and after the lapse shock were assumed, based on which the capital requirement was calculated, as shown in Table 43.

Table 43: Capital requirement for lapse risk of the Serbian insurance company (health)

Initial values before lapse shock in EUR		Values after lapse shock in EUR		SCR in EUR
Assets (1)	Liabilities (2)	Assets (3)	Liabilities (4)	(1)-(2)-((3)-(4))
-8,761	644,927	-22,709	942,000	311,020

Source: Own work

Regarding catastrophe risk, it is assumed that the Serbian insurance company is only exposed to accident concentration risk, which is why the capital requirement for catastrophe risk is equal to the capital requirement for accident concentration risk, as shown in Table 44.

Table 44: Capital requirement for catastrophe risk of the Serbian insurance company (health)

Risk module	SCR in EUR
Mass accident risk	0
Accident concentration risk	1,005,182
Pandemic risk	0
Total health catastrophe risk	1,005,182

Source: Own work

The capital requirement for health underwriting risk is 1,659,897 EUR and it represents 5% of the own funds. The same as non-life underwriting risk, this module is composed of three sub-modules: premium and reserve risk, lapse risk and catastrophe risk.

As shown in Table 45, the capital requirements for premium and reserve risk, and for catastrophe risk represent 3% of the own funds (each individually) and the capital requirement for lapse risk represents 1% of the own funds, which shows, that in terms of materiality, health underwriting risk is far less significant compared to non-life underwriting risk.

Table 45: Capital requirement for health underwriting risk and its sub-modules of the Serbian insurance company

Health underwriting risk	Value	Share in own funds
Exposure to premium risk	5,892,601	19
Exposure to reserve risk	797,399	3
Premium and reserve risk	1,048,158	3
Lapse risk	311,020	1
CAT	1,005,183	3
Total SCR for health underwriting risk	1,659,897	5

Source: Own work

For the life underwriting module, as well as for the Slovenian insurance company, values of assets and liabilities before and after shocks were assumed and the capital requirement was calculated for separate sub-modules and for the total life underwriting risk, as shown in Table 46.

Table 46: Initial values and values after shock of assets and liabilities for each life sub-module of the Serbian insurance company

Risk module	Initial values before shock in EUR		Values after shock in EUR		SCR in EUR
	Assets (1)	Liabilities (2)	Assets (3)	Liabilities (4)	(5) ((5)=(1)-(2)-((3)-(4))
Mortality risk	0	3,891,652	0	4,977,697	1,086,045
Longevity risk	0	4,412,396	0	4,454,996	42,600
Disability-morbidity risk	0	0	0	0	0
Lapse risk					
risk of increase in lapse rates	0	3,888,045	0	4,304,798	416,753
risk of decrease in lapse rates	0	3,888,045	0	4,197,823	309,777
mass lapse risk	0	3,888,054	0	4,118,340	230,287
Life expense risk	0	4,474,707	0	5,018,482	543,775
Revision risk	0	520,744	0	560,038	39,294
Life catastrophe risk	0	3,891,652	0	4,182,145	290,493
Diversification (Total SCR life-sum of separate SCR of sub-modules)					-814,184
Total life underwriting risk $SCR_{life} = \sqrt{\sum_{i,j} CorrNL_{(i,j)} * SCR_i * SCR_j}$					1,604,775

Source: Own work

As shown in Table 47, the capital requirement for life underwriting risk is 1,604,775 EUR and it represents 5% of the own funds. Mortality risk, with the capital requirement of 1,086,045 EUR, represents the highest share of own funds (4%). Similar to health

underwriting risk, life underwriting risk is far less material compared to non-life underwriting risk.

Table 47: Capital requirement for life underwriting risk and its sub-modules of the Serbian insurance company

Life underwriting risk	Value in EUR	Share in own funds in %
Mortality risk	1,086,045	4
Longevity risk	42,600	0
Disability-morbidity risk	0	0
Lapse risk	416,753	1
Life expense risk	543,775	2
Revision risk	39,294	0
Life catastrophe risk	290,493	1
SCR	1,604,775	5

Source: Own work

4.2.1.2 Market risk

Exposure to market risk is one of the most significant exposures of the underwriting. The same as for the Slovenian insurance company, the values of assets and liabilities before and after the market shocks are assumed, based on which the capital requirement for separate market sub-modules were calculated. The results are shown in Table 48.

Table 48: Initial values and values after shocks for each market risk sub-module of the Serbian insurance company

Risk module	Initial values before shock in EUR		Values after shock in EUR		SCR in EUR
	Assets	Liabilities	Assets	Liabilities	
Interest rate risk					418,180
interest rate down shock	61,988,534	40,760,968	62,288,882	41,479,496	418,179
interest rate up shock	61,988,534	40,760,968	59,641,936	38,433,142	18,771
Equity risk					30,899
type 1 equities	-	-	-	-	-
type 2 equities	61,654	0	30,755	0	30,899
Property risk	9,727,441	2,916,762	7,295,580	2,187,572	1,702,670
Spread risk	60,012,880		54,387,167		5,625,713
Market risk concentrations	69,801,975	-	-	-	12,844,832
Currency risk					558,527

(table continues)

Table 48: Initial values and values after shocks for each market risk sub-module of the Serbian insurance company (continued)

increase in the value of foreign currency	6,481,424	4,247,315	8,101,780	5,309,143	0
decrease of the value of foreign currency	6,481,424	4,247,315	4,861,068	3,185,486	558,527
Diversification					-6,511,360
Total market risk					14,669,460

Source: Own work

As spread risk and market risk concentrations are the main risk modules for which the assumptions given in the Regulation are analyzed, in this part a more detailed analysis is done regarding the assumptions used and the calculations made for these modules.

Regarding the spread risk module, it is assumed that the Serbian insurance company has investments that only belong to the "bonds and loans" category according to Article 175 of the Regulation. It is assumed that these investments in bonds and loans are in total amount of 60,012,880 EUR. That would be the value of assets that are exposed to spread risk, i.e. the initial value before shock. It is assumed that out of the total portfolio with market value of 60,012,880 EUR, there are investments in 12 corporate bonds with a credit quality step 4 and 10 corporate bonds without a credit assessment (with total market value of 12,808,137 EUR) and investments in 26 government bonds, which also have a credit quality 4 (with market value of 47,204,743 EUR). Regarding the portfolio of 22 corporate bonds, it is assumed that 15 bonds have a duration up to 5 years, 4 bonds have a duration from 5 to 10 years and 3 bonds have a duration from 10 to 15 years. The bonds are split in these three categories based on Article 176 of the Regulation. It is assumed that there are no bonds in the portfolio with a duration of more than 15 years. After that, I calculated the market value of each bond *i* after the risk factors from Article 176 of the Regulation were applied. The risk factors for bonds and loans with a credit quality 4 are shown in Table 49.

Table 49: Risk factors for spread risk for bonds (standard formula)

Duration (in years)	Stress formula	Risk factors (in %)	
		a_i	b_i
up to 5	b_i*duration$_i$	-	4.5
more than 5 and up to 10	a_i+b_i*(duration$_i$ – 5)	22.5	2.5
more than 10 and up to 15	a_i+b_i*(duration$_i$ – 10)	35.0	1.8

Adapted from the Commission Delegated Regulation (EU) 2015/35

For the bonds and loans without a credit assessment, I used the stress factor $stress_i=3\%*duration_i$ defined in Article 176 of the Regulation for bonds and loans with a duration up to 5 years.

After applying the shocks, the market value of the bonds would be 10,924,647 EUR, which is a decrease of 1,883,490 EUR in comparison with the value before the shocks.

Regarding the government bonds, I assumed that there are 20 government bonds in the portfolio with a duration of up to 5 years and 6 government bonds with a duration of 5 to 10 years. It is assumed that there are no government bonds with a duration longer than 10 years. Based on Article 180 of the Regulation, each government bond *i* should be shocked with the risk factors shown in Table 50.

Table 50: Risk factors for spread risk for government bonds (standard formula)

Duration (in years)	Stress formula	Risk factors (in %)	
		a_i	b_i
up to 5	$b_i*duration_i$	-	2.5
more than 5 and up to 10	$a_i+b_i*(duration_i - 5)$	12.5	1.5

Adapted from the Commission Delegated Regulation (EU) 2015/35

After applying the shocks, the market value of the government bonds would be 43,462,521 EUR, which is a decrease of 3,742,222 EUR compared to the value before the shocks. That means that the total value of assets after shocks in spread risk module would be 54,387,167 EUR. This means that the basic own funds would decrease for 5,625,713 EUR as a result of a decrease in the market value of the bonds in the portfolio (calculated according to the risk factors given in Article 176 and Article 180 of the Regulation).

Regarding the market risk concentration module, I assumed that the value of assets that are considered in this risk module, i.e. all the investments that the insurance company has (equities, bonds, deposits and property) is 69,801,975 EUR. It is assumed that the company has 54 securities in its portfolio, out of which 15 securities refer to counterparties with credit quality step 6, 38 securities refer to counterparties with credit quality step 4 and one security refers to counterparty with credit quality step 3. Out of the securities with credit quality step 4, 26 are the government bonds that were considered in the spread risk module as well, with total market value of 47,204,743 EUR.

