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DEPARTMENT OF FINANCE AND CREDIT

Doctoral Student Beatris Ventsislavova Lyubenova

d020218170

AUTHOR'S ABSTRACT

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Risk assessment and Risk management of regulated financial institutions

Dissertation Advisor:

Prof. Stoyan Stanimirov Prodanov, PhD

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All materials related to the defence are available upon request at the Department of Doctoral Studies and Academic Staff Development.

Contents

I. GENERAL CHARACTERISTICS OF THE DISSERTATION

1. Relevance of the topic

The relevance of the problem studied in the dissertation arises from the fact that financial institutions have an important role in the economy, and their stability is of key importance for the development of the economic system. The instability or failure of a financial institution can have a significant impact not only on its customers, but also on the financial sector and the economy as a whole. The reliability of the financial system and the trust in it are the responsibility of every financial institution, but especially of the regulatory and supervisory authorities, which observe the protection of the public interest.

Indicators of total capital adequacy ratio, common equity Tier 1 capital adequacy ratio for liquidity, solvency and solvency capital requirement coverage ratio are the basis of the financial stability and solvency of financial institutions, which is why they are covered by a strict regulatory framework in which reporting, monitoring and control conducted by the supervisory authorities are clearly regulated. When assessing the safety and soundness of a financial institution, capital is one of the most important factors, as it determines the risk capacity of the financial institution, i.e. the risks it can take.

The financial crisis of 2008 gave rise to the need to improve the legal framework and regulatory instruments for monitoring and assessing the financial stability of financial institutions, for this purpose increasing the importance of compliance with capital requirements and emphasizing the use of stress tests in monitoring their financial stability. Thus, in practice, the emphasis is now placed not only on the regulation and supervision of individual financial institutions, but the risk for the financial system is also assessed.

The regulatory frameworks designed for the banking sector and the insurance industry share common characteristics and peculiarities. Because both sectors play a crucial role in the financial system and can significantly affect the economy, they are subject to extensive regulation and strict supervision. One of the most important common features is the capital adequacy requirement: Both banks and insurance companies are required to maintain a certain level of capital to ensure that they have sufficient financial resources to absorb losses and protect consumers – holders of policies or depositors. The other particularly important feature is risk management. Both sectors must implement sound risk management practices to identify, assess and manage various types of risk such as credit risk,

market risk, operational risk, liquidity risk, catastrophe risk and underwriter risk. In terms of solvency and liquidity requirements, both insurance companies and banks must comply with these requirements to ensure that they can meet their obligations to policyholders or depositors.

Apart from these common key principles of regulation, there are several other similarities in governance and supervision in the insurance and banking sectors. Providing transparent and accurate information to regulators, stakeholders and the public requires that both sectors are subject to complex and stringent reporting and disclosure requirements. Regulatory frameworks also typically include guidance on corporate governance principles to ensure effective supervision, accountability and responsibility within organizations. Regarding consumer protection, both industries have regulations aimed at protecting consumer interests by ensuring fair practices, transparency and disclosure of important information. Both sectors apply AML/CFT provisions to prevent illegal activities and ensure compliance with international standards.

In most countries, there are separate regulatory bodies that control the banking and insurance industry, and the supervisory activity is organized in a similar way in Bulgaria. However, it should be noted that quite a few countries establish integrated regulatory bodies that supervise both the banking and insurance industries. These integrated regulatory authorities are often referred to as ‘financial regulators’ or ‘financial services regulators’. Having a single regulatory authority can streamline the supervision of financial institutions and promote coordination between the banking and insurance sectors. Among the countries with integrated regulatory bodies are Great Britain, Australia, Singapore, Hong Kong, Malaysia, South Africa. This once again emphasizes the presence of common characteristics and peculiarities in the supervisory paradigm for the two financial sectors with systemic importance for the economy.

Although they have a number of common characteristics, it is important to note that there are also significant differences in the regulatory frameworks between the banking and insurance sectors due to their unique characteristics and risk profiles. Some of the most significant differences concern the types of risk that the two industries operate with. While banks are involved in managing credit risk, market risk and operational risk, insurance companies, on the other hand, face underwriting risk, mortality risk and catastrophe risk. Banks also typically have higher capital requirements than insurance companies due to the higher levels of leverage and risk associated with their activities. Capital requirements for banks are designed to ensure stability and protect depositors, while for

insurance companies the focus is on the ability to meet policyholder obligations. Banks must manage their assets and liabilities to maintain liquidity and manage interest rate risk. In contrast, insurance companies manage their investment portfolios in order to support their long-term liabilities and provide a steady stream of income to cover claims. There are also a number of peculiarities in the two sectors concerning business models, the systemic nature of banks and insurers, the complexity of operations, product and market characteristics. Last but not least, international coordination: which for banking regulations is organized through the Basel Committee on Banking Supervision, while for insurance the global coordination is more decentralized.

These differences reflect the different nature of banking and insurance activities, which necessitate specific regulatory approaches to address specific risks and challenges. However, both sectors play a crucial role in the economy and effective regulation is essential to ensure their stability and protect consumers and stakeholders.

Stability in the banking and insurance sectors has a common economic basis in terms of both qualitative characteristics and quantitative equity requirements to ensure solvency and capital coverage. It is this that has given rise to the need for specialized regulators to implement, apply and supervise the application of the common European regulations in the banking and insurance sectors. The parallel analysis of the measures and requirements in banking and insurance risk management allow for more effective control and the maintenance of more rational standards that ensure not only risk coverage, but also the more efficient and viable development of the banking and insurance business in the EU countries.

2. Subject and object of the research

Banks and insurance companies are the **object** of research in the dissertation.

The **subject** of research is risk management in banks and insurance companies under the conditions of increasing regulatory requirements.

3. Research thesis statement

The author's research thesis statement is that in order to achieve stability, predictability and solvency of banks and insurance companies under the conditions of periodic turbulence of the global environment and dynamic changes

and transformations in the financial services sector, it is necessary to constantly revise, adapt and expand the regulatory requirements in risk management. This dynamics in the regulatory framework poses new challenges to the management of insurance companies and banks in making adequate, innovative and responsible managerial decisions.

4. Research aim

The aim of the dissertation is to examine the regulatory requirements in terms of risk assessment and capital positions of the banking and insurance sector under the conditions of the Basel III and Solvency II regulatory mechanisms.

5. Research objectives and methodology

To achieve the aim of the research, the following tasks were formulated:

1. To present concepts about the essence of risk.
2. To clarify the peculiarities of risk management in banks and insurance companies.
3. To characterize risk measurement methods in the banking and insurance sectors.
4. To present the theoretical and methodological basis of stress tests and their application in risk management in the banking and insurance sectors.
5. To characterize and compare the regulatory requirements of Basel I, II and III for the banking sector and Solvency I and II for the insurance sector.
6. To analyze key indicators for capital and risk management in credit institutions and insurance companies.

The research methodology in the dissertation includes the deductive and inductive approach, the method of analysis and synthesis, the interdisciplinary approach and the statistical approach in studying mass phenomena in the financial sector. In the process of the research, publications of Bulgarian and foreign authors in the field of finance, management, probability theory, statistical methods for the analysis of variation distributions, for the analysis of relations and dependencies, etc., were studied and systematized. Calculations were performed using MS Excel software.

6. Research scope

The **information provision** of the research is based on official statistical data of the BNB, the ECB and the European Banking Authority (EBA) for the banking sector, and of the FSC and the European Insurance and Occupational Pensions Authority (EIOPA) for the insurance sector.

The specifics of the activity of financial institutions and their key role in the economy of the countries are among the reasons why they function in a highly regulated environment. As a result, a group of regulated financial institutions is distinguished and it includes banking and non-banking financial institutions – banks, insurance companies, pension insurance companies, investment intermediaries, collective investment schemes. The great variety and specificity of the regulations in the financial sector underlie the choice for the dissertation to focus only on two main representatives of the regulated financial institutions, namely the banks and insurance companies, which becomes an important limiting condition of the research. Banks and insurance companies are key representatives of the financial sector and their stability is of utmost importance for the stability of the economy both of the individual countries and on a regional and global scale.

7. Research structure

The overall volume of the dissertation is 271 standard pages and it includes three chapters, an introduction and a conclusion structured as follows:

INTRODUCTION

CHAPTER ONE. THEORETICAL FOUNDATIONS OF RISK MANAGEMENT IN THE BANKING AND INSURANCE SECTOR

1. Concepts of the essence of risk
2. Risk management in the banking and insurance sectors – essence and characteristics
3. Models and methods for quantitative risk assessment
4. Stress tests as an integral approach to risk and capital management

CHAPTER TWO. REGULATORY FRAMEWORK OF THE BANKING AND INSURANCE SECTOR

1. Development of the Basel international regulatory framework for the banking sector – Basel I, II and III

1.1. Basel I regulatory framework
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1.3. Basel III international regulatory framework – response to the global financial crisis and achieving stability in the banking sector

2. Development of the international regulatory framework for the insurance sector
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CHAPTER THREE. ANALYSIS OF KEY INDICATORS FOR CAPITAL AND RISK MANAGEMENT IN BANKS AND INSURANCE COMPANIES

1. Analysis of the equity capital structure in the banking and insurance sectors
2. Analysis of the implementation of capital requirements in the banking and insurance sectors
3. Analysis of the dependence between risks and equity in the banking sector
4. Analysis of the dependence between risks and equity in the insurance sector

CONCLUSION

APPENDICES

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Declaration for originality and credibility of the dissertation

8. Practical applicability of the research findings

The theoretical concepts, views and empirically obtained results presented in the dissertation can be applied both scientifically and practically in the analysis and management of financial institutions in the banking and insurance sectors.

II. CONTENTS OF THE DISSERTATION

Chapter One. Theoretical foundations of risk management in the banking and insurance sectors

Chapter one is dedicated to clarifying basic aspects of the theoretical concepts of risk and risk management in the banking and insurance sectors, risk assessment methods and stress tests as an integrated approach to risk and capital management.

1. Concepts of the essence of risk

The dissertation characterizes basic concepts of the nature of risk and the risk in banking and insurance. It clarifies that over time, not only the meaning attached to it changes, but also the use of the concept of 'risk'. Douglas and Ewald considered risk as a neutral concept, which represents the probability of something happening, combined with possible losses or gains, and until the beginning of the 19th century, the dominant views were that two separate variants of risk should be considered – 'good risk' and 'bad risk' (Douglas, 1992, pp. 23-24), (Ewald, 1991). According to them, in the twentieth century, the differences between risk and uncertainty were almost lost, and this is explained as being due to the progress of science and the possibility of calculating probabilities. Risk is no longer used and associated only with negative and undesirable outcomes, but in many cases with positive outcomes as well. In this sense, when analyzing risk, attention is paid to both costs and benefits, which means that both negative and positive aspects of risks are considered.

According to the quantitative theory of risk, it represents an attitude to outcomes that would occur in a given period of time in a given situation, and according to them, risk and probability are two different concepts. Knowledge of the probability distribution underlies the estimation of the deviation between the objective and the subjective distribution of the expected probabilities of the occurrence of the risk. In order for risk assessment to be adequate, certain requirements must be met, namely, to have data for aggregates large enough in volume that are uniform so as to highlight patterns and to use the effect of the law of large numbers.

The dissertation paper clarifies that the activity of banks is related to taking various risks and therefore exposure of a certain outcome to uncertainty is considered as a definition of risk in banking. According to a number of authors, risk in banking is defined as exposure of a given outcome to uncertainty, and the range of uncertainty is reflected in the variability of potential outcomes, which

can be quantified, as it is within a certain range of deviation from the expected outcome (Cade E. , 1996) (Cade E. , 1999).

The concept of 'risk' is the basis of understanding the essence of insurance and its benefit, which is expressed in the possibility of providing insurance protection to the person and their activity, thus making them less dependent on chance. Very often, risk is defined as the probability of the occurrence of an event, as the possibility of realizing losses from the occurrence of an event that causes damage. In many publications, risk is defined rather broadly, namely, as the possibility of a negative deviation from the goals, but that is argued by the fact that this formulation allows all spheres of human activity to be covered and gives an idea of the total or so-called aggregate risk, which is considered as a sum of possible individual events.