In order to calculate the capital requirement for market risk concentrations, based on Article 183 of the Regulation, I had to firstly calculate the excess exposure for each SNE. In order to do that, I assigned relative excess exposure thresholds to each single name exposure based on the parameters given in Article 185 of the Regulation, i.e. threshold of 1.5%. Having done that, I calculated the excess exposure for each single name exposure based on the formula given in Article 184 of the Regulation. Then, I assigned each single name exposure a risk factor based on the parameters given in Article 186 of the Regulation, i.e. risk factor of 27%

for the exposures that refer to counterparties with credit quality step of 3 and risk factor of 73% for the exposures that refer to counterparties with credit quality step of 6. Based on Article 187 of the Regulation, the government bonds are assigned a risk factor of 27%. Additionally, I applied a risk factor of 12% and a relative excess exposure threshold of 10% for exposure to immovable property (whose assumed value is 9,727,441 EUR), according to Article 187 of the Regulation. Based on the risk factors and on the excess exposures, I calculated the capital requirement for market risk concentrations.

Finally, as it can be seen in Table 51, the capital requirement for market risk is 14,669,460 EUR and it is one of the risks the undertaking is mostly exposed to, by representing 48% of its own funds. As it is shown in Table 51, regarding market risk, the undertaking is mostly exposed to market risk concentrations (61%), followed by spread risk (27%). The capital requirement for market risk concentrations is a result of a high share of government bonds in the investment portfolio of the undertaking. Considering that Serbia is not a member of the EU, due to Solvency II Directive, it would have a risk factor other than 0% (unlike EU member states) which would depend on its weighted average credit quality step. As the weighted average credit quality step of Serbian government bonds is 4, the assigned risk factor would be 27%, which influences higher capital requirements.

The undertaking is also significantly exposed to spread risk. The capital requirement for spread risk depends on assets' type, credit rating and duration. In this case also, investments in government bonds are the main reason for the higher capital requirements, as they have lower credit rating which leads to higher risk stress factors applied.

Table 51: Capital requirement for market risk and its sub-modules of the Serbian insurance company

Market risks	Capital requirement in EUR	Share in own funds in %	Share of risk sub-modules in market risk in %
Interest rate risk	418,180	1	2
Equity risk	30,899	0	0
Property risk	1,702,670	6	8
Spread risk	5,625,713	19	27
Market risk concentrations	12,844,832	42	61
Currency risk	558,527	2	3
Total market risk	14,669,460	48	-

Source: Own work

For obtaining a wider picture of the asset type allocation in the Serbian insurance market in 2021, it is important to have in mind that 60% of the portfolio refers to debt securities, 7.9% refers to property, 6.6% refers to cash and short-term deposits, 8.3% refers to receivables, 0.6% refers to equity securities and 16.6% refers to remaining asset types (NBS, 2021). It can be notified that there is quite a difference in the portfolio structures in the Serbian and EU market. Insurance companies in Serbia tend to invest even more in debt securities

compared to EU companies and there is a significant difference in investment in equity securities – as they are one of the highest shares in EU market and only 0.6% in the Serbian market.

4.2.1.3 Counterparty default risk

Regarding the counterparty default risk and based on the categorization of exposures in Article 189 of the Regulation, I considered reinsurance arrangements and cash at banks as type 1 exposures. For type 2 exposures I assumed that the company has receivables from policyholder debtors and receivables for mortgage loans. Regarding type 2 exposures I only assumed that the receivables from policyholder debtors are in the amount of 3,969,993 EUR and that the receivables for mortgage loans are in the amount of 492,965 EUR.

The part that I calculated and the data for which I tested the provided parameters in the Regulation is the capital requirement for type 1 exposures. Firstly, regarding the reinsurance arrangements, the risk-mitigation effect should be calculated. Based on Article 196 of the Regulation, the risk-mitigation effect would be the difference between the hypothetical capital requirement for underwriting risk if the reinsurance arrangement did not exist and the capital requirement for underwriting risk. For this purpose, I have used the capital requirement for underwriting risk that was explained in chapter 4.2.1.1. The part that I additionally calculated is the hypothetical capital requirement for underwriting risk if the reinsurance arrangement did not exist, in order to calculate the capital requirement that refers only to the reinsurance risk, i.e. the risk that the reinsurance companies that have arrangements with the company would default.

For the purpose of the simulation, I have assumed that the insurance company has reinsurance arrangements with 15 counterparties that all are based in Serbia, and only one of them has credit quality step 3, for the other 14 counterparties I assumed that they do not have a credit assessment by a nominated External Credit Assessment Institution (hereinafter ECAI), thus based on Article 199 of the Regulation, have credit quality step 6. The probability of default (hereinafter PD) of counterparties that have credit quality step 6 is 4.2% according to Article 199 of the Regulation. Additionally, I have assumed the premium and reserve volume by lines of business if, hypothetically, there is no reinsurance, as shown in Table 52.

Table 52: Assumed premium and reserve volume for counterparty default risk of the Serbian insurance company

Line of business	Premium volume in EUR	Reserve volume in EUR
ME	3,946,075	514,799
IP	2,057,678	309,478
MTPL	29,455,185	16,501,700

(table continues)

Table 52: Assumed premium and reserve volume for counterparty default risk of the Serbian insurance company (continued)

Line of business	Premium volume in EUR	Reserve volume in EUR
MO	9,184,388	2,300,110
MAT	943,525	471,862
Fire	17,319,720	1,865,073
GL	4,060,487	1,083,083
CS	3,110,832	746,474
LE	0	0
AS	1,695,608	54,214
Misc	1,798,395	176,181

Source: Own work

The difference between the premium volume described in chapter 4.2.1.1 and the hypothetical premium volume with no reinsurance would be the reinsurance volume premium. The same goes for reserve volume premium. Additionally, for each reinsurer I assumed certain shares in premium and reserves in the total premiums and reserves ceded for every line of business. In the end, I multiplied each share of the reinsurer with the total premium/reserve reinsurance volume. That was done in order to obtain the single name exposures (in terms of premiums and volumes), as described in Article 190 in the Regulation, which is needed for the calculation of the risk-mitigating effect. In the same manner described in chapter 4.2.1.1, with the given assumptions in Table 52, I calculated the capital requirement for premium and reserve risk.

I also assumed the capital requirement for each sub-module of catastrophe risk if, hypothetically, there is no reinsurance, and calculated the capital requirements for each module (natural catastrophe risk, man-made catastrophe risk, total non-life catastrophe risk and total health catastrophe risk). The assumptions for catastrophe risk are shown in Table 53.

Table 53: Assumed capital requirements for catastrophe risk for counterparty default risk (Serbian insurance company)

Risk module/sub-module	Capital requirement in EUR
Windstorm	40,024,165
Earthquake	2,153,352
Flood	15,426,726
Hail	7,499,631
Subsidence	0
Natural catastrophe risk $\mathrm{SCR}_{\mathrm{natCAT}} = \sqrt{\sum_i \mathrm{SCR}_i^2}$	43,598,154
Man-made risk Fire	26,604,802
Man-made risk Motor	10,967,500
Man-made risk Marine	3,534,448
Man-made risk Credit and suretyship	3,500,042
Man-made risk Liability	4,051,642

(table continues)

Table 53: Assumed capital requirements for catastrophe risk for counterparty default risk (Serbian insurance company) (continued)

Risk module/sub-module	Capital requirement in EUR
Man-made risk Aviation	0
Man-made catastrophe risk $SCR_{mmCAT=}\sqrt{\sum_i SCR_i^2}$	29,483,215
Other non-life catastrophe risk	1,211,756
Total catastrophe risk $SCR_{nlCAT} = \sqrt{(SCR_{natCAT} + SCR_{npproperty})^2 + SCR_{mmCAT}^2 + SCR_{CATother}^2}$	52,645,297
Mass accident risk	0
Accident concentration risk	1,570,598
Pandemic risk	0
Total health catastrophe risk	1,570,598

Source: Own work

Based on these assumptions, the total capital requirement for underwriting risk, if, hypothetically, there is no reinsurance, calculated in the same manner and based on the same formulas as in chapter 4.2.1.1, would be 58,588,907. The difference between the capital requirements described in chapter 4.2.1.1 and the hypothetical capital requirements, if there was no reinsurance, would be the reinsurance capital requirements for catastrophe risk. The same as for the premium and reserve risk, I also assumed certain shares of each reinsurer in the capital requirements of each sub-module of catastrophe risk. Then, each share was multiplied with the total reinsurance capital requirements, in order to obtain the single name exposures to catastrophe risk by counterparties.

In the end, premium and reserve risk and catastrophe risk by counterparties were used in order to calculate the risk-mitigating effect as described in Article 196 of the Regulation.

The additional assumptions in the simulation were the values of reinsurance recoverables of each reinsurer that the insurance company has arrangements with. Based on those assumed reinsurance recoverables and based on the risk-mitigating effect for each reinsurer, the loss-given default was calculated based on the formula provided in Article 192 of the Regulation (assuming there is no collateral in the reinsurance arrangements).

According to Article 200 and Article 201 in the Regulation, the capital requirement for reinsurance arrangement finally depends on the loss-given default of each counterparty and their probability of default, as assigned in Article 199 of the Regulation. Based on the parameters given in Article 199 of the Regulation, the counterparties that have credit quality step 3 would be assigned PD of 0.24% and counterparties that have credit quality step 6 would be assigned PD of 4.2%.

Regarding the other exposures type 1, i.e. the cash in banks, according to Article 192 of the Regulation, the loss-given default should be equal to the exposure itself to each counterparty. I assumed that the insurance company has cash in 11 banks (in total amount of 4,033,644

EUR), out of which only one has a credit quality step 3 and the others are non-rated, thus have credit quality step 6, according to Article 199 of the Regulation. The same as for the reinsurance arrangements, counterparties with credit quality step 3 would have PD of 0.24% and counterparties with credit quality step 6 would have PD of 4.2%. The calculation of capital requirements was calculated in the same manner as the reinsurance arrangements.

As it is shown in Table 54, the capital requirement for counterparty default risk is 15,798,902 EUR and it represents 52% of the undertaking's own funds. Type 1 exposures have significantly higher share in own funds (50%) than Type 2 exposures (2%). Analyzing Type 1 exposures in more detail, it can be concluded that the capital requirement for the risk mitigation contracts is much higher (13,481,598 EUR) compared to the capital requirement for the financial contracts (2,903,110 EUR). What is worth mentioning at this point is the fact that, according to the current legislation in Serbia, reinsurance can only be transacted by authorized domestic reinsurance companies. This means that insurance companies in Serbia need to cede through either a local reinsurer or to establish their own reinsurance subsidiaries (Ghetu, 2013).

Table 54: Capital requirement for counterparty default risk of the Serbian insurance company

Counterparty default risk	Capital requirement in EUR	Share in own funds in %
Capital requirement for Type 1 exposures	15,290,613	50
Risk mitigation contracts	13,481,598	44
Financial contracts (cash)	2,903,110	10
Capital requirement for Type 2 exposures	669,444	2
Receivables from intermediaries due more than 90 days	0	0
Other receivables	3,969,993	13
Financial contracts (mortgage loans)	492,966	2
Capital requirement for counterparty default risk	15,798,902	52

Source: Own work

4.2.1.4 Operational risk

Regarding the operational risk, two calculations of capital requirements are made: capital requirement based on premium and capital requirement based on technical provisions. The capital requirement based on premium considers the earned gross premiums in the last 12 months and in the previous 12 months, whereas the capital requirement based on technical provisions considers the gross technical provision. The capital requirement for operational risk is the maximum of two: the one based on premium and the one based on technical provisions.

As shown in Table 55, the capital requirement based on premiums is double the capital requirement based on technical provisions, which leads to the result that the capital requirement for operational risk of the undertaking is 2,417,770 EUR. By its share in own funds (8%) this risk represents a far smaller exposure, compared to the previous risks.

Table 55: Capital requirement for operational risk of the Serbian insurance company

Operational risk	Value in EUR	Share in own funds in %
Capital requirement based on premium	2,417,770	8
Capital requirement based on technical provisions	1,101,676	4
Earned gross premium (in the last 12 months)	76,334,295	-
Earned gross premium (in the previous 12 months)	67,529,893	-
Gross technical provisions - non-life	36,142,975	-
Gross technical provisions - life	3,863,818	-
Capital requirement for operational risk	2,417,770	8

Source: Own work

4.2.1.5 Capital adequacy

After calculating the capital requirement for each risk module (non-life underwriting risk, health underwriting risk, life underwriting risk, market risk and counterparty default risk), BSCR is calculated. The calculation of SCR considers BSCR, operational risk and LACDT.

As shown in Table 56, the total solvency capital requirements of the undertaking amount to 36,701,427 EUR, while the assumed own funds are equal to 30,355,267 EUR. That means that there is deficiency of capital in the amount of 6,346,160 EUR for the undertaking to satisfy its capital requirements based on the standard formula. Interpreting the results, the undertaking is capitally inadequate as its solvency ratio is 83%.

Table 56: Capital adequacy of the Serbian insurance company

BSCR	34,305,031 EUR
Operational risk	2,417,770 EUR
Loss-absorbing capacity of deferred taxes	-21,374 EUR
Solvency capital requirement	36,701,427 EUR
Own funds	30,355,267 EUR
Solvency ratio	83%

Source: Own work

4.2.2 Solvency capital requirements and capital adequacy calculation with changed parameters

In this part, a simulation of solvency capital requirements with changed parameters will be shown. Precisely, the goal is to see how the capital requirement would differ if a difference is made in the assumptions used in the standard formula.

Two risk modules were tested for this simulation: market risk and counterparty default risk, as both of them are two out of the three largest exposures of the undertaking and as they are mostly influenced by parameters set in the Regulation that materially differ between EU and non-EU countries. Two scenarios are made in the analysis – the difference between them is in capital requirement for counterparty default risk, i.e. different credit ratings are used for the counterparties to test the volatility of the parameter. Scenario 1 is the scenario where for the counterparty default risk capital requirements, I assumed credit rating step 2 for all the counterparties of the Serbian insurance company. Scenario 2 is the scenario where for the counterparty default risk capital requirements, I assumed credit rating step 4 for all the counterparties of the Serbian insurance company. The capital requirements for market risk are equal in both scenarios (the assumption that Serbia is an EU member state is used for calculations for market risk). All the other risk modules are unchanged, compared to the initial scenario based on the standard approach (described in chapter 4.2.1).

The test on market risk is made to test whether the high risk factors, that are mandatory for government bonds issued in countries outside the EU, significantly influence the level of capital requirement and to analyze whether the same undertaking would have a better solvency ratio and bigger capital adequacy only if we assume that it is an EU member state (the rest of the indicators remain the same). The changes in the capital requirement for market risk are in the sub-modules market risk concentrations and spread risk. The test on counterparty default risk is made to test by how much the capital requirement for Type 1 exposures would change if the counterparties had better credit ratings (the rest of the data remains unchanged compared to the calculation in chapter 4.2.1.3) and analyze how that would affect the undertaking's capital adequacy. The capital requirement for Type 2 exposures remains unchanged.

The capital requirements for each risk module in this analysis are shown in Table 57. In addition, there are more detailed explanations about the parameters used and about the change in the results, compared to the standard approach.

Table 57: Capital requirements of the Serbian insurance company (changed parameters)

	SCR (scenario 1) in EUR	SCR (scenario 2) in EUR	Share of risks in own funds (scenario 1) in %	Share of risks in own funds (scenario 2) in %	Share of risks in SCR (scenario 1) in %	Share of risks in SCR (scenario 2) in %

(table continues)

Table 57: Capital requirements of the Serbian insurance company (changed parameters) (continued)

	SCR (scenario 1) in EUR	SCR (scenario 2) in EUR	Share of risks in own funds (scenario 1) in %	Share of risks in own funds (scenario 2) in %	Share of risks in SCR (scenario 1) in %	Share of risks in SCR (scenario 2) in %
Market risk	4,756,132	4,756,132	16	16	20	15
Counterparty default risk	1,614,843	9,035,632	5	30	7	29
Life	1,604,775	1,604,775	5	5	7	5
Health	1,659,897	1,659,897	5	5	7	5
Non-life	14,386,031	14,386,031	47	47	60	46
Diversification	-6,399,796	-8,505,996	-	-	-	-
BSCR	17,621,882	22,936,471	-	-	-	-
Operational risk	2,417,770	2,417,770	8	8	-	-
LACDT	-21,374	-21,374	-	-	-	-
Own funds	30,355,267	30,355,267	-	-	-	-
Solvency capital requirement	20,018,278	25,332,867	-	-	-	-

Source: Own work

Regarding market risk concentrations, based on the Regulation, all exposures to the EU member states' government are assigned a risk factor of 0% for market concentration risk, according to Article 187 of the Regulation. In this simulation, it is assumed that Serbia is an EU member state, thus the exposures to government bonds are not assigned a risk factor. The rest of the exposures remain unchanged.

Regarding spread risk, based on Article 180 of the Regulation, the exposures to bonds and loans to central governments and central banks in EU member states are assigned a risk factor of 0%, i.e. they are treated as risk-free. In this simulation, it is assumed that Serbia is an EU member state, thus the exposures to government bonds are not assigned risk factors. The modified duration of the government bonds and all other exposures remain unchanged.

As it can be seen in Table 57, if we assume that Serbia is an EU member state, thus the government bonds issued in Serbia are risk-free, the capital requirement for market risk would be 4,756,132 EUR, which is 9,913,328 EUR less than in the actual scenario.