Based on the views and definitions of risk presented so far and the ways of mitigating it, it can be summarized that risk can generate both positive and negative effects depending on many other factors. The concept of 'risk' is increasingly being used both in everyday life and in various scientific fields. The use of the term 'risk' in the scientific literature has also grown enormously since the 1960s, and this is evidenced by the many publications and the development of a comprehensive concept of risk, which includes the following areas: risk analysis, risk assessment, risk impact, risk management, risk control, etc. (Lupton, 2005).

In summary, we can point out that most authors are united around the view that 'risk' means the potential deviation from the expected outcome, which is caused by the occurrence of one or several unforeseen events. In a number of scientific studies, the consideration of risk in the financial sector is understood as a situation where there is uncertainty about the realization of a positive scenario and danger of generating losses. The study of risk continues to be an important issue in economic theory and is extremely relevant nowadays, as there is an ongoing process of evolution of financial instruments on the market, digitization of a number of processes and activities, cyclicality in economic development, economic and financial crises, etc. The global financial and economic crisis of 2008, as well as the crisis caused by the COVID-19 pandemic, have re-raised the questions of risk, assessment, forecasting, risk management and limiting the negative manifestation and its effects. The scale of the consequences of these crises in the financial sector is proof that the processes of researching, assessing and managing risk are extremely important and the condition, stability and

sustainability of the banking and insurance sectors depend on them to a great extent.

2. Risk management in the banking and insurance sectors – essence and characteristics

In the process of their operations, financial institutions from the banking and insurance sectors face various risks, the adequate management of which requires that they be identified, measured and managed. Banking risk management goes through four stages – risk identification, risk assessment or risk measurement, risk management and control of the actions performed (Trifonova, 2015).

Risk management as an important part of banking and insurance management is the basis of achieving long-term strategic goals while maintaining the solvency of the bank and insurance company. Based on the research carried out, we support the view that the current best standards for risk assessment and management are based on an approach including the following components or stages: system definition; risk identification; risk analysis; risk assessment; risk impact or treatment; risk monitoring; risk communications.

The dissertation highlights the following as main functions of risk management – risk analysis, investment decisions and pricing, risk quantification, risk monitoring and reporting, strategic decision-making, maintaining the solvency of the institution.

Based on the conducted literature research, we believe that successful risk management is associated with the implementation of four main stages in the implementation of the risk management process – identification, measurement, treatment and execution, which are presented in Figure 1. The process begins with the identification of all potential risks by analyzing the possible sources of risk but also determining the likely threats. The adequate assessment of potential risks requires a detailed knowledge of financial products and the risks arising from them. In this case, the main risk is related to the applied methodology for identifying the risks to which the financial institution is exposed.

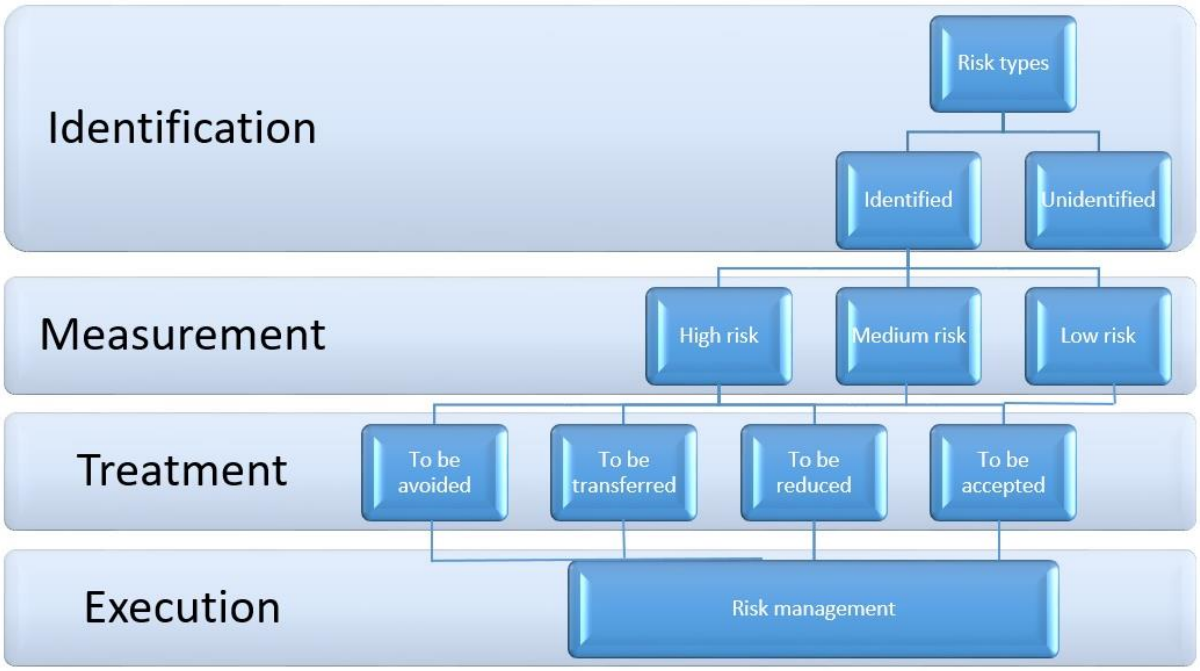


Figure 1. Stages in an ongoing risk management process.

After identifying the sources of risk, there follows the stage of quantitative risk measurement. The quantitative risk assessment is carried out on the basis of a thorough statistical analysis of historical information about the banking institution, market positions and segments, the macroeconomic environment, banking products, customers, credit portfolio, investments, etc. When there is incomplete data for a past period, theoretical models are applied, in which the relevant assumptions and restrictive conditions in the quantitative risk measurement are laid down. In summary, it can be pointed out that quantitative risk measurement requires clear and precise definitions of risk criteria and the availability of data that contains the risk history and on this basis to perform quantitative risk modelling analyses.

Risk mitigation is a way to partially, rather than fully, take a risk, which is why riskier exposures require the client to provide collateral that the bank can sell in the event of default. Risk acceptance is most often applied to low-risk assets. It was found that there is no serious discussion on this issue in the literature and it is considered that an acceptable level of risk is achieved by diversifying the credit portfolio, through investments in different sectors and countries, thus avoiding or minimizing the likelihood of worsening the economic conditions in all sectors or all countries in which there are credit exposures. Risk transfer is a way of managing risk by using specific credit derivatives to another bank, insurance company or another company that are seen as financial guarantors. For the successful risk management in financial institutions, it does not suffice to just

carry out the quantification or the so-called 'risk assessment', but it is necessary to proceed to one of the four ways of treatment or impact presented by Dorfmann – risk avoidance, risk mitigation, risk acceptance, risk transfer (Dorfmann, 1997).

The dissertation justifies that risk management has a key role in making strategic decisions regarding the long-term vision for the development of the bank's product portfolio. It also analyzes to what extent the investment strategy and the risk return position are in line with the banking strategy. This is because by its very nature risk is characterized by uncertainty, and higher risk would lead to greater losses, which would affect the bank's capital soundness. For this reason, risk management is necessary to assess the impact of changing economic and market conditions on the state and development of the bank, as well as how the already high risks taken could be optimized.

The risk management of an insurance company is an important part of its management and for the most part their objectives overlap, as they are expressed in organizing means and resources for the fulfillment of the set goals. In this sense, the decisions related to risk management are an important and inseparable part of the managerial decision, because managerial decision-making must be carried out taking risk into account and not be allowed to belittle or ignore the risk. The systematization of the characteristic features of risk management in insurance can be carried out in several directions: firstly, as an activity that refers to risk identification, risk assessment, development of a risk prevention program, control and analysis; secondly, application of a system for influencing the risk to reach the desired level of security, with adequate information provision of the analysis of the risk situation and justification of the measures for influencing the risk; thirdly, it is aimed at the security of the insurer, because on the basis of risk monitoring, it offers adequate solutions to fulfill the objectives of the insurance company. The following main phases of risk management in insurance are highlighted: risk identification; risk assessment; development of variants and selection of the optimal variant of a security system and the corresponding managerial decision; analysis and control of the effective risk management system.

Risk management in insurance companies is expressed in decision-making based on the identification, registration, control, minimization of insurance risks, with the aim of avoiding and preventing their accumulation, which necessitates the building of an orderly system for their management in order to realize the goals of the insurance company and to implement its development strategy. The objectives of the risk management system are aimed at outlining a framework for

risk management, defining minimum standards for identifying, assessing, monitoring, controlling and reporting risks, tracking changes in the environment and risk factors. Therefore, risk management in insurance companies is based on an ongoing operating system for identifying, measuring, tracking, reporting and controlling, which is a guarantee for the timely and adequate risk management, taking into account their specifics and peculiarities in the context of the activity of the insurance company.

The dissertation characterizes the many risks to which the banking and insurance sectors are exposed, among which credit, market, liquidity and operational risks are highlighted as key for the banking sector, and for the insurance sector – underwriter risk (respectively in life insurance, non-life insurance, health insurance), operational risk, market risk and counterparty default risk.

The view substantiated is that the development and adoption of a risk management strategy, as well as the policies and procedures accompanying it, occupy a very important place in the overall risk management process of banks and insurance companies. It is clarified that their implementation goes through several main stages, such as risk identification, assessment of the source of risk, quantitative risk assessment, improvement of the applied methodology, managerial decision, control, inclusion of reverse testing procedures. In today's conditions, the regulatory requirements for banks and insurance companies are constantly increasing, with capital requirements occupying a key place, and besides the legally defined minimum capital requirements, additional requirements for capital and its quality are also included. Risk management occupies an increasingly important place in the management of banks and insurance companies, and effective risk management means both assessing and considering the potential risk impact, as well as taking measures to reduce the possibility of their occurrence and to minimize their impact.

3. Models and methods for quantitative risk assessment

Successful risk management aims to predict what could happen in the future under certain economic conditions. VaR and ES models have proven their benefits in ongoing risk monitoring, but are limited in performing historical review and analysis. VaRs are used not only to quantify market risk and internal financial risk, but also to determine the necessary capital according to regulatory requirements. In them, value at risk is considered as the worst expected loss caused by the change in the value of a given asset or portfolio of financial assets

under normal market conditions, at a given level of probability for a given time period (Cyprian, 2017). The need to monitor and verify that banks and insurance companies have sufficient capital to maintain their solvency even in adverse scenarios is increasingly being applied both by regulatory authorities and by banks and insurance companies themselves. The most popular approach in calculating VaR and ES models is the simulation approach based on historically accumulated information. VaR is preferred because of the easy interpretation of the results obtained and it shows how negatively the situation could develop and what the losses would be, while ES represents a measure that leads to better incentives for activity.

One of the most commonly used risk assessment methods is Monte Carlo Simulation, as it has proven and established itself as a reliable and flexible risk assessment method based on a stochastic process for simulating stock prices, asset size and other indicators and associated risk factors. Through Monte Carlo Simulation, risk is assessed by generating models of possible outcomes, creating models for each factor that is characterized by uncertainty, which is replaced by values in a certain range and their probability distribution. Monte Carlo Simulation generates multiple outcomes at different combinations of random probability values (with different probability distribution function). The Monte Carlo method is considered a universal method, one of the most accurate methods for assessing market risk, because it presents a complete picture of the risk, and then different theoretical distributions can be applied.

An important place in risk assessment is occupied by the theory of risk in insurance. In summary, it can be stated that the role of the theory of risk in personal insurance is reduced to determining the insurance maximum, treatment of insurance with abnormal risk, reinsurance, theoretical justification of problems in insurance. The theory of risk in property insurance is a part of insurance statistics, and an important feature in this case is that a small amount of data is available in assessing the risk for some of the trends, which becomes a serious difficulty for establishing sound and reliable mathematical and statistical foundations. For example, there is a significant number of statistical data for fire, hail and livestock insurance. In the theory of risk in insurance, risk is considered as the risk of the insured and the insurer, but the following possibilities are considered – single insurance risk, multiple insurance risk and average risk.