It is important to consider the volatility of capital requirements for market risk to the not necessarily appropriate assumptions used by default when a country is an EU member state. Generally, it can underestimate the exposures of the insurer and its capital requirements for market risk, especially if we consider the Mediterranean member states. For example, Greece has a credit rating of BB according to Fitch (n.d.), BB+ based on S&P (n.d.) or Ba3 based on Moody's (n.d.), and if we want to grade how adequate the standard formula is, i.e. how high the capital requirements for market risk would be if we consider its credit rating - that

would definitely assign its exposures to a risky group class, where risk factors other than 0% are applied. Ultimately, the capital requirements would be higher and thus, underestimated by using the standard approach.

A more detailed overview of the capital requirements for each market risk sub-module in this analysis is shown in Table 58.

Table 58: Capital requirements for market risk and its sub-modules of the Serbian insurance company (changed parameters)

Market risks	Capital requirement in EUR	Share of risks in own funds in %	Share of risk sub-modules in market risk in %
Interest rate risk	418,180	1	5
Equity risk	30,899	0	0
Property risk	1,702,670	6	22
Spread risk	1,883,491	6	24
Market risk concentrations	3,110,263	10	40
Currency risk	558,527	2	7
Total market risk	4,756,132	16	-

Source: Own work

On the other hand, regarding the counterparty default risk, as mentioned before, the regulation in Serbia allows insurance companies to cede part of their obligations only to local reinsurers. Even though these reinsurers might be subsidiaries of well-know and established European (re)insurance companies with better credit quality steps, they still have lower credit quality step.

For the purpose of the simulation, in the first scenario I assumed that all the counterparties of the insurance company (reinsurers and banks) have a credit rating 2, which is assigned a PD of 0.05% (based on Article 199 of the Regulation), in order to see how significant the difference would be when the counterparty has a better rating. In the second scenario I assumed a less significant difference in the rating compared to the initial data used in chapter 4.2.1 – I took credit rating 4 for all the counterparties of the insurance company. The PD for exposures to counterparties with credit rating 4 is 1.2% (based on Article 199 of the Regulation). Exposures to counterparties remain unchanged in the simulations. As shown in Table 59, the capital requirement for counterparty default risk, assuming the counterparties are rated and/or have better credit ratings, is 1,614,843 EUR in scenario 1 and 9,035,632 EUR in scenario 2. The capital requirement in scenario 1 is 14,184,060 EUR lower than in the actual scenario and the capital requirement in scenario 2 is 6,763,270 EUR lower than in the actual scenario.

Table 59: Capital requirement for counterparty default risk of the Serbian insurance company (changed parameters)

(table continues)

Table 59: Capital requirement for counterparty default risk of the Serbian insurance company (changed parameters) (continued)

Counterparty default risk	Capital requirement (scenario 1) in EUR	Capital requirement (scenario 2) in EUR	Share of risks in own funds (scenario 1) in %	Share of risks in own funds (scenario 2) in %
Capital requirement for Type 1 exposures	1,050,866	8,522,693	3	28
Risk mitigation contracts	924,421	7,502,281	3	25
Financial contracts (cash)	195,803	1,586,159	1	5
Capital requirement for Type 2 exposures	669,444	669,444	2	2
Receivables from intermediaries due more than 90 days	0	0	0	0
Other receivables	3,969,993	3,969,993	13	13
Financial contracts (mortgage loans)	492,966	492,966	2	2
Capital requirement for counterparty default risk	1,614,843	9,035,632	5	30

Source: Own work

As presented in Table 60, if we assume that Serbia is an EU member state, thus its government bonds are risk-free, and if we assume that the credit default swap of the company's counterparties is 2, the company will have a solvency ratio of 152%, i.e. a difference of 69 p.p. compared to the initial calculation. However, if we keep the assumptions for the government bonds, but we assume that the credit quality step of the counterparties is 4 instead of 2, the capital requirement will be higher than in scenario 1, but still significantly lower than the initial scenario – the company in this case would have a solvency ratio of 120% and that is a difference of 37 p.p. compared to the initial scenario.

Table 60: Capital adequacy of the Serbian insurance company (changed parameters)

	Scenario 1	Scenario 2
BSCR	17,621,882 EUR	22,936,471 EUR
Operational risk	2,417,770 EUR	2,417,770 EUR
Loss-absorbing capacity of deferred taxes	-21,374 EUR	-21,374 EUR
Solvency capital requirement	20,018,278 EUR	25,332,867 EUR
Own funds	30,355,267 EUR	30,355,267 EUR
Solvency ratio	152%	120%

Source: Own work

Based on the simulation analysis, I concluded that the capital requirements for market risk can materially differ depending on the risk factors used for government bonds. The Regulation shows a significant difference in the risk treatment for government bonds of countries in the EU and countries outside the EU. Only by assuming that a country is an EU

member state and that their government bonds are risk-free, we get capital requirements for market risk that are 68% lower compared to the requirements calculated if Serbia is not an EU member state. The second conclusion regarding the counterparty default risk is that because of the legal restrictions regarding reinsurance arrangements in Serbia in terms of relying only on Serbian companies, which are mostly non-rated, the probability of default of the reinsurers would be significantly higher even if the reinsurers are subsidiaries of European companies with good credit quality steps. A similar conclusion was made regarding the cash in banks, where European banks are assigned lower probability of default than banks outside the EU, which in this analysis are mostly non-rated. Assuming better credit quality steps for the company's counterparties, the capital requirements for counterparty default risk are 90% lower in scenario 1 compared to the initial calculation (where credit quality step 2 is assumed) and 43% lower in scenario 2 compared to the initial calculation (where credit quality step 4 is assumed).

4.2.3 Sensitivity analysis

In order to test the sensitivity of the capital requirement results to the changes in the data used as an assumption, sensitivity analysis was made for the market risk module of the Serbian insurance company. Market module was chosen for this analysis as it is one of the most material modules for the Serbian insurance company. The previous simulations showed how the results for spread risk sub-module and market risk concentrations sub-module differ when the parameters given by the standard formula are changed. In the following part, it will be shown how the results would differ if we changed the assumed structure of the portfolio that is considered in the two sub-modules (regarding type of securities, duration of the securities, their credit quality and market value).

Namely, for both sub-modules (spread risk and market risk concentrations), I assessed the change in the capital requirement if specific changes are made in the assumptions used when defining the company's investments. The changes in the capital requirements were calculated in relation to the basic scenario, which is the capital requirement for spread and market risk concentrations that was considered in the simulation based on changed parameters in chapter 4.2.2.

Regarding the spread risk sub-module, I calculated the capital requirements for three different scenarios: scenario 1 that was defined by change in the portfolio structure in terms of bonds type, scenario 2 that was defined by change in the portfolio structure in terms of duration and scenario 3 that was defined by an equal increase of the duration for all exposures assumed in the basic scenario.

In scenario 1 for the spread risk sensitivity analysis, I assumed a lower share of the government bonds in the portfolio for 8.22 p.p. compared to the basic scenario. In scenario 2, I assumed a change in the structure of the portfolio in terms of the bonds' duration, i.e. 15 corporate bonds with a duration from 5 to 10 years, 4 corporate bonds with a duration up to

5 years and 3 corporate bonds with a duration from 10 to 15 years on one hand, and on the other hand – 20 government bonds with a duration from 5 to 10 years and 6 government bonds with a duration up to 5 years. In scenario 3, I assumed an increase of the duration of all bonds for 0.5 years assuming the same structure from the basic scenario.

The capital requirements for each scenario for the spread risk sub-module are shown in Table 61.

Table 61: Sensitivity analysis for spread risk

	Basic scenario	Scenario 1	Scenario 2	Scenario 3
Capital requirement for spread risk	1,883,491	3,899,325	2,790,170	1,985,740
Relative change		107.03%	48.14%	5.43%

Source: Own work

As it is shown in Table 61, scenario 1 shows that if we restructure the bonds in the portfolio, i.e. if we decrease the share of government bonds by 8.22 p.p. and increase the share of corporate bonds by 8.22 p.p. (the bonds that are restructured having a total market value of 23,967,291 EUR), the capital requirement for spread risk will increase by 107.03% compared to the basic scenario. The increase of the capital requirement is significantly influenced by the higher risk factors that are applied to corporate bonds (for which in this example is assumed to have a credit quality 4) compared to the government bonds (assuming Serbia is an EU member state).

Table 61 also shows that if we assign a longer duration (from 5 to 10 years) to the 15 corporate bonds from the basic scenario, shorter duration (up to 5 years) to the 4 corporate bonds from the basic scenario, longer duration (from 5 to 10 years) to the 20 government bonds from the basic scenario and shorter duration (up to 5 years) to the 6 government bonds from the basic scenario, we will get a capital requirement for spread risk that is higher for 48.14% compared to the basic scenario.

The last scenario, as shown in Table 61, shows that if we simply increase the duration assumed for all exposures from the basic scenario by 0.5 years, the capital requirement for spread risk will increase by 5.43%.

The sensitivity analysis for spread risk which was done for these three scenarios, shows that the highest impact on the capital requirement is noticed in scenario 1, which is mostly influenced by the assumptions given in the Regulation that refer to the non-riskiness of government bonds in the EU member states.

Regarding the market risk concentrations sub-module, I calculated the capital requirement for three different scenarios: scenario 1 that was defined by decreasing the share of government bonds by 20.37 p.p. (on the account to corporate bonds), scenario 2 that was defined by assuming that all the exposures (with exception of the government bonds) have

a credit quality 3 and scenario 3 that was defined by increasing the market value of all exposures by 10% compared to the basic scenario.

The capital requirements for each scenario for the market concentrations risk sub-module are shown in Table 62.

Table 62: Sensitivity analysis for market risk concentrations

	Basic scenario	Scenario 1	Scenario 2	Scenario 3
Capital requirement for market risk concentrations	3,110,263	20,833,738	1,190,449	3,430,396
Relative change		569.84%	-61.73%	10.29%

Source: Own work

As it is shown in Table 62, if 11 government bonds (with total market value of 24,315,414 EUR) from the basic scenario are classified as corporate bonds with credit quality 4, the capital requirement will increase by 569.84%. The most significant impact on this increase comes from the difference in risk factors applied to the different exposures according to Article 186 and Article 187 of the Regulation – a risk factor of 73% applied to exposures with credit quality 4 and risk factor of 0% applied to government bonds of EU member states.

Table 62 also shows that if we assume that all exposures from the basic scenario (except for the government bonds) have better credit quality, i.e. credit quality 3, the capital requirement for market concentrations risk will decrease by 61.73%.

Finally, as shown in Table 62, if we assume a 10% increase in the market value of all exposures from the basic scenario, the capital requirement will increase by 10.29%.

Similarly as for the spread risk, the sensitivity analysis for market concentrations risk which was done for these three scenarios, shows that the highest impact on the capital requirement is noticed in scenario 1, which is mostly influenced by the assumptions given in the Regulation that refer to the non-riskiness of government bonds in EU member states.

5 INTERPRETATION OF SIMULATION ANALYSIS

To sum up the results from all the simulations done, I made a comparative analysis with a graphic overview of the risks for both insurance companies analyzed in the simulations: the Slovenian and the Serbian company. Firstly, I considered the general structure of risk profiles of the companies, shown through shares of capital requirement for each risk module in the sum of all the capital requirements considered in the BSCR. Additionally, I showed the market risk structure graphically, shown through shares of market risk sub-modules in the sum of all capital requirements for market risk. The shares of each risk module shown in

the comparative analysis are shown as shares in the undiversified sum of capital requirements.

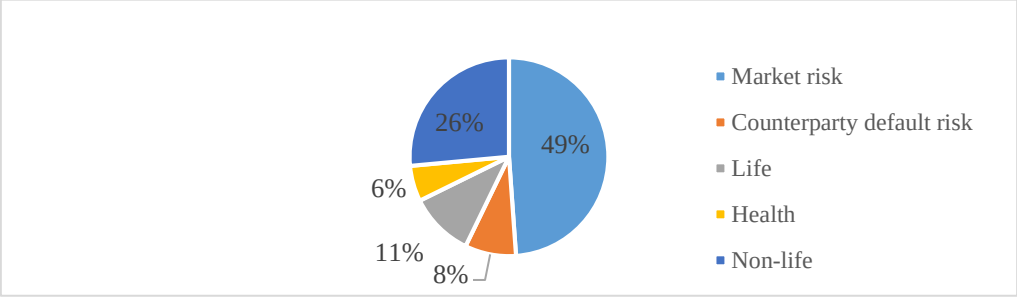
For the Serbian insurance company, I showed two graphs for the structure of risk profile for both scenarios analyzed in the previous chapter. As the only difference between the two scenarios is the capital requirement for counterparty default risk, the market risk structure remains unchanged in both scenarios.

5.1 Comparative analysis

In the following part, there is a graphical analysis of the risk structure of two analyzed undertakings (the Slovenian and the Serbian one). The goal is to see which risk factors affect the capital requirement the most and to analyze the differences between the two undertakings and see how the assumptions in the standard formula affect their results.

As it was explained in chapter 4.1, almost half of the capital requirements of the Slovenian undertaking refer to the capital requirement for market risk, i.e. 49%. The other risk that the Slovenian undertaking is most exposed to is non-life underwriting risk, whereas the rest of the risks are lower (especially compared to market risk). This would mean that the Slovenian undertaking is generally mostly exposed to the changes that happen in the macroeconomic environment, i.e. to how the current environment affects its capital. The risk structure of the Slovenian undertaking is shown in Figure 4:

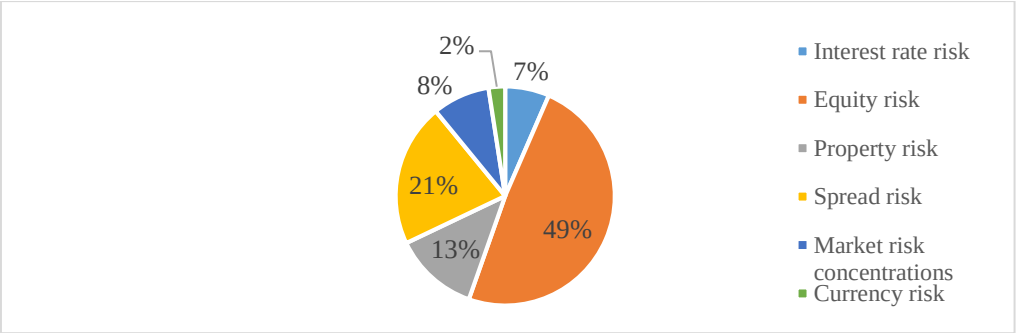
Figure 4: Structure of risk profile – Slovenia



Source: Own work

Figure 5 shows that, regarding the market risk, the undertaking is mostly affected by equity risk, as the capital requirement for equity risk is 49% of the capital requirement for market risk. The capital requirement for spread risk is 21% and the rest of the sub-modules are pretty much lower.

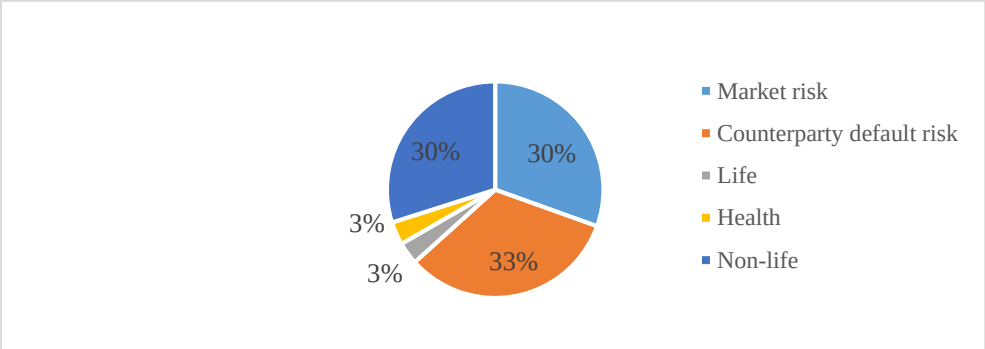
Figure 5: Market risk structure - Slovenia



Source: Own work

When it comes to the Serbian undertaking, Figure 6 shows that the risk structure is much more diversified compared to the Slovene undertakings, as three sub-modules create almost equal capital requirements: market risk, non-life underwriting risk and counterparty default risk. Health and life sub-modules are significantly lower compared to these three, which is linked to the smaller portfolios in these segments. An interesting result is also the share of counterparty default risk, especially when compared to the Slovenian undertaking, where this risk module represents only 8% of the capital requirements.

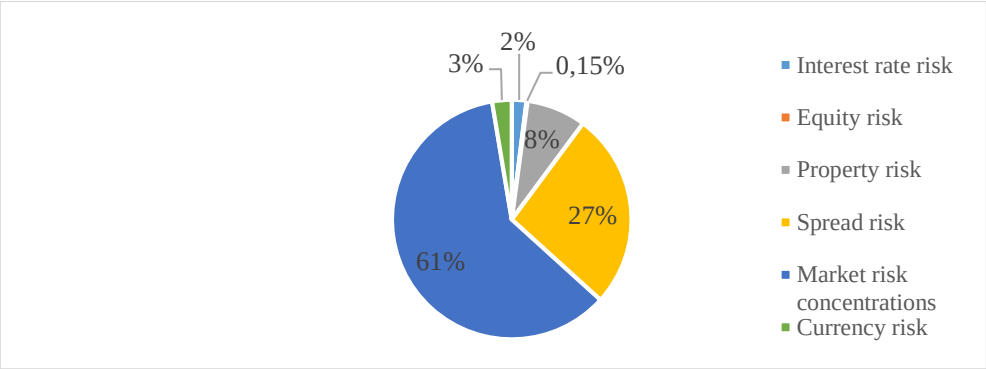
Figure 6: Structure of risk profile – Serbia



Source: Own work

Figure 7 shows the market risk structure of the Serbian undertaking, where it can be seen that more than a half of the market risk capital requirement comes from the sub-module market risk concentrations (i.e. 61%), whereas this sub-module was only 8% of the market capital requirement in the Slovene undertaking. On the other hand, the equity sub-module which was the most significant market risk module in the Slovene undertaking, is lower than 1% in the Serbian undertaking, which shows an important difference between the two markets.