The research proves that deviations from the assumed total loss can be predicted on the basis of statistical data, and for this purpose, objects are grouped into separate risk groups according to the values of the same risk signs. Defining

the size of the risk is based on the equivalent principle, according to which the payments of the insured must be equal to the payments of the insurer, but the special thing here is that the rule is valid at the time of drawing up the insurance tariff, since there is a continuous change in risk and costs. Risk equalization plays an important role in insurance risk theory, and risk equalization is considered to be better the greater the number of uniform independent risks and the longer the observation period. The main risk equalization methods applied are in-pool and out-of-pool risk equalization.

4. Stress tests as an integral approach to risk and capital management

In modern banking and insurance risk management, stress tests occupy an important place, because based on them, the influence of a certain risk factor is determined, as well as the joint influence of changes in a group of factors, and different scenarios are considered for this purpose. Financial institutions already in the 1990s used stress tests to assess their risk exposures, especially with regard to large risk exposures, but their increased application began after the global financial and economic crisis, gradually becoming an invariable part of risk management of banks and insurance companies, but also of the banking and insurance sector.

Regulatory stress tests are characterized by a special methodology prepared in accordance with the financial and regulatory framework, as well as various scenarios for the economic situation. By carrying out the regulatory stress tests, the aim is to assess and guarantee the stability and capital security of both individual banks and the entire sector under various scenarios for the development of the economy. It has been proven that the benefit of applying stress tests is great, which is why they are becoming an important tool for supervisory authorities in the banking and insurance sectors, as well as the currently prepared regulatory reports. Since the global financial crisis, stress tests have become an important part of regulation in the banking and insurance sectors, which now include higher standards for risk reporting, more capital requirements, capital adequacy, liquidity and solvency. The capital adequacy of banks and the solvency of insurance companies are receiving even greater attention and the regulatory requirements for the capital base have risen since the global financial and economic crisis. Supervisory authorities are increasing their scrutiny of banking and insurance institutions, and stress tests are becoming an important tool for assessing the impact of adverse macroeconomic scenarios on their sustainability.

The conclusion reached is that the risk management system in banks and insurance companies is a complex of techniques, methods and approaches that allow to discover, identify, locate and assess risks, on the basis of which to take appropriate measures to eliminate or mitigate negative outcomes, thus guaranteeing favourable financial results and the stability of the financial institution. For this purpose, banks and insurance companies develop their own risk management strategy, the implementation of which makes it possible to use all the opportunities for the development of the financial institution, but while controlling the risk and maintaining it at an acceptable level. The capital adequacy requirements, the focus on risk management, the solvency and liquidity requirements are highlighted as key characteristics common to the banking and insurance sectors.

Chapter two. Regulatory framework of the banking and insurance sector

The second chapter of the dissertation focuses on clarifying the regulatory framework of the banking and insurance sectors, tracing the evolution of Basel I, II, III and Solvency I and II standards, clarifying the main aspects of each subsequent version of the regulatory frameworks and making a comparative analysis of Basel III and Solvency II.

1. Development of the international regulatory framework for the Basel banking sector – Basel I, II and III

This part presents the historical evolution of the approved reports and guidelines of the Basel Committee on Banking Supervision, which apply both to the banking sector and to the national regulatory authorities. These decisions of the Committee are transposed in the course of time into the national legislations, and this gives rise to the idea of creating a single regulatory framework, aimed at reporting the capital adequacy of credit institutions that are part of international banking groups.

The Basel I regulatory framework was adopted in 1988, and sets two main goals – achieving soundness and resilience of the international banking system and presenting a unified methodology in determining capital requirements for international banking groups that operate in different countries. Quantitative and qualitative requirements have been introduced for the eligible equity capital items, a methodology for calculating risk exposures according to the type of exposure with predetermined risk weights, as well as a requirement for a capital adequacy

ratio of 8%. With the introduction of the Basel I regulatory framework, a benchmark was adopted for the methodology for calculating the capital requirements for the banking sector, but the development of financial instruments and innovations established the need to develop a more complex and precise regulatory framework. A logical corrective as a result of the implementation of Basel I is presented as the Proposal for Basel II to apply supervisory requirements in accordance with the economic situation.

The three main objectives with the introduction of the Basel II regulatory requirements set by the Basel Committee on Banking Supervision are discussed, as follows:

- To achieve an increase in the quality and stability of the international banking sector;
- To create and maintain equal conditions for banks that carry out international activities;
- To encourage the banking sector to adopt stricter practices and procedures regarding the management of risks to which credit institutions are exposed.

This chapter presents and discusses in detail the regulatory requirements in the three main pillars (Figure 2), which are designed to complement each other and ensure the achievement of financial stability in the banking sector by introducing better practices and procedures in risk management in credit institutions.

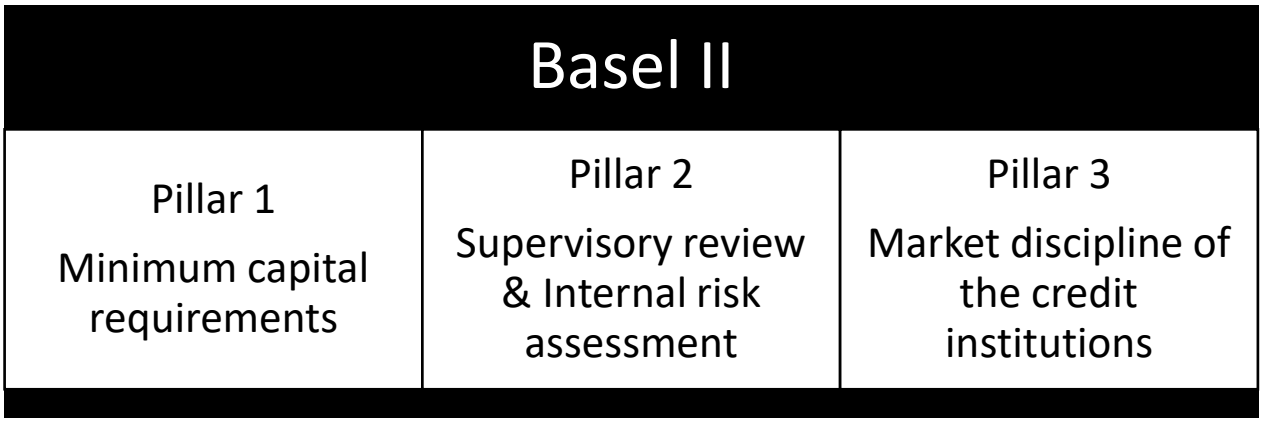


Figure 2. The three pillars in the introduction of the Basel II regulatory framework

Pillar 1 presents the main types of risks to which the credit institution is exposed, namely credit risk, market risk and operational risk. For each individual risk, several approaches are provided for calculating the capital requirements, which represent a methodology of varying complexity. For its part, the Standardized Approach is revised with regard to the risk weights of the exposures,

a methodology is introduced using an external credit assessment and distribution by individual classes of exposures. In addition to the Standardized Approach, the possibility of applying the Internal Ratings-Based Approach after regulatory approval is introduced, which is one of the most important innovations in the Basel II regulatory framework.

The second pillar of the regulatory framework requires banks to develop internal systems and models for assessing their capital requirements, which are applied in parallel with the regulatory framework in accordance with the risk profile of the credit institution. For their part, supervisory authorities are committed to check and confirm whether the credit institutions effectively comply with the capital requirements presented in Pillar 1.

The third pillar examines the market discipline of the participants in the banking sector, as well as the requirements related to public disclosure of information. Basel II regulatory requirements require detailed reporting on their internal risk management systems and how the regulatory framework is implemented. In this way, the aim is to provide useful information to both potential investors and analysts, customers and other market participants regarding the quantitative data on the stability of the credit institution.

The conclusion substantiated is that the new regulatory capital adequacy requirements, also known as Basel II, represent an improvement of the regulatory requirements regarding risk management by introducing practices and procedures for a more accurate assessment of risk exposures. Its adoption and subsequent implementation has led to the elimination of many of the weaknesses of the 1988 Basel Accord, which have been identified over time and in the development of financial markets under the conditions of the economic situation. It is an indisputable fact that the introduction of Basel II regulatory requirements improved the financial discipline in the banking sector and this is achieved with the introduction of the three main pillars with requirements for credit institutions. With the onset of the global financial and economic crisis of 2008-2009, various deficiencies of the Basel II regulatory framework became apparent, some of which were partially resolved in the subsequent revisions of the regulation, such as the deceptive sense of security, the key role of External Credit Assessment Institution (ECAI) in determining an objective credit assessment of financial instruments, as well as taking into account the phase of the economic cycle in credit activity.

The Basel III regulatory framework was created in response to the identified deficiencies of the Basel II regulatory framework during the global

financial crisis. It was transposed into banking legislation in the EU through Regulation 575/2013, also called the Capital Requirements Regulation (CRR) and Directive 2013/36, also called the Capital Requirements Directive (CRD). The main changes are related to expanding the scope of the three pillars with regulatory requirements, as well as revising the approaches for calculating capital requirements. Liquidity ratios (LCR, NSFR) as well as a leverage ratio are introduced in Pillar 1. The reason for calculating liquidity indicators is the identified deficiencies of Basel II. The Standardized Approach and methodology for applying risk weights, as well as the Internal Ratings-Based Approach, are revised. Deficiencies found in setting the capital requirements for operational risk are eliminated through the possibility of applying only one approach.

Regarding Pillar 2, methodologies are introduced for applying stress tests and simulations in pre-developed scenarios by the regulatory authorities, as well as different capital buffers, which depend on the risk profile and the scale of activity of each credit institution. The following deficiencies of Basel II are also removed by introducing limits in the credit portfolio management, as well as a methodology for determining concentration risk.

Pillar 3 provides for more detailed disclosure of information on all identified risks to which each credit institution is exposed. Samples are introduced for the disclosure of information, which aim to achieve comparability between the published data between individual credit institutions.

Since the adoption of the Basel III regulatory requirements, the regulatory framework related to individual risks has been subject to subsequent revisions until the final version of Basel III is reached. At the time of the research, the latest revised version of the Basel III regulatory framework has not yet been fully transposed into EU legislation.

2. Development of the international regulatory framework for the insurance sector

The evolution of financial instruments, combined with the growing role of insurance in the financial sector, necessitates the creation of regulatory requirements for the insurance sector. This is a prerequisite for the adoption of the First Directives on non-life and life insurance in 1973 and 1979, which aimed to create a single insurance market through the application of a single methodology in the exercise of insurance activity on the territory of the EU. The purpose of introducing the regulatory requirements for the insurance sector, known as Solvency I, was to review and update the current regulatory regime in the EU.

With each revision of Solvency I, an improvement has been achieved in terms of accuracy in the calculation of the minimum capital requirements of insurance companies. The main focus of the Solvency I regulatory framework falls on the technical reserves of insurance companies to determine the amount of required capital. The main drawback of the Solvency I regulatory requirements is expressed in the lack of a methodology for reflecting the different types of risk to which the representatives of the insurance sector are exposed. One of the main obstacles to this is the different accounting standards applied when valuing assets and liabilities in individual countries.

The development of Solvency II aims to eliminate the identified weaknesses of Solvency I. The new regulatory framework in European legislation is implemented through Directive 2009/138/EC. One of the main reasons for creating the new regulatory requirements is the need for insurance companies to adequately measure and manage the risks they are exposed to. Other important reasons for the development of Solvency II are to continue maintaining a single European market for financial services, as well as to increase the resilience of insurance companies by enabling them to withstand adverse economic conditions and unforeseen events, contributing to the overall stability of the financial system. Solvency II introduced improved reporting and disclosure requirements for insurers, providing more transparency about their financial position and risk exposures. This increased transparency contributes to market confidence and helps stakeholders make informed decisions. In order to achieve effective risk management in the insurance sector, it is necessary to develop and implement an integrated risk management framework. In the application of the risk management concept, the Solvency II regulatory principles, two approaches have been developed, the Standardized Approach and the Internal Models Based Approach, which is subject to regulatory approval. In the development of the Solvency II regulatory framework, similarities were noted with the Basel II concept of regulatory requirements introduced in the banking sector four years earlier in terms of the three pillars of regulatory requirements.