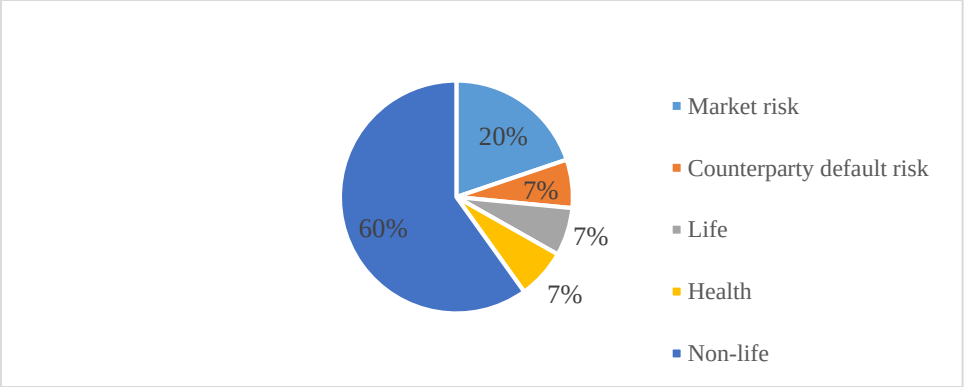
Figure 7: Market risk structure – Serbia



Source: Own work

What can be seen from the risk structure analysis for scenario 1 (as shown in Figure 8) is that there is no longer an almost equal distribution between three sub-modules, but that the non-life underwriting risk increases its share and, in this case, represents 60% of the capital requirement. On the other hand, by appointing a credit rating of 2 for the counterparties the undertaking is exposed to, the credit default risk capital requirement decreases its share in total capital requirements from 33% to 7%. Finally, by applying lower risk factors to the Serbian government bonds, i.e. by assuming that Serbia is a country member of the EU, the market risk module decreases its share from 30% to 20%.

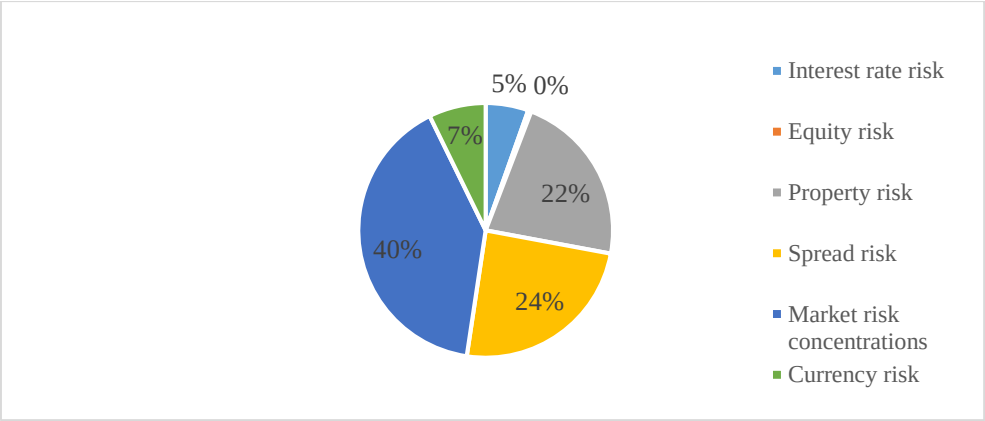
Figure 8: Structure of risk profile – Serbia (scenario 1)



Source: Own work

Analyzing the market risk structure, we can see significant movements in the shares of its submodules, as shown in Figure 9. By assuming that the Serbian government bonds are risk-free, the share of market risk concentrations remain being the highest portion of the total market risk and spread risk is still the second highest. However, the share of market risk concentrations decreases for 21 p.p. and spread risk for 3 p.p., which, on the other hand, changes the overall market risk structure, as now the share of property risk increases from 8% to 22%.

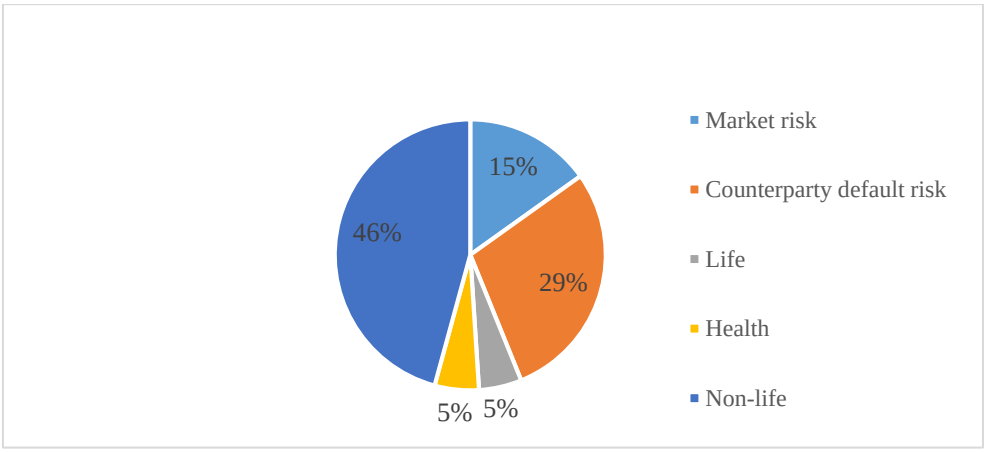
Figure 9: Market risk structure – Serbia (remains equal in scenario 1 & 2, assumption that Serbia is in the EU)



Source: Own work

As explained before, scenario 2 differs from scenario 1 only in the assumption used for credit ratings. With this analysis, the sensitivity of the risk structure based on the credit ratings of the undertaking's counterparties is additionally tested. As it can be seen in Figure 10, by assuming that the credit ratings of the counterparties are better than in the actual scenario, i.e. 4, (but not as good as in scenario 1), the capital requirement of counterparty default risk slightly decreases and its share in total capital requirement decreases for 4 p.p. What can be concluded from this sensitivity analysis is that a change in the credit quality step for two levels on the scale can affect the share of the counterparty default risk by more than 20 p.p., which significantly changes the final results.

Figure 10: Structure of risk profile – Serbia (scenario 2)



Source: Own work

5.2 Findings

Based on my simulation analysis, regarding market risk, I concluded that even though both insurance companies – Slovenian and Serbian have similar share of government bonds in their investment portfolios, still the share of capital requirements for market risk concentration and spread risk in the total market risk are quite different. I realized that the

assumption of government bond being risk-free in the EU member states strongly affects the capital requirement for market risk concentration and spread risk, and it can potentially underestimate or overestimate the capital requirement for market risk, based on the actual credit rating of the country. Thus, when assumed that Serbia becomes a member state of the EU, its capital requirement (for market risk and total) would significantly decrease. This opens the question whether the standard formula really provides a valid picture of exposure to market risk of insurance companies in member states of the EU, and how much insurance companies "get" or "lose" in the capital requirements calculations based on the given parameters, in terms of how much their solvency ratio differs from the ratio they would have if they used a different model for valuation, with adjusted assumptions.

Regarding counterparty default risk, I realized that the Serbian insurance companies, by being limited to cede part of their obligations only to local reinsurers, are exposed to a higher risk of counterparties defaulting based on the standard formula. Even if the reinsurers are subsidiaries of big European (re)insurance companies, their probability of default is much higher because they do not have credit assessment by a nominated ECAI. The poor credit ratings of the local banks, to which the insurance company has exposures to in the form of cash, also leads to a higher probability of default. By assuming that a credit assessment by a nominated ECAI is available and the rating of the company is better, material differences happen in the capital requirements. Based on the analysis, I can conclude that insurance companies in Serbia that have reinsurance contract with companies for which there is no available credit assessment face stricter valuations of the counterparty default risk, which might overestimate their capital requirements, especially for those exposures in subsidiaries of foreign companies that really do have better credit ratings.

CONCLUSION

Considering the essence of insurance business, which is pooling risk and relying on the law of large numbers, having in mind the fact that a lot of insurance contracts made are long-term, as well as considering that insurance actually protects a large number of households, companies and communities, it is inevitable that this industry is one of the most regulated ones. Focusing on the European market, there has been an implementation of rules whose purpose was to coordinate insurance markets and regulations ever since the 1970s. However, especially after the global financial crisis in 2008, a major step ahead was done for the improvement of the insurance regulation with introducing the supervisory framework Solvency II. The first research question set down in my analysis was "What is the purpose of Solvency II Directive and what does it consist of?". Based on the research I have done, I concluded that the main purpose of this Directive is to ensure financial firmness and stability of insurance companies and specially to ensure that they would be solvent through difficult periods. It is founded on three pillars, which aim to ensure a high standard of risk assessment, efficient capital allocation, increased transparency and, with that being said, it provides a common system of control, creating a single market.