The first pillar of Solvency II deals with the quantitative requirements that every insurance company operating in the EU must fulfill. It is a combination of three numerical exercises. These are the establishment and analysis of the economic balance, calculation of the capital requirements for solvency (MCR and SCR), as well as the subsequent identification of the acceptable own funds of the insurance companies. The main aim in implementing the new regulatory

requirements is that all risks that are subject to quantitative measurement are covered by the capital requirements adopted with Solvency II.

The introduction of Pillar 2 aims to supplement the requirements presented in Pillar 1. This is due to the impossibility of all types of risk to which the insurance company is exposed to be adequately assessed by applying only quantitative measures. A requirement has been introduced for an independent review by a regulatory body to determine whether risks are adequately assessed. With the introduction of the Solvency II regulatory requirements, four main corporate governance functions are defined – risk management function, compliance function, internal audit function and the actuarial function.

The third pillar of Solvency II addresses the regulatory reporting requirements of insurance companies. Two main types of reports are introduced – reports for the regulator and reports subject to public disclosure. The purpose of these reports is to provide transparency to the insurance market, both to the regulatory authorities and to the public. Thanks to the public disclosure of information about the insurance company, the audience has the opportunity to receive systematized, specific and clear information about the capital requirements for solvency and the financial condition of each market participant.

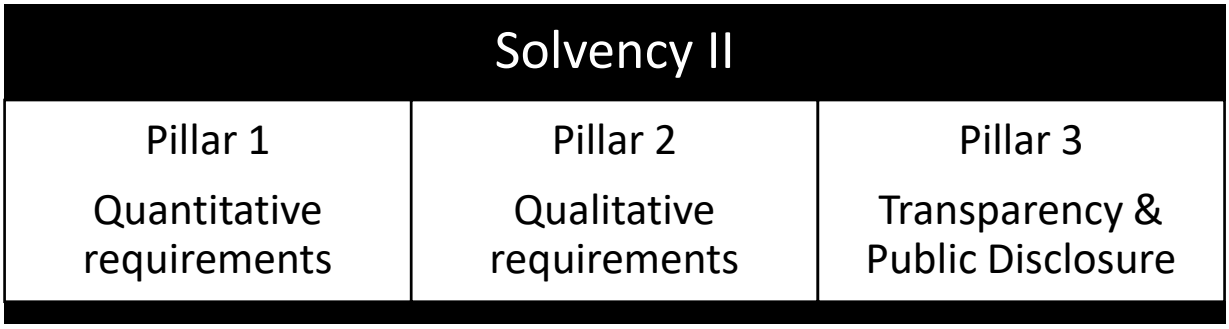


Figure 3. Pillars of Solvency II

3. Comparison between Basel III and Solvency II regulatory requirements

The growing role of regulatory requirements, as well as the coverage of more and more factors that have an impact on the financial sector, create a need for a thorough analysis of their methodological features. This fact is the basis of the prepared comparative analysis of several distinctive features of the Basel III regulatory framework regarding the requirements for the banking sector, as well

as Solvency II, according to which the insurance sector operates. Three key components are identified that are subject to comparison between the two regulatory frameworks, namely – scope of application, equity eligibility requirements and the concept of risk management.

Regarding the scope of application of the Basel III and Solvency II regulatory frameworks, one of the main differences between the two regulations has been identified. The Basel Normative Reports are an internationally recognized agreement on a standard for determining capital requirements in the banking sector. By their nature, the regulatory requirements of the Basel Committee are not legislative acts, but a package of requirements that are transposed into the national banking legislation of most countries in the world. For its part, the Solvency II regulatory framework represents legislative requirements for the insurance sector in the EU, as it is the result of the joint work of the European Commission (EC) and the European Insurance and Occupational Pensions Authority (EIOPA). While Basel III represents an international regulatory standard for measuring capital adequacy in the banking sector, Solvency II presents regulatory requirements for the initiation and exercise of insurance and reinsurance activities on the territory of the EU. Solvency II regulatory requirements are adopted by EU bodies, but not by the International Association of Insurance Supervisors (IAIS), therefore its scope of application is significantly more limited compared to the Basel regulatory framework.

Both regulatory frameworks place an important emphasis on the qualitative and quantitative characteristics of the eligibility of equity capital items. Over time, it has been concluded that the quality of equity capital of financial sector companies plays a key role in achieving profitability. In this aspect, the regulatory requirements for both the banking and insurance sectors have some similarity, focusing on reaching and maintaining the necessary amount of eligible equity capital items to achieve reasonable levels of capital requirements for solvency. Although certain similarities were found in the understanding of the equity capital items, there are again significant differences between the Basel III and Solvency II regulatory requirements. One of the main differences in this regard is the understanding of the quality of equity capital items.

Regarding the concept of risk management, there has been a significant convergence of viewpoints, both in the banking and insurance sectors. The reason for this is that with the onset of the global financial and economic crisis in 2008, emphasis was placed on identifying the sources of risk and their subsequent management to achieve stability in the financial sector. This led to the finding of

deficiencies in the Basel II regulatory requirements and the adoption of several revisions to the regulatory framework. In response to the consequences of the financial and economic collapse, the question of creating new regulatory requirements known as Basel III was raised. During this period, the Solvency II regulatory framework was also adopted, which introduces a new approach to the calculation of capital requirements compared to the previous Solvency I regulation. The new regulatory requirements for the insurance sector are based on the concept of risk detection and management. Unlike the Basel standards for setting capital requirements in the banking sector, where there is a revision and upgrade of the concept of ascertainment and subsequent risk management, the Solvency II regulatory framework represents an initial introduction of the new regulation, which is based on the concept of risk management.

Chapter Three. Analysis of key indicators for capital and risk management in banks and insurance companies

Chapter three is devoted to an empirical analysis of key indicators of equity capital, capital adequacy and solvency, and of factor influences of major risks on the amount of equity capital in the banking and insurance sectors.

The empirical analysis was carried out in the following directions:

1. Analysis of the equity capital structure in the banking and insurance sectors.
2. Analysis of the implementation of capital requirements in the banking and insurance sectors.
3. Analysis of the dependence between risks and equity in the banking sector.
4. Analysis of the dependence between risks and equity in the insurance sector.

The empirical study is based on official statistical data of the BNB, ECB and the European Banking Authority (EBA) for the banking sector and of the FSC and the European Insurance and Occupational Pensions Authority (EIOPA) for the insurance sector for the period 2017-2021. The in-depth study of the information database of the European Banking Authority made it possible to form historical data series for 77 banks at the highest level of consolidation, for which there is available information on the studied indicators for all years of the period. The analysis of the implementation of the capital requirements and the factor influences for the insurance sector are based on official statistics of the European Insurance and Occupational Pensions Authority for 30 countries for the period 2017-2020. The main criterion for choosing the analyzed periods for the banking

and insurance sectors is that the data are comparable and allow both comparative analysis and generalization of conclusions.

1. Analysis of the equity capital structure in the banking and insurance sectors

Tracking the relative shares of individual types of capital in the capital structure of banks makes it possible to establish compliance with the regulatory requirements for equity capital and the ratios between them, but also to track trends and regularities in their change and to reveal important aspects of the capital structure of the banks. According to Basel III, Tier 2 capital is not acceptable above 1/3 (33.33%) of the amount of Tier 1 capital. The analysis showed that the relative share of Tier 2 capital tends to decrease compared to Tier 1 capital – at the beginning of the studied period (2017), and for some of the studied banks there is an excess of the value for acceptable Tier 2 capital according to Basel III, while for 2021, for all banks, Tier 2 capital is within the permissible limits to be acceptable. The results show that the existence of a regulatory mechanism and requirements for the quality of the capital base are extremely important for the management of credit institutions to take the necessary measures to ensure that the capital ratios are within the permissible limits in order to guarantee the financial soundness and resilience of the banks. Tracking the dynamics of the relative shares of the capital groups gives reason to summarize that in the period 2017-2021 the share of common equity Tier 1 capital tends to increase. This trend is in line with the Basel Standards, which place increasing importance on Tier 1 capital (Figure 4) and, in particular, on Common Equity Tier 1 (CET 1).

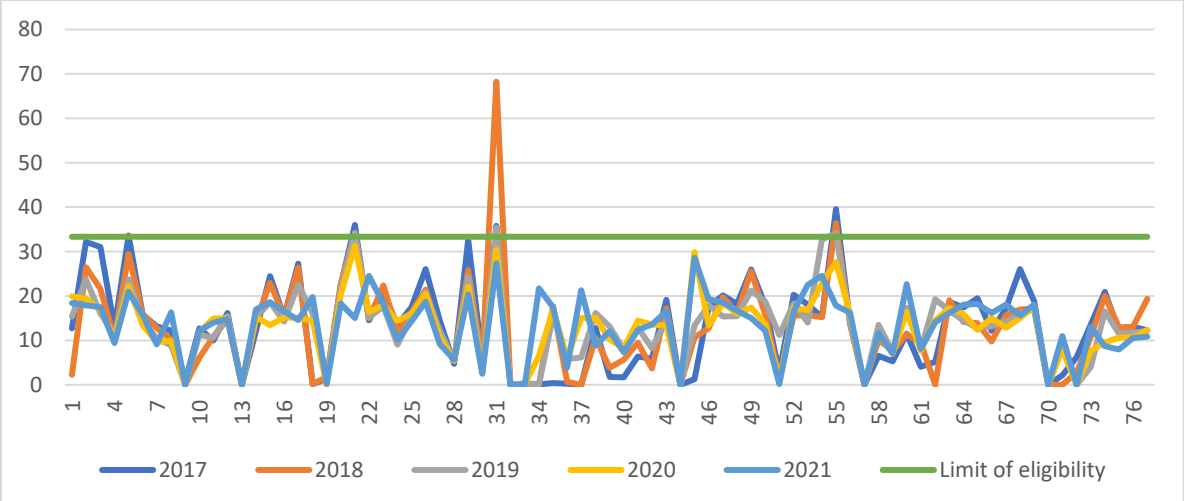


Figure 4. Ratio of Tier 2 capital to Tier 1 capital

Empirical data on banks according to the relative share of Tier 1 capital by year, represented by histograms, show that there is a dynamic in their distribution. As a result of the analysis of the distribution of banks according to the relative share of Tier 1 capital, in order to achieve comparability between the results, banks were grouped according to the relative share in intervals with a width of 5%, starting from 55% share of Tier 1 capital and reaching a 100% relative share of Tier 1 capital. The results of this grouping are presented in Table 1, and it is clear that the distribution for 2017 and 2018 is bimodal, and for 2019, 2020 and 2021 the distribution is unimodal. When distributed with equal intervals, the groups with the largest number of banks are clearly visible, and for 2017, 2018, 2019 and 2021, the largest number of banks is in the interval from 85% to 90% relative share of Tier 1 capital in the equity capital structure. In 2021, only 2 banks have a relative share of Tier 1 capital in the range of 75% to 80%.

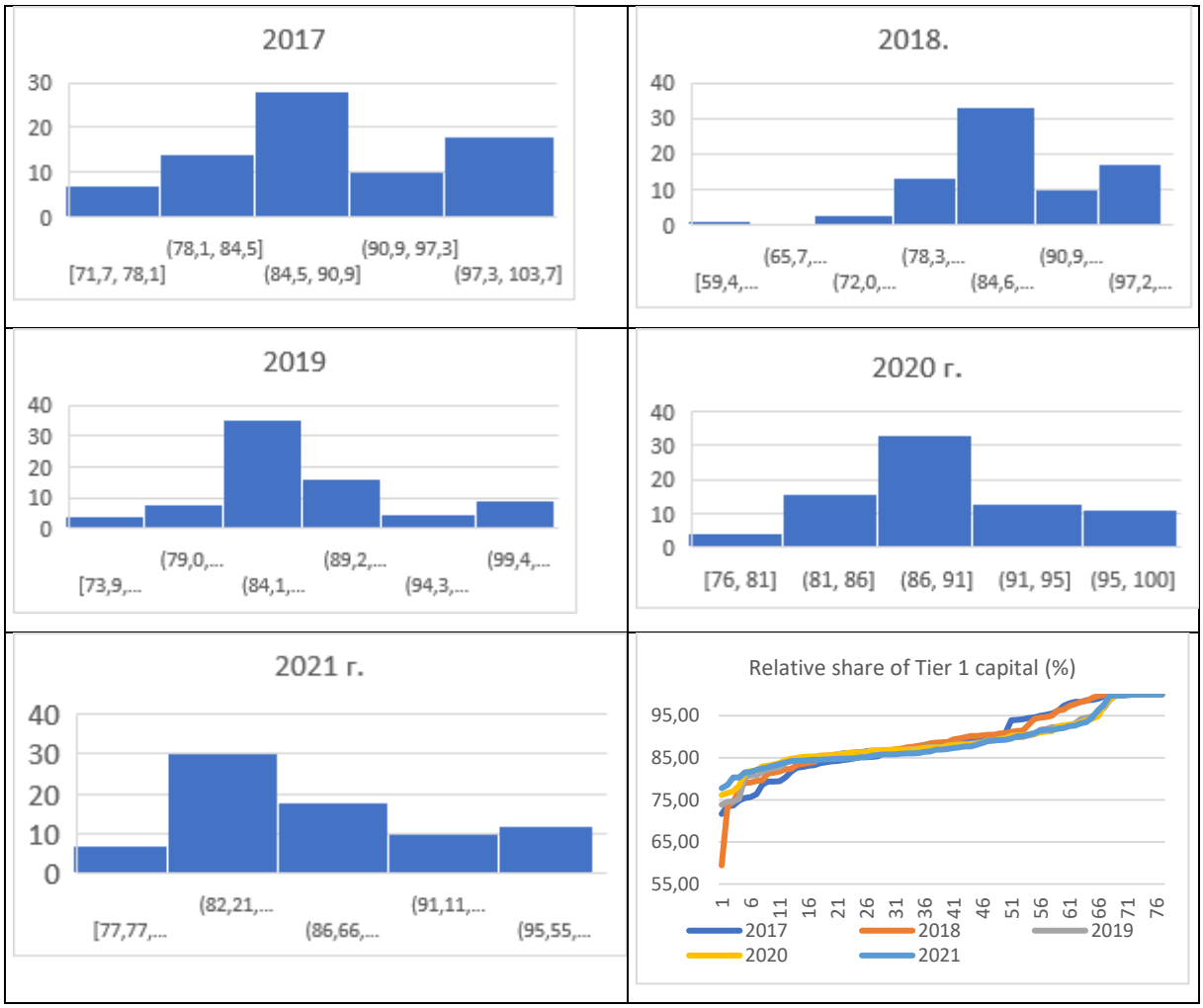


Figure 5. Distribution of banks according to the relative share of Tier 1 capital

The presented grouping clearly highlights the trend towards an increase in the number of banks, where the relative share of Tier 1 capital is over 80%. The ascertained change in the distribution of banks according to the relative share of Tier 1 capital is the result of the increase in regulatory requirements for the quality of the capital base, and more specifically for Tier 1 capital, which are related to the need to increase the amount of shareholder capital at the expense of hybrid instruments and subordinated term debt.

Table 1. Distribution of banks according to the relative share of Tier 1 capital in the total amount of equity capital

Relative share of Tier 1 capital (%)	Banks				
	2017	2018	2019	2020	2021
over 55 to 60	-	1	-	-	-
over 60 to 65	-	-	-	-	-
over 65 to 70	-	-	-	-	-
over 70 to 75	4	2	3	4	-
over 75 to 80	7	5	1	9	2
over 80 to 85	13	10	12	37	22
over 85 to 90	25	25	37	16	27
over 90 to 95	7	14	12	11	14
over 95 to 100	21	20	12	-	12
Total	**77**	**77**	**77**	**77**	**77**

Source: Author's calculations

The Solvency II regulatory framework for the insurance sector places an important emphasis on the management of risk arising from the activities of insurance companies, but it also pays special attention to the capital requirements and capital reserves that must be maintained. The capital base for the insurance sector includes Tier 1 capital, Tier 2 capital and Tier 3 capital. Tracking the dynamics of the relative shares of the individual types of capital gives reason to summarize that in the period 2017-2020 the share of Tier 1 capital tends to increase. This trend is in line with the Solvency II methodology, which places increasing importance on asset quality and Tier 1 capital.

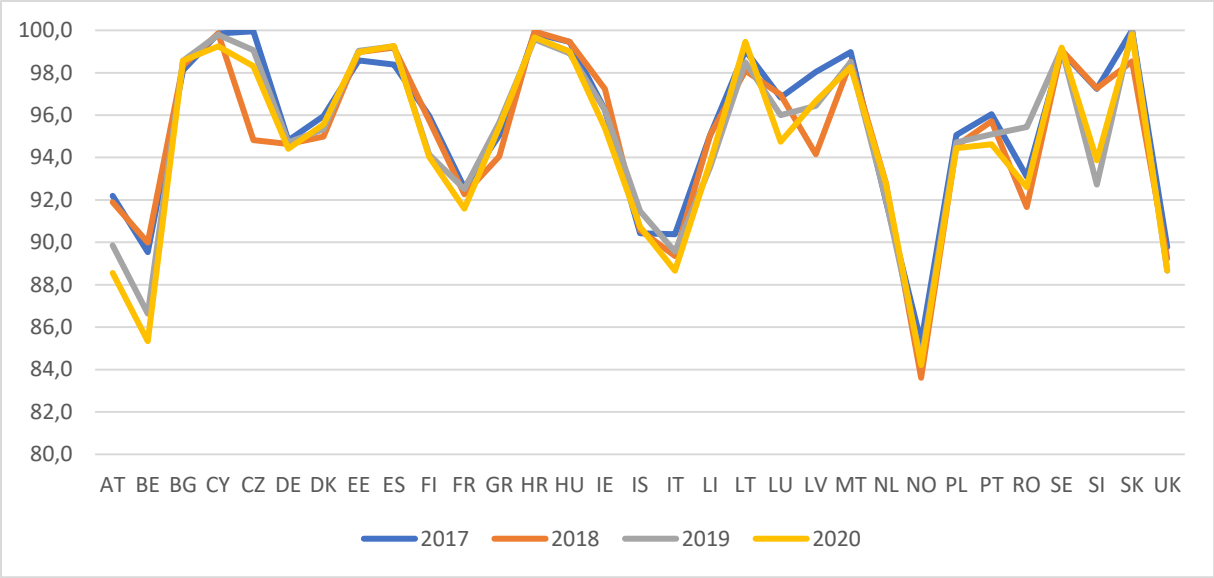
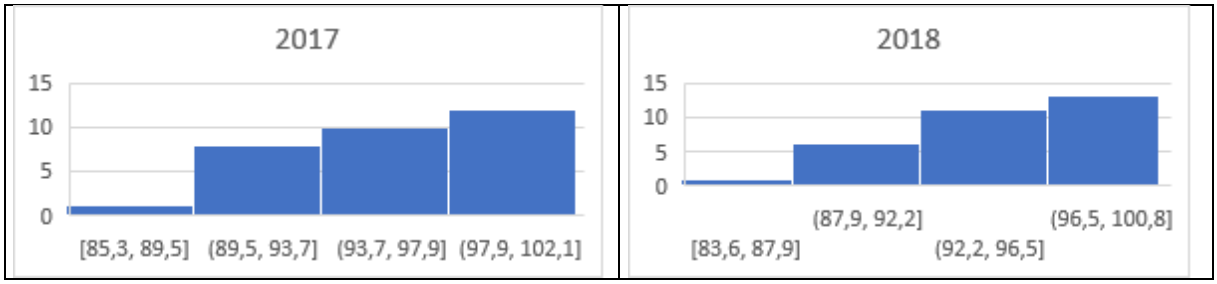


Figure 6. Relative share of Tier 1 capital to equity capital

The empirical distribution of data for the insurance sector according to the relative share of Tier 1 capital by year, represented by distribution histograms, shows that there is dynamics in their distribution. In the individual years, the arithmetic mean fluctuates between 94.7% and 95.6%, with the lowest in 2020 and the highest in 2017. Based on the root mean square deviation, the variation in the relative share of Tier 1 capital is established being the largest for 2020, and the weakest for 2017 (3.791%). There are similar distributions for 2017 and 2018, which can be defined as highly left-skewed distributions for which skewness coefficients are above -0.8. For 2019, there are albeit minimal changes in the distribution of countries according to the relative share of Tier 1 capital in the capital base, but overall the significant left skewness remains. Significant changes in the distribution of countries according to the relative share of Tier 1 capital in the insurance sector do not occur, and the distribution histogram clearly shows that there is a change in the direction of reducing the number of countries that fall into the last interval group. The empirical distribution of data for the insurance sector according to the relative share of Tier 1 capital by year, presented by distribution histograms (Figure 7), also shows that there is dynamics in its distribution, but it is not so pronounced.



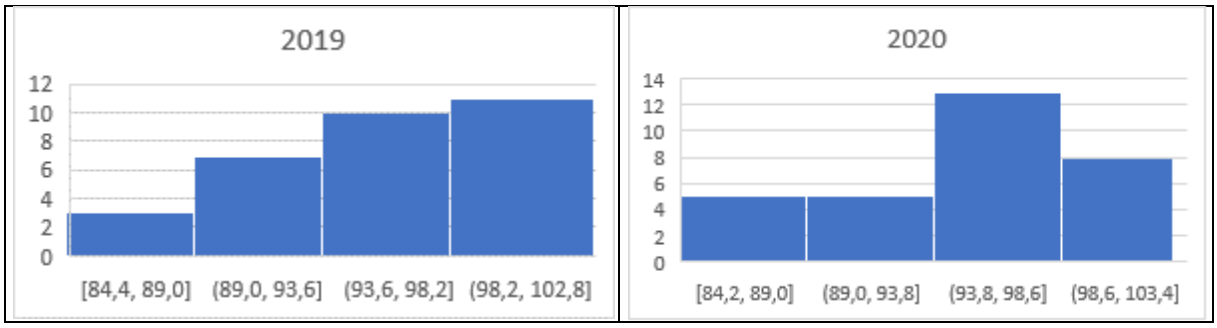


Figure 7. Distribution histograms of countries according to the relative share of Tier 1 capital in the insurance sector

As a result of the distribution analysis of the countries according to the relative share of Tier 1 capital for the insurance sector, in order to achieve comparability of the results, a grouping was again carried out in intervals with a width of 5%, starting from an 80% share of the Tier 1 capital and reaching 100% relative share of Tier 1 capital, presented in Table 2. When countries are distributed according to the relative share of Tier 1 capital in equal intervals, it is clearly seen that for all analyzed years the largest number of countries was established for the interval above 95% to 100% relative share of Tier 1 capital in their insurance sectors. At the same time, the number of countries in the range above 95% to 100% of Tier 1 capital can be seen to be decreasing over the period, meaning that insurance companies have taken the opportunity to increase the share of Tier 2 capital as well as to include Tier 3 capital in their capital base. The established change in the distribution of countries according to the relative share of Tier 1 capital in their insurance sector is the result of the admission of Tier 2 and Tier 3 capital in the structure of the capital base.

Table 2. Distribution of countries according to the relative share of Tier 1 capital in the insurance sector to the total amount of equity capital

Relative share of Tier 1 capital in the insurance sector (%)	Countries			
	2017	2018	2019	2020
over 80 to 85	-	1	1	1
over 85 to 90	3	2	4	4
over 90 to 95	7	12	8	11
over 95 to 100	21	16	18	15
Total	**31**	**31**	**31**	**31**

Source: Author's calculations

The analysis carried out confirms the importance that Solvency II and Basel III place on the qualitative and quantitative characteristics of capital positions, emphasizing the role that Tier 1 capital has on the stability of institutions against the risks of their activities. The increase in capital requirements in both regulatory frameworks shows the importance of strengthening the capital base given the expansion of risks and specifics in the banking and insurance sectors. To ensure additional resilience during the various phases of the economic cycle, both regulations include measures such as the creation of capital buffers under the conditions of Basel III and the introduction of technical reserves provided for in Solvency II, their purpose being to set aside a financial resource in a period of upswing, which will serve as an additional strengthening of the capital positions of both sectors in the event of an unfavourable economic situation.