The second research question was “How is the Directive implemented and what is the difference in implementation in the EU and the Western Balkan countries?”. My research shows that, by being a Framework Directive, Solvency II had a direct effect in all 28 member states of the EU at the time of implementation, meaning that it did not have to be transposed into national law. Three areas of connection with the third countries were considered when the European Commission adopted the third country equivalence decisions under Solvency II: group solvency calculation, group supervision and reinsurance. The assumption used in the simulation in my paper was that the third country insurance undertaking was a subsidiary of an EU country insurance undertaking, meaning that the first area of legislation equivalence was considered. Up until this date, Western Balkan countries, including Serbia, have not received equivalent decisions under Solvency II, since they still have Solvency I regime as a local regulatory requirement. As it follows, the non-EU subsidiaries that are part of insurance groups based in the EU, have to evaluate their solvency adequacy based on Solvency II Directive, so the groups based in the EU will be able to calculate their group capital requirement.

Solvency II capital adequacy valuation is based on market-based valuation of assets and liabilities in the balance sheet, which are the foundation of calculating the risk-based capital requirements. The basic capital requirement is centered on six different risk modules: non-life, health and life underwriting risk, market risk, counterparty default risk and intangible asset module. The final capital requirement of the insurance company is calculated considering the basic solvency capital requirement, the capital requirement for operational risk and the loss-absorbing capacity of technical provisions and deferred taxes. The standard formula for capital requirement of each risk module aims to test whether the insurance company has sufficient funds to cover losses over a 1-year horizon with 99,5% probability. That would sum up the answer to the third research question “How is the SCR calculated?”.

Based on the analysis and the simulation in my paper, I realized that the shares of capital requirements of separate risk modules in the total solvency capital requirement significantly differ in EU insurance companies and in Western Balkan countries. Even though capital requirements for market risk are a significant share of both insurance companies analyzed (the share is even higher in the EU company), the shares of capital requirements of risk sub-modules that market risk consists of, significantly differ. The capital requirements for equity risk are much higher in the EU insurance company, whereas in the Western Balkan insurance company, the capital requirements for market risk are generally driven by the market risk concentrations risk and the spread risk module. On the other hand, the capital requirements for counterparty default risk importantly differ in both companies – their share in total capital requirements is much lower in the EU insurance company, compared to the high share in the Western Balkan insurance company. Apart from that, the capital requirements for non-life underwriting risk represent a significant share of the total capital requirements in both insurance companies. That would be the answer, based on the analysis done, to the fourth research question “Which risk modules impact the capital requirement the most? Is there a difference in this impact in the EU vs. the Western Balkan countries?”.

Analyzing the results of the simulation done, I realized that the capital adequacy of an insurance company, calculated on the basis of the standard formula, can materially differ depending on whether the country where the insurance company operates is or is not a member state of the EU. This realization refers to the market risk module, precisely to the market risk concentrations and spread risk sub-modules, for whose calculation, the standard formula assigns a higher level of risk for government exposures outside of the EU and assumes no risk at all for all member countries of the EU. However, the credit ratings of separate member states in the EU differ, and the capital requirements of a company in a member state with lower credit rating can be underestimated, just because that country is part of the EU, thus it is assumed that government bonds of all member states are risk-free. Regarding the counterparty default risk, having in mind that the local legislation in Serbia does not allow ceding obligations to foreign (re)insurers, Serbian insurance companies can only reinsure in local (re)insurance companies or in subsidiaries of foreign (re)insurance companies based in Serbia. Considering the fact that almost all (re)insurance companies based in Serbia do not have credit assessment by a nominated ECAI, thus they are non-rated, the standard formula assigns them the lowest credit rating of 6, which assumes a high risk of defaulting. This means that a much higher risk is assumed for (re)insurance companies just because they are based in a third country, even though they might be subsidiaries of large EU insurance groups. Simulations done led to a conclusion that assumptions used in the standard formula might not necessarily reflect the actual risk of certain exposures, thus they might lead to overestimating or underestimating the total capital requirement of an insurance company and its capital adequacy. This explanation sums up the answer to the last two research questions of my analysis: “Does the Solvency II standard formula reflect the real and fair valuation of capital adequacy?” and “Would the capital adequacy results be different when using different methodology/assumptions?”.

The simulations showed that there are certain assumptions in the standard formula that are crucial for assessing how solvent an insurance company is. Apart from that, there was research done for other potential lack in Solvency II framework, i.e. liquidity. It is important to be aware that solvency is not related to its liquidity. This means that, in addition to solvency constraints, insurance companies also need to make sure that they have sufficient liquidity, i.e. there are further constraints about their asset allocation (Wüthrich & Merz, 2013). This is especially important for the types of insurance that have more variable claims distribution, in which case investment strategies must allow for providing cash at irregular and unpredictable intervals (Berry-Stolzle, 2008).

However, the Solvency II framework was a significant step towards risk assessment, capital adequacy calculation and increased transparency. It provided a unified model for estimating capital requirements and it obliged the insurance sector to regularly report their solvency to the public and, with that, to provide information to all the economic agents involved, especially the policyholders. Even though the assumptions (which do not necessarily reflect the real risk exposure) used in the standard formula might materially influence the overall capital requirements and capital adequacy of the insurance companies, the Solvency II

framework also provides an opportunity for calculating solvency adequacy based on internal models, with which an insurance company can adjust the certain assumptions used. With that being said, insurance companies can regularly calculate their solvency based on their own risk assessment.

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APPENDICES

Appendix 1: Povzetek (Summary in Slovene language)

Ob upoštevanju narave zavarovalniške dejavnosti ter samega dejstva, da je zavarovalništvo pomemben del finančnega sistema in s tem znatno vpliva na makroekonomski položaj vsake države, je povsem razumljivo, da zavarovalniška industrija sodi med najbolj regulirane. Na evropskem zavarovalnem trgu se tako že od sedemdesetih let prejšnjega stoletja izvajajo pravila, s katerimi se usklajujejo zavarovalniški trgi in regulacije v Evropi. Pomemben korak naprej z vidika izboljšanja nadzora zavarovalnih subjektov pa je bil narejen z uvedbo regulatornega okvira Solventnost II. Na podlagi opravljenih raziskav sem ugotovila, da je glavni namen Solventnosti II zagotoviti finančno trdnost in stabilnost zavarovalnic, predvsem pa zagotoviti, da bodo slednje v težkih obdobjih solventne. Solventnost II temelji na treh stebrih, ki so namenjeni zagotavljanju visokega standarda ocene tveganj, učinkovitega razporejanja kapitala in pa večji transparentnosti, ki ustvarja enotni pregled solventnosti zavarovalnic ter skupni sistem nadzora.

Vrednotenje kapitalske ustreznosti po Solventnosti II temelji na tržnem vrednotenju sredstev in obveznosti ter na izračunu kapitalskih zahtev na podlagi tveganj. Osnovni zahtevani solventnostni kapital temelji na šestih različnih modulih tveganja: zavarovalna tveganja premoženjskih zavarovanj, zavarovalna tveganja življenskih zavarovanj, zavarovalna tveganja zdravstvenih zavarovanj, tržna tveganja, tveganje neplačila nasprotne stranke in tveganja neopredmetenih sredstev. Zahtevani solventnostni kapital upošteva osnovni zahtevani solventnostni kapital, kapitalsko zahtevo za operativna tveganja in prilagoditev zaradi absorbcijske zmožnosti zavarovalno-tehničnih rezervacij in odloženih davkov.

V sklopu narejenih simulacij sem analizirala izračune kapitalskih zahtev v zavarovalnici s sedežem v EU (Slovenija) ter v zavarovalnici s sedežem izven EU (Srbija). Pri analizi rezultatov opravljenih simulacij sem ugotovila, da se lahko kapitalska ustreznost zavarovalnice, izračunana na podlagi standardne formule, bistveno razlikuje, če je država članica EU ali ne. Slednje se nanaša predvsem na modul tržnih tveganj, natančneje na podmodula tveganja tržne koncentracije in tveganja spremembe kreditnih pribitkov, za izračun katerih standardna formula dodeli višji faktor tveganja pri izpostavljenosti do držav zunaj EU, medtem ko državne izpostavljenosti v EU upošteva kot netvegane. Zaradi dejstva, da se bonitetne ocene članic EU razlikujejo, hkrati pa velja predpostavka, da so državne obveznice vseh članic EU netvegane, so lahko kapitalske zahteve določenih zavarovalnic s sedežem v članici EU, ki ima slabšo bonitetno oceno, podcenjene, njihova kapitalska ustreznost pa je lahko precenjena. Z vidika tveganja neplačila nasprotne stranke, zakonodaja v Srbiji ne dovoljuje sklepanja pozavarovalnih pogodb s tujimi (po)zavarovalnicami, prav tako pa skoraj vse (po)zavarovalnice s sedežem v Srbiji nimajo bonitetne ocene. Iz tega izhaja, da jim standardna formula dodeli najnižjo bonitetno oceno, ki predvideva visoko tveganje neplačila. To pa pomeni, da se (po)zavarovalnice soočajo z veliko večjim tveganjem samo zaradi dejstva, da imajo sedež v tretji državi, čeprav so lahko odvisne družbe velikih zavarovalniških skupin iz EU. Skladno z opravljenimi analizami lahko sklepamo, da

predpostavke, določene v standardni formuli, nujno ne predstavljajo dejanskega tveganja do določenih izpostavljenosti, kar pa lahko posledično vodi do precenjevanja ali podcenjevanja celotne kapitalske zahteve zavarovalnice in njene kapitalske ustreznosti.