2. Analysis of the implementation of capital requirements in the banking and insurance sectors

The results of the analysis show that for all analyzed banks in the period 2017-2021, the capital adequacy ratios as a percentage of the total risk exposure – common equity Tier 1 capital ratio, Tier 1 capital ratio and total capital adequacy ratio, compared to the regulatory minimum ratios, are not only met, but the banks' indicators significantly exceed them.

Table 3. Characteristics of capital adequacy indicators for the period 2017-2021.

Characteristics	2017	2018	2019	2020	2021
CET 1 capital ratio					
Minimum	11.19	6.63	11.61	12.2	13.94
Average	20.19	19.12	18.73	22.75	23.14
Standard deviation	24.14	21.35	15.75	40.21	45.15
Coefficient of variation	119.54	111.66	84.08	176.75	195.10
Ratio of minimal significance to MCR (4.5%)	2.49	1.47	2.58	2.70	2.47
Ratio of mean value to MCR (4.5%)	4.49	4.25	4.16	5.06	5.14
Tier 1 capital ratio					
Minimum	11.19	7.53	12.13	12.13	15.03
Average	21.17	20.39	19.70	24.28	24.62
Standard deviation	24.90	22.30	17.31	40.99	45.58
Coefficient of variation	117.60	109.35	87.84	168.86	185.15
Ratio of minimal significance to MCR (6%)	1.86	1.26	2.03	2.02	2.09
Ratio of mean value to MCR (6%)	3.53	3.40	3.28	4.05	4.10

Total capital adequacy ratio					
Minimum	13.37	12.67	11.12	12.54	15.39
Average	23.70	22.43	21.88	26.48	26.86
Standard deviation	25.97	22.49	16.99	40.64	45.23
Coefficient of variation	109.57	100.28	77.64	153.47	168.37
Ratio of minimal significance to MCR (8%)	1.67	1.58	1.74	1.88	1.92
Ratio of mean value to MCR (8%)	2.96	2.80	2.74	3.31	3.36

Source: Author's calculations.

The performed analysis of the insurance sector and its results give sufficient grounds to state that for the period 2017-2020 there is a fulfillment of the solvency capital requirement coverage ratio, the average value being twice as high as the critical minimum of 100%, and the minimum value of the indicator by year marked a significant growth from 134% for 2017 to 156% for 2020, which clearly shows that insurance companies have no problems complying with the stricter capital requirements regulations.

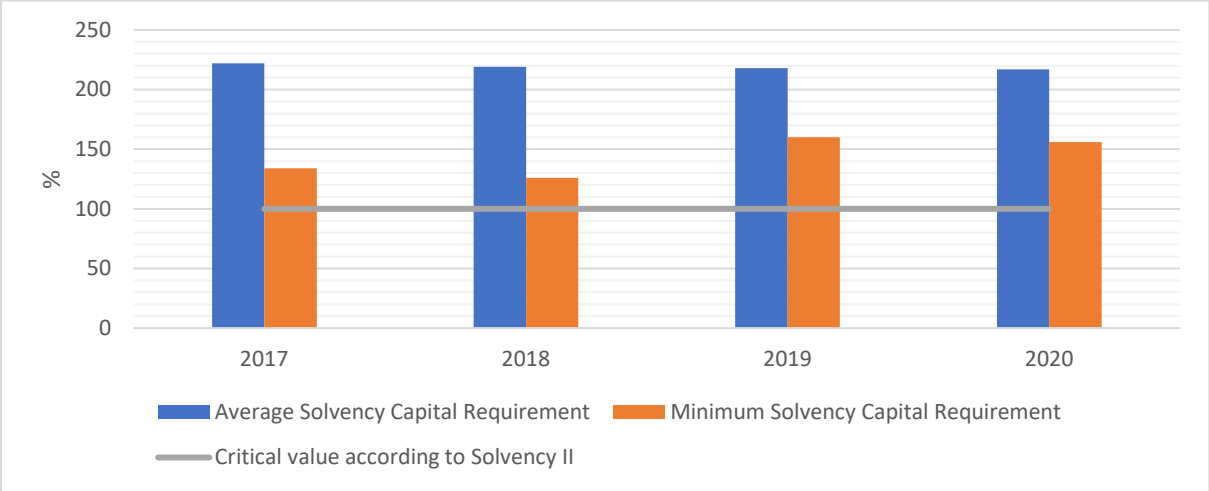


Figure 8. Solvency Capital Requirement coverage ratio for the period 2017-2020

Source: EIOPA and author's calculations

The results of the analysis of capital requirements for the banking and insurance sectors give sufficient grounds to state that risk management strengthens its key role in terms of fulfilling the capital requirements and guaranteeing the solvency of credit institutions and insurance companies.

3. Analysis of the dependence between risks and equity in the banking sector

The establishment of the dependence between the total risk-weighted assets and the weighted assets for the main risks on the equity capital, the common equity Tier 1 capital and the Tier 1 capital was carried out on the basis of official data of the European Banking Authority at the end of December for the period 2017-2021. Our aim is to empirically test and develop a conceptual model in which to identify and justify the most relevant factor variables that have a statistically significant impact on the amount of equity capital. The selection of factor variables is based on previous research and other authors' research, according to which credit risk, market risk, operational risk, counterparty credit risk, credit valuation adjustment, excess provisions and total risk-weighted assets.

As factors affecting the dependent variables – Capital base (y_1), Tier 1 (y_2), CET 1 (y_3), the following risks are addressed – Credit risk (x_1), Operational risk (x_2), Market risk (x_3), Credit valuation adjustment (x_4) and Total RWA (x_5). The number and type of factors involved in the models determines the composition of single and multiple regression models, for which the parameters and corresponding characteristics are calculated, on the basis of which the adequacy of the models and the significance of their parameters are assessed. In the process of analyzing the influence of individual bank risks on equity capital, Tier 1 capital, common equity Tier 1 capital, six types of regression relationship models were tested – linear, logarithmic, parabola, cubic function, exponential and power function. The selection of the most appropriate model is based on the correlation coefficient (r), the coefficient of determination (R^2) and the Fisher criterion (F), and the most suitable models are those for which the highest values of the specified characteristics are obtained.

Analyzing the strength and direction of influence of the factors on the amount of equity capital allows to make an objective assessment of the coverage of risks, capital adequacy and resilience of the individual bank and the banking system as a whole. Regression models are presented with corresponding graphics. The results of testing the adequacy of the models and the statistical significance of the parameters of the regression equations show that they are a reliable tool for predicting changes in the required amount of equity capital and common equity Tier 1 capital to cover banks' risks. The studied dependences are described accurately enough with linear regression models for the individual factor influences, which are also the basis for their inclusion in multiple regression models. The obtained single and multiple regression models are adequate and they

can be used for forecasting, for simulating different variants of changes in risks and the required coverage with common equity Tier 1 capital. In multiple regression, the total amount of risk-weighted assets is excluded from the factors, as it contains the influence of the other risks and will lead to incorrect results.

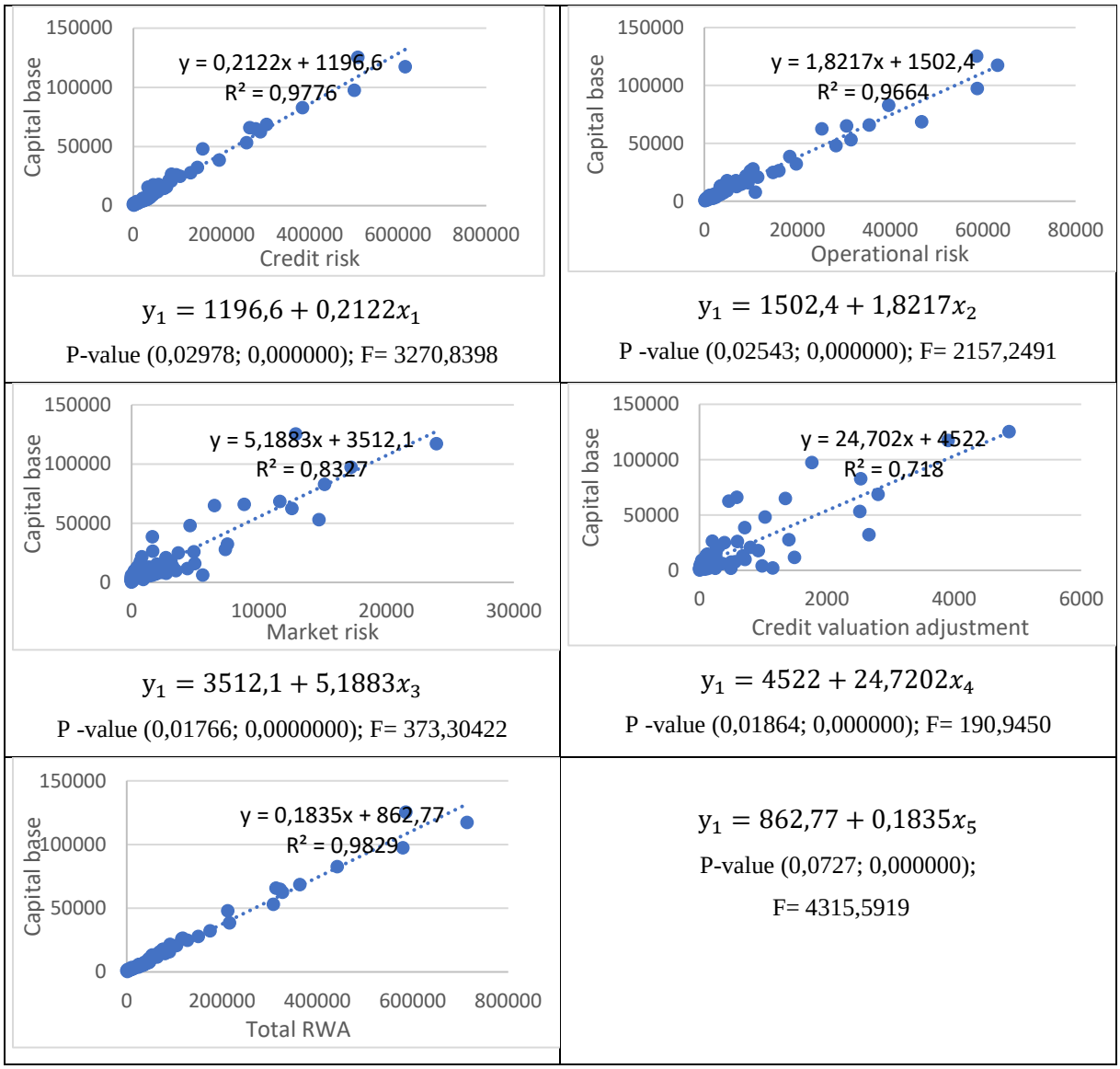


Figure 9. Regression models of the dependence between individual risks and equity as of December 31, 2021.

The obtained results (Table 4) show that the dependence between Capital base (y_1), Tier 1 (y_2), CET 1 (y_3) and the studied factor variables is very high – the multiple correlation coefficients are above 0.98 and show a very strong influence on the risks included in the model as factor variables. From the coefficients of determination, it was found that more than 97% of the amount of Capital base, Tier 1 and CET 1 depends on the studied risks included in the models. The obtained multiple linear regression models are adequate and suitable for

describing the studied dependences. It was found that the ranking of the factors according to the strength of their influence on the amount of Capital base, Tier 1 and CET 1 is as follows: credit risk has the strongest influence, followed by operational risk, the market risk, and the influence of the credit valuation adjustment is the weakest.

Table 4. Characteristics of multiple regression models for banks

Multiple regression models	Correlation coefficient	Coefficient of determination
2017		
$y_1 = 885.7129 + 0.16923x_1 + 0.16053x_2 - 0.27633x_3 + 2.4808x_4$	0.989	0.9782
$y_2 = 978.1577 + 0.15842x_1 + 0.041331x_2 - 0.30618x_3 + 2.047879x_4$	0.9921	0.9842
$y_3 = 1013.722 + 0.158501x_1 - 0.04565x_2 - 0.36321x_3 + 1.794994x_4$	0.9926	0.9852
2018		
$y_1 = 989.6775 + 0.16493x_1 + 0.2631x_2 - 0.304x_3 + 1.5066x_4$	0.9880	0.9761
$y_2 = 967.8748 + 0.154114x_1 + 0.141x_2 - 0.26173x_3 + 0.852x_4$	0.9908	0.9816
$y_3 = 1053.392 + 0.1591x_1 - 0.00078x_2 - 0.42816x_3 + 1.15878x_4$	0.9887	0.9775
2019		
$y_1 = 1158.346 + 0.1252x_1 + 0.6057x_2 - 0.1856x_3 + 1.4789x_4$	0.9904	0.9808
$0.y_2 = 1033.697 + 0.12987x_1 + 0.34155x_2 - 0.17699x_3 + 1.19424x_4$	0.9913	0.9872
$y_3 = 1048.969 + 0.13897x_1 + 0.16361x_2 - 0.3039x_3 + 1.37866x_4$	0.9888	0.9777
2020		
$y_1 = 1164.716 + 0.164x_1 + 0.374x_2 - 0.3228x_3 + 2.8062x_4$	0.9913	0.9824
$y_2 = 1087.665 + 0.15695x_1 + 0.2049x_2 - 0.3044x_3 + 2.3273x_4$	0.9912	0.9824
$y_3 = 1102.119 + 0.16244x_1 + 0.05465x_2 - 0.1650x_3 + 2.53166x_4$	0.9893	0.9784
2021		
$y_1 = 1053.024 + 0.154923x_1 + 0.625946x_2 - 0.67091x_3 + 1.62169x_4$	0.9926	0.9852
$y_2 = 1120.012 + 0.139274x_1 + 0.481009x_2 - 0.6233x_3 + 1.5009x_4$	0.9914	0.9828
$y_3 = 1031.173 + 0.141925x_1 + 0.293007x_2 - 0.67905x_3 + 2282476x_4$	0.9886	0.9772

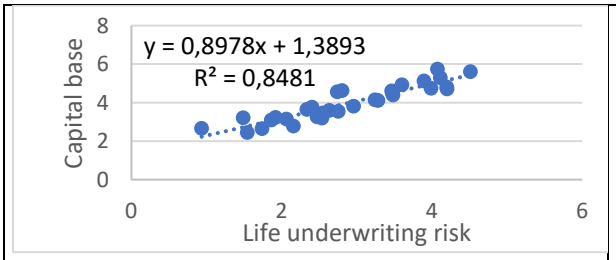
Source: Author's calculations.

4. Analysis of the dependence between risks and equity in the insurance sector

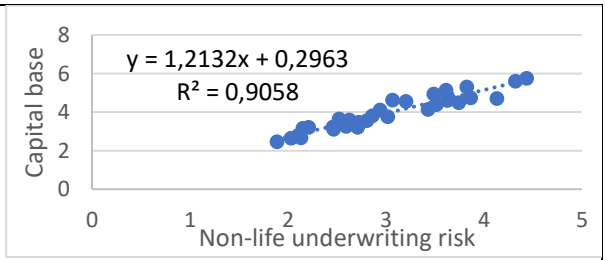
This part analyzes data on Life underwriting risk (x_1); Non-life underwriting risk (x_2); Health underwriting risk (x_3); Market risk (x_4); Counterparty default risk (x_5); Basic Solvency Capital Requirement (x_6); Capital base (y_1); Tier 1 (y_2); for the insurance sector in the following countries: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Germany, Denmark, Estonia, Finland, France, Spain, Greece, Croatia, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden, United Kingdom.

Single and multiple regression and correlation were applied, and for the obtained regression models, the parameters and corresponding characteristics of the models were presented, on the basis of which their adequacy and the significance of their parameters were assessed. As the data are for the insurance sector of individual countries, and within each country the development and scope of life insurance, non-life insurance and health insurance are different and accordingly the investigated factors and the result also have a significant variation, despite bringing them to the same measure unit, the studied variables have to be logarithmized.

The checks for model adequacy and significance of the parameters were carried out at the significance level $\alpha = 0{,}05$. The model adequacy was assessed based on Fisher's F-criterion, and for almost all of the six types of models tested (linear, logarithmic function, parabola, cubic function, exponential and power function), the empirical value of Fisher's criterion was higher than the theoretical value of the criterion ($F_{EM} > F_T$), therefore, each of them could be used to characterize the studied dependence, but the choice in this case falls on the regression models that allow a clear economic interpretation of the parameters. From the analysis for the period 2017-2020, it was found that with each subsequent year since the introduction of the Solvency II regulation, equity in the insurance sector is increasingly beginning to depend on the risks included in the model, and this is a sure sign that regulatory standards are strictly followed and a good coverage of the Solvency Capital Requirement is achieved. The high correlation coefficients indicate that the risks included in the single regression models are the determining factors for the amount of equity capital in the insurance sector. The conclusions drawn are also confirmed with regard to the investigated factor influences on the amount of Tier 1 capital.



$$y_1 = 1.3893 + 0.8978x_1$$



$$y_1 = 0.2963 + 1.2132x_2$$

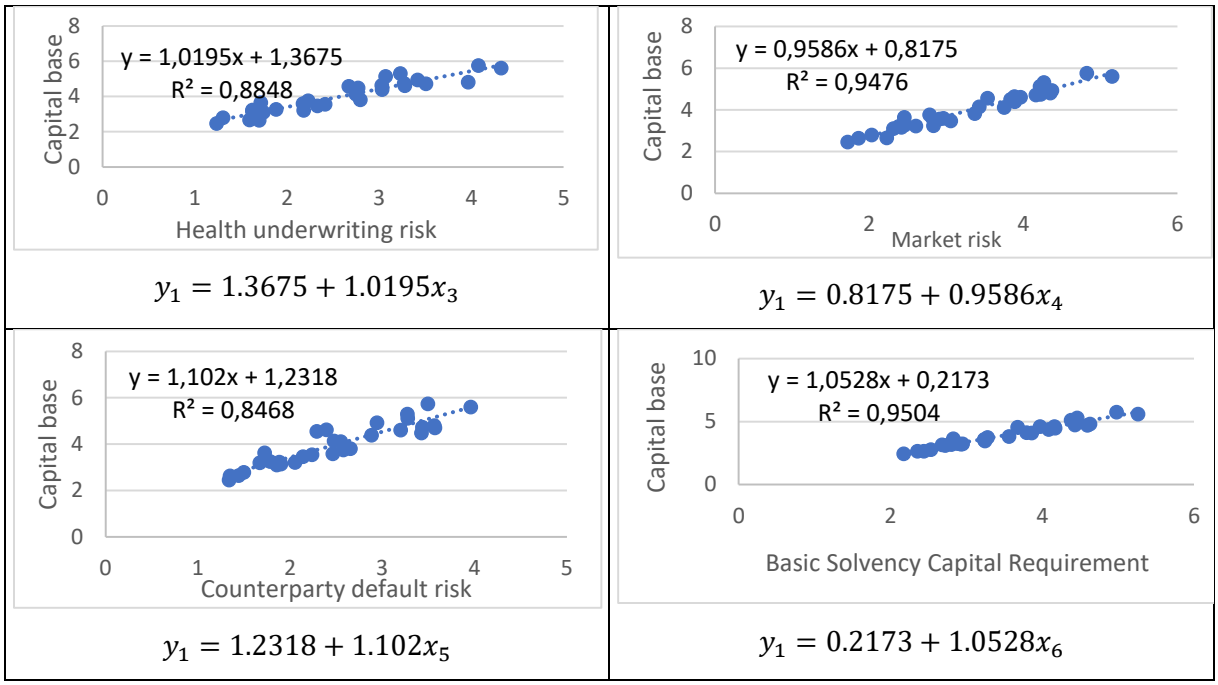


Figure 10. Regression models of the dependence between individual risks and capital base in insurance for 2020.

The study of the joint influence of the presented risks on the amount of equity in insurance is very important, therefore multiple regression was applied, characterizing the influence of underwriter risk in life insurance, underwriter risk in non-life insurance, underwriter risk in health insurance, market risk and counterparty default risk on the amount of equity capital. The special thing here is that the basic solvency capital requirement is excluded from the factors, since it contains the influence of the other risks and will lead to incorrect results.

The obtained results confirm (Table 5) that the dependence between the amount of equity capital in insurance and the studied risks is very high – the multiple correlation coefficients are over 0.8 and the multiple determination coefficients are over 0.96, indicating that over 96% of the equity capital is determined by the risks included in the multiple models. The models are adequate and can be used both for modeling the studied dependences and for forecasting the equity capital and Tier 1 capital in case of changes in the individual risks involved in the tested models. The conclusion is again confirmed that the dependence of equity capital on the examined risks becomes even stronger and that the application of the standards for calculating insurance risks and the capital required to cover them, according to Solvency II, clearly gives results, because the amount of equity capital increasingly depends on the risks being investigated.

Table 5. Characteristics of multiple regression models for insurance

Multiple regression models	Correlation coefficient	Coefficient of determination
2017		
$y_1 = 1.8045 + 0.5764x_1 - 0.7194x_2 - 0.4132x_3 + 1.4517x_4 - 0.491x_5$	0.8269	0.6838
$y_2 = 1.8073 + 0.5795x_1 - 0.7226x_2 - 0.4781x_3 + 1.4465x_4 - 0.7226x_5$	0.8265	0.6832
2018		
$y_1 = 1.9327 + 0.4601x_1 - 0.967x_2 - 0.2493x_3 + 1.5563x_4 - 0.38187x_5$	0.8282	0.6858
$y_2 = 1.9322 + 0.4623x_1 - 0.9712x_2 - 0.2584x_3 + 1.5495x_4 - 0.3691x_5$	0.8275	0.6848
2019		
$y_1 = 0.4705 + 0.1734x_1 + 0.5262x_2 - 0.1386x_3 + 0.848x_4 - 0.4113x_5$	0.9790	0.9585
$y_2 = 0.4769 + 0.1817x_1 + 0.5254x_2 - 0.1508x_3 + 0.8442x_4 - 0.4139x_5$	0.9786	0.9577
2020		
$\hat{y}_1 = 0.4612 + 0.1938x_1 + 0.5530x_2 - 0.116x_3 + 0.7970x_4 - 0.3941x_5$	0.99814	0.9632
$\hat{y}_2 = 0.4736 + 0.2027x_1 + 0.5257x_2 - 0.1192x_3 + 0.7868x_4 - 0.3966x_5$	0.9811	0.9628

Source: Author's calculations.

From the empirical analysis carried out using EIOPA data for the period 2017-2020 by country, it was found that the following factors play a key role in determining the amount of equity capital in the insurance sector: underwriter risk in general, as well as separately for underwriter risk in life insurance, underwriter risk in non-life insurance, underwriter risk in health insurance, market risk, counterparty default risk. It was proved that at the beginning of the period after the introduction of Solvency II, the impact of risks on the amount of equity capital in insurance is not strongly expressed, but in each subsequent year of the analyzed period, the effect of the introduction and application of this regulatory regime is clearly visible. It was found that with each subsequent year of the implementation of the Solvency II regulation, the amount of equity capital in insurance increasingly depends on the risks included in the model, which is a sure sign that the standards of the regulation are strictly followed and a good coverage of the solvency capital requirement is achieved. The high correlation coefficients clearly show that these are the determinants of the amount of equity capital in the insurance sector.

Conclusion

Financial institutions play an important role in the economy, and their stability is key to the development of the economic system, as the instability or bankruptcy of a financial institution can have a significant impact not only on its customers, but also on the financial sector and the economy as a whole. The

reliability of the financial system and the trust in it are the responsibility of every financial institution, but above all of the regulatory and supervisory authorities. The dissertation proves that when assessing the safety and soundness of a financial institution, capital is one of the most important factors, as it determines the risk capacity of the financial institution.

The study of risk continues to be an important issue in economic theory and is extremely relevant in modern conditions, as there is an ongoing process of evolution of financial instruments on the market, digitization of a number of processes and activities, cyclicality in economic development, economic and financial crises, etc. The global financial and economic crisis of 2008, as well as the crisis caused by the COVID-19 pandemic, have once again raised questions about risk, assessment, forecasting, risk management and limiting the negative manifestation and its effects. The scale of the consequences of these crises in the financial sector is proof that the processes of researching, assessing and managing risk are extremely important and the condition, stability and sustainability of the banking and insurance sectors depend to a great extent on them. The presented risk assessment methods not only occupy an important place in theory, but also find practical application in the process of risk management in regulated financial institutions.