Regulatorni okvir Solventnost II je bil pomemben korak k oceni tveganj, izračunu kapitalske ustreznosti in večji transparentnosti. Zagotovil je enoten model za ocenjevanje kapitalskih zahtev in zavarovalnice zavezal k rednemu javnemu poročanju o solventnosti. Čeprav lahko predpostavke določene v standardni formuli bistveno vplivajo na kapitalske zahteve in kapitalsko ustreznost zavarovalnic, okvir Solventnost II ponuja tudi priložnost za izračun kapitalske ustreznosti na podlagi notranjega modela, s katerim lahko zavarovalnice prilagodijo določene predpostavke in lahko tako izračunavajo svojo kapitalsko ustreznost na podlagi lastne ocene tveganj.

Appendix 2: Capital adequacy for life insurances in Serbia (Solvency I)

No	DESCRIPTION	Amount in RSD thousand (except under X)
I	CORE CAPITAL (1+2+3+4+5)	
1.	Paid-up core capital for common shares	
2.	Reserves regulated by the Articles of Association and other acts of the undertaking, except for reserves linked to preferred shares	
3.	Revaluation reserves with unrealised gains	
4.	Retained profit from previous years	
5.	Retained profit from the current year, up to 50%	
II	SUPPLEMENTARY CAPITAL (6+7+8)	
6.	Paid-up core capital for preferred shares	
7.	Reserves linked to preferred shares	
8.	Long-term liabilities convertible to capital	
III	DEDUCTIONS, PART ONE (9+10+11+12)	
9.	Intangible assets (investments)	
10.	Redeemed own shares	
11.	Loss in the current year and uncovered losses from previous years	
IV	GUARANTEE CAPITAL (I+II-III)	
V	DEDUCTIONS, PART TWO (12+13+14)	
12.	Equity interest and/or shares in other insurance undertakings with the head office in the Republic of Serbia	
13.	Net amount of investment in subordinated debt instruments and other debt instruments of legal entities in which the undertaking has a controlling participation	
14.	Illiquid assets	
VI	GUARANTEE RESERVE, PRELIMINARY RESULT (I+II-III-V)	
15.	Deduction for the case referred to in Article 124, paragraph 6, item 1) of the Law	
16.	Deduction for the case referred to in Article 124, paragraph 6, item 2) of the Law	
17.	Deduction for the case referred to in Article 124, paragraph 6, item 3) of the Law	
VII	GUARANTEE RESERVE, FINAL RESULT, AVAILABLE SOLVENCY MARGIN (VI-15-16-17)	
VIII	REQUIRED SOLVENCY MARGIN FOR LIFE INSURANCES (Article 125 of the Law – Form RSM-LI)	
IX	DIFFERENCE BETWEEN AVAILABLE AND REQUIRED SOLVENCY MARGIN FOR LIFE INSURANCES (Article 127, paragraph 1 of the Law) VII-VIII $\geq$ 3	
X	RATIO BETWEEN REQUIRED SOLVENCY MARGIN FOR LIFE INSURANCES AND GUARANTEE CAPITAL (Article 128, paragraph 1 of the Law) VIII/IV $\leq$ 3	

XI	AMOUNT LAID DOWN BY ARTICLE 27 OF THE LAW (in accordance with a valid operating license)	
XII	DIFFERENCE BETWEEN GUARANTEE CAPITAL AND THE AMOUNG LAID DOWN BY ARTICLE 27 OF THE LAW (Article 128, paragraph 2 of the Law) IV-XI ≥ 0	

Adapted from RS Official Gazette, No 51/2015

Appendix 3: Capital adequacy for non-life insurances in Serbia (Solvency I)

No	DESCRIPTION	Amount in RSD thousand (except under X)
I	CORE CAPITAL (1+2+3+4+5)	
1.	Paid-up core capital for common shares	
2.	Reserves regulated by the Articles of Association and other acts of the undertaking, except for reserves linked to preferred shares	
3.	Revaluation reserves with unrealised gains	
4.	Retained profit from previous years	
5.	Retained profit from the current year, up to 50%	
II	SUPPLEMENTARY CAPITAL (6+7+8)	
6.	Paid-up core capital for preferred shares	
7.	Reserves linked to preferred shares	
8.	Long-term liabilities convertible to capital	
III	DEDUCTIONS, PART ONE (9+10+11+12)	
9.	Intangible assets (investments)	
10.	Redeemed own shares	
11.	Loss in the current year and uncovered losses from previous years	
12.	Difference between non-discounted and discounted outstanding claims reserves	
IV	GUARANTEE CAPITAL (I+II-III)	
V	DEDUCTIONS, PART TWO (13+14+15)	
13.	Equity interest or shares in other insurance undertakings with the head office in the Republic of Serbia	
14.	Net amount of investment in subordinated debt instruments and other debt instruments of legal entities in which the undertaking has a controlling participation	
15.	Illiquid assets	
VI	GUARANTEE RESERVE, PRELIMINARY RESULT (I+II-III-V)	
16.	Deduction for the case referred to in Article 124, paragraph 6, item 1) of the Law	
17.	Deduction for the case referred to in Article 124, paragraph 6, item 2) of the Law	
18.	Deduction for the case referred to in Article 124, paragraph 6, item 3) of the Law	
VII	GUARANTEE RESERVE, FINAL RESULT, AVAILABLE SOLVENCY MARGIN (VI-16-17-18)	
VIII	REQUIRED SOLVENCY MARGIN FOR NON-LIFE INSURANCES/REINSURANCE (Article 126 of the Law – Form RSM-NI/RE)	
IX	DIFFERENCE BETWEEN AVAILABLE AND REQUIRED SOLVENCY MARGIN FOR NON-LIFE	

	INSURANCES/REINSURANCE (Article 126, paragraph 9 And Article 127, paragraph 2 of the Law) VII-VIII ≥ 0	
X	RATIO BETWEEN REQUIRED SOLVENCY MARGIN FOR NON-LIFE INSURANCES/REINSURANCE AND GUARANTEE CAPITAL (Article 128, paragraph 1 of the Law) VIII/IV ≤ 3	
XI	AMOUNT LAID DOWN BY ARTICLE 27 OF THE LAW (in accordance with a valid operating license)	
XII	DIFFERENCE BETWEEN GUARANTEE CAPITAL AND THE AMOUNG LAID DOWN BY ARTICLE 27 OF THE LAW (Article 128, paragraph 2 of the Law) IV-XI ≥ 0	

Adapted from RS Official Gazette, No 51/2015

Appendix 4: Correlation matrix for non-life underwriting risk

i \ *j*	Non-life premium and reserve	Non-life catastrophe	Non-life lapse
Non-life premium and reserve	1	0.25	0
Non-life catastrophe	0.25	1	0
Non-life lapse	0	0	1

Adapted from the Commission Delegated Regulation (EU) 2015/35

Appendix 5: Correlation matrix for health underwriting risk

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

Adapted from the Commission Delegated Regulation (EU) 2015/35

Appendix 6: Correlation matrix for SLT health underwriting risk

i \ *j*	Health mortality	Health longevity	Health disability-morbidity	Health expense	Health revision	SLT health lapse
Health mortality	1	-0.25	0.25	0.25	0	0
Health longevity	-0.25	1	0	0.25	0.25	0.25
Health disability-morbidity	0.25	0	1	0.5	0	0
Health expense	0.25	0.25	0.5	1	0.5	0.5
Health revision	0	0.25	0	0.5	1	0
SLT health lapse	0	0.25	0	0.5	0	1

Adapted from the Commission Delegated Regulation (EU) 2015/35

Appendix 7: Correlation matrix for life underwriting risk

i \ *j*	Mortality	Longevity	Disability	Life expense	Revision	Lapse	Life catastrophe
Mortality	1	-0.25	0.25	0.25	0	0	0.25
Longevity	-0.25	1	0	0.25	0.25	0.25	0
Disability	0.25	0	1	0.5	0	0	0.25
Life expense	0.25	0.25	0.5	1	0.5	0.5	0.25
Revision	0	0.25	0	0.5	1	0	0
Lapse	0	0.25	0	0.5	0	1	0.25
Life catastrophe	0.25	0	0.25	0.25	0	0.25	1

Adapted from the Commission Delegated Regulation (EU) 2015/35

Appendix 8: Correlation matrix for market risk

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

Adapted from the Commission Delegated Regulation (EU) 2015/35

Appendix 9: Correlation matrix for Basic solvency capital requirement

i \ *j*	Market	Default	Life	Health	Non-life
Market	1	0.25	0.25	0.25	0.25
Default	0.25	1	0.25	0.25	0.5
Life	0.25	0.25	1	0.25	0
Health	0.25	0.25	0.25	1	0
Non-life	0.25	0.5	0	0	1

Adapted from the Commission Delegated Regulation (EU) 2015/35