The risk management system in banks and insurance companies is a complex of techniques, methods and approaches that allow to detect, identify, locate and assess risks, on the basis of which adequate measures can be taken to eliminate or mitigate negative outcomes, thus guaranteeing favourable financial results and the stability of the financial institution.

Risk management in banks and insurance companies is carried out in the following sequence – first, analyzing the consequences that the risk may lead to, then proposing and justifying measures to minimize losses, and at the next stage developing and implementing a system for rapid adaptation to individual risks, in order to take adequate actions to neutralize them and mitigate negative consequences.

The financial sector is developing under the conditions of increasing regulatory requirements and supervisory activities, which present a number of challenges related to their methodological soundness and application possibilities. Capital requirements occupy an important place among the many regulatory requirements that the banking and insurance sector must comply with. The Solvency II and Basel III regulatory frameworks emphasize the qualitative and quantitative characteristics for the eligibility of equity capital items, and the

increase in capital requirements in both regulatory frameworks shows the significance of strengthening the capital base when expanding risks in the banking and insurance sectors. To ensure additional resilience during the various phases of the economic cycle, both regulations present the necessary measures – the creation of capital buffers under the conditions of Basel III and the introduction of technical reserves provided for in Solvency II. Certain similarities were found in the understanding of equity capital items, but there are also significant differences between the regulatory requirements Basel III and Solvency II, one of the main differences being in the interpretation of the quality of equity capital items.

A significant convergence of the philosophies of the regulatory frameworks regarding the concept of risk management was found in the banking and insurance sectors. The reason for this is that with the onset of the global financial and economic crisis in 2008, emphasis was placed on identifying the sources of risk and their subsequent management to achieve stability in the financial sector, which is the basis of the identified deficiencies in the Basel II regulatory requirements and leads to several revisions of the regulatory framework, as well as to the creation and adoption of the new Basel III regulatory requirements. At the same time, the Solvency II regulatory framework was adopted in this period, which introduces a new approach to the calculation of capital requirements compared to the previous Solvency I regulation, and the new regulatory requirements for the insurance sector are based on the concept of risk detection and management.

Based on the study of the methodological features of the Basel III and Solvency II regulatory frameworks, three key components describing the regulatory impact – scope of application, equity eligibility requirements and the concept of risk management – are derived and substantiated. We concluded that, unlike the Basel standards for determining capital requirements in the banking sector, where there is a revision and upgrade of the concept of ascertainment and subsequent risk management, the Solvency II regulatory framework represents an initial introduction of the new regulation, which is based on the concept of risk management.

The presented grouping of banks highlights the trend towards an increase in the number of banks, where the relative share of Tier 1 capital is over 80%, this change being a direct result of the increase in regulatory requirements for the quality of the capital base and, more specifically, for Tier 1 capital, which are

related to the need to increase the amount of share capital at the expense of hybrid instruments and subordinated term debt.

Tracking the dynamics of the relative shares of individual types of capital for the insurance sector gives reason to summarize that in the period 2017-2020 there is a tendency to increase the share of Tier 1 capital. This trend is in line with the Solvency II methodology, which places increasing importance on asset quality and Tier 1 capital. This trend was also confirmed by our grouping of the countries according to the relative share of Tier 1 capital in equal intervals. It is clearly seen that for all the analyzed years the largest number of countries was found in the interval above 95% to 100% relative share of Tier 1 capital in their insurance sectors. At the same time, the number of countries in the range above 95% to 100% share of Tier 1 capital was found to be decreasing over the period, meaning that insurance companies took advantage of the opportunity to increase Tier 2 capital as well as include Tier 3 capital in their capital base. The identified change in the distribution of countries according to the relative share of Tier 1 capital in their insurance sector is the result of the admission of Tier 2 and Tier 3 capital in the structure of the capital base of insurance companies.

The results of the analysis show that for all analyzed banks in the period 2017-2021, the capital adequacy ratios as a percentage of the total risk exposure – the common equity Tier 1 capital ratio, Tier 1 capital ratio and the total capital adequacy ratio, compared to the regulatory minimum ratios, are not only met, but the banks' indicators significantly exceed them.

Empirically, it was confirmed that for the period 2017-2020, the solvency capital requirement coverage ratio was fulfilled for the insurance sector, with the average value being twice as high as the critical minimum of 100%, and the minimum value of the indicator by year marked a significant increase from 134% in 2017 to 156% in 2020, which clearly shows that insurance companies have no problems complying with the stricter regulations on capital requirements.

The results of the analysis of the capital requirements for the banking and insurance sectors give sufficient grounds to state that risk management strengthens its key role in terms of fulfilling capital requirements and guaranteeing the solvency of credit institutions and insurance companies.

On the basis of the constructed single and multiple regression models, it was established that throughout the entire period, credit risk had the greatest influence on the capital base, followed by operational risk and market risk. Undoubtedly, the credit valuation adjustment had the least impact on the capital base during the analyzed period. The identified factor influences on the capital

base and the obtained single and multiple models empirically confirm the concept of the applied approach to selecting factor variables influencing the capital base and reinforce the view that a complex assessment of risk management, asset quality, solvency and sustainability of banks can be carried out through the analysis of factor influences.

From the empirical analysis for the insurance sector by means of the applied single and multiple regression, it was found that the following factors play a key role in determining the amount of capital base: underwriting risk, differentiated into underwriting risk in life insurance, underwriting risk in non-life insurance, underwriting risk in health insurance, market risk and counterparty default risk. It was proved that with each subsequent year of the implementation of the Solvency II regulatory framework, the amount of equity capital in the insurance sector is increasingly beginning to depend on the examined risks and they determine what part of the capital is needed to cover them, and this clearly shows that adhering strictly to the regulatory standards leads to better solvency capital requirement coverage ratio. The high correlation coefficients clearly show that these are the determinants of the amount of equity capital in the insurance sector.

III. Directions for future research in the field of the dissertation

The researched issues are topical and can hardly be considered in all possible aspects in the dissertation, which sets before the author tasks for future scientific and research and publication activities.

The scientific and research interests of the author, which will be the basis of her future research on the topic of the dissertation. are in the following directions:

- Comparative analysis between the Solvency 2 regulatory regime and the regulatory requirements of the International Organization of Insurance Supervisors (IAIS).
- Comparative analysis between the regulatory requirements of the International Organization of Insurance Supervisors and the Basel standards for capital requirements in the banking sector.
- Empirical analysis of indicators for the banking and insurance sectors, which are not covered in the dissertation.

IV. List of the scientific contributions of the dissertation

The theoretical and practical significance of the dissertation and its main contributions are expressed in the following:

First. It presents the author's interpretation of the regulatory paradigm in insurance and banking. The banking and insurance sectors play a crucial role in the financial system and can significantly affect the economy, which makes them subject to extensive regulation and supervision. Based on an in-depth review of leading theoretical concepts for risk assessment and management in the banking and insurance sectors, specific features and differences in risk management have been identified. Key features common to both sectors include capital adequacy requirements, a focus on risk management, solvency and liquidity requirements.

Second. It clarifies the essence, role and significance of the regulatory requirements of the Basel I, II and III Accords for the banking sector and Solvency I and II for the insurance sector. Important aspects of the regulatory mechanisms regarding risk management and capital requirements are revealed, emphasizing the importance of strengthening the capital base under the conditions of the continuous expansion and complication of risks in the banking and insurance sectors. At the same time, the regulatory frameworks for the banking and insurance sectors differ significantly due to their unique characteristics and risk profiles. Banking supervisors often focus on prudential regulation and systemic stability, while insurance supervisors typically focus on solvency and consumer protection.

Third. It carries out a historical and comparative analysis of the evolution of the Basel standards in the banking industry and the Solvency directives in the insurance industry. The similarities and differences are explained, as well as the reasons for them. As a result of an in-depth study of the methodological features of the Basel III and Solvency II regulatory frameworks, three key components describing the regulatory impact – scope of application, equity eligibility requirements and the concept of risk management – are derived and substantiated. Based on the identified key parameters, a comparison is made between the regulatory frameworks in the two sectors.

Fourth. An institutional analysis of the role and place of risk management in the banking and insurance sectors is carried out. The conclusion is substantiated that due to the complicated business environment and the growing regulatory requirements in the banking and insurance sector, risk management strengthens its key role in fulfilling capital requirements and guaranteeing the solvency of

financial institutions from the banking and insurance sector. Regulations will continue to develop, expand and upgrade in parallel with the advanced supervision of the banking and insurance sector, and this will set new challenges and expectations for innovation, creativity and regulatory robustness of managerial decisions made by the senior management of banking and insurance institutions.

Fifth. An empirical study is prepared and conducted, systematizing indicators for analysis and evaluation of financial institutions from the banking and insurance sectors. Based on the empirical research using official statistical data of the European Banking Authority and the European Insurance and Occupational Pensions Authority, key indicators of risk management, equity structure and the fulfillment of capital requirements in the banking and insurance sector are analyzed, factor influences are highlighted and cause-and-effect relationships and dependencies are substantiated.

V. Author's publications related to the topic of the dissertation

Studies: 2

1. **Lyubenova. B.** Stress tests as an integral approach for a complex assessment of risk management, asset quality and bank sustainability. Doctoral Research Annual Almanac. Issue XIV – 2021, Book 17.
2. **Lyubenova. B.** Models for risk assessment when performing stress tests in the banking sector. Doctoral Research Annual Almanac. Issue XIII – 2020. Book 16.

Articles: 1

1. **Lyubenova. B.** Capital requirements under the conditions of Basel III and Solvency II. Annual almanac "Scientific research of doctoral students". Issue XII - 2019. Book 15.

Scientific papers: **4**

1**. Lyubenova. B.** Stress tests of the Bulgarian banking system in the context of Basel III regulatory requirements. Scientific and practical conference "The Economy of Bulgaria – 30 years after the beginning of the changes", organized by the Union of Scientists in Bulgaria, branch Svishtov and D. A. Tsenov Academy of Economics – Svishtov, 22.11.2019.

2. **Lyubenova. B.** Assessment and risk management of banks in lending to transport and logistics activities. Scientific conference "Logistics and public systems" 2021 organized by National Military University "Vasil Levski" – Veliko Tarnovo, 25-26.02.2021.

3. Prodanov, S., Slaveva, K., Stanimirov, S., **Lyubenova, B.** Empirical analysis of the determinants of non-life insurance consumption in Bulgaria since its accession to the European Union. Varazdin Development and Entrepreneurship Agency and University North in cooperation with Faculty of Finance – D. A. Tsenov Academy of Economics, 2022, pp. 365-376.

4. Prodanov, S., Slaveva, K., Stanimirov, S., **Lyubenova, B.** Empirical analysis of the impact of inflation on the insurance penetration of non-life insurance in Bulgaria. Varazdin Development and Entrepreneurship Agency, 2022, pp. 251-261.

VI. Reference for compliance with the national requirements under the Regulations on the Implementation of the Development of Academic Staff in the Republic of Bulgaria Act

National requirement: **30.00 points**

Number of **studies** published in non-referenced peer-reviewed journals or reviewed collections: 2

Score: 30 points

Number of **articles** published in non-referenced peer-reviewed journals or reviewed collections: 1

Score: 10 points

Number of **papers** published in non-referenced peer-reviewed journals or reviewed collections: 4

Score: 25 points

Total score: 65.00 points with a minimum requirement of 30.00 points

VII. Statement of originality of the dissertation

The dissertation entitled **Risk assessment and management of regulated financial institutions** comprising 271 pages and the author's abstract thereof are authentic scientific works of the author. They are based on their author's ideas. texts and visualization in terms of graphs, schemes, tables and formulas and comply with all the requirements of the Law on copyright and its related rights for proper citing and referencing of other authors' publications and data, including:

1. The results achieved in the dissertation and its scientific contributions are original and are not borrowed from research and publications in which the author has not participated.

2. The information presented by the author in the form of copies of documents and publications, personally compiled references, etc. corresponds to objective truth.

3. Scientific results obtained, described and/or published by other authors are duly and correctly cited in the references section.

Date: 06 July 2023 **Doctoral Student**: ……

/Beatris Lyubenova/