

# Capital adequacy of insurance companies in the Solvency II system

## Summary

One of the fundamental principles of sound financial management of insurance companies is the maintenance of solvency, which is closely linked to the reality of the insurance services provided. Under the new Solvency II regime, insurance and reinsurance undertakings are required to comply with new capital requirements and to maintain an adequate level of own funds. In addition, the new solvency regime imposes new, more detailed information requirements on insurers in the area of solvency and financial condition. As a result, insurance companies are facing new challenges in the development of prudential measures.

The Solvency II framework is a regulatory regime for insurance and reinsurance companies that came into force on January 1, 2016. Work on the directive was initiated by the European Commission in 2001 with the aim of harmonizing the rules governing the European insurance market. As a result, Solvency II has extended its reach as many countries outside the European Union have obtained full equivalence status with the European Solvency II framework. National regulators are seeking to reduce risk in financial markets to prevent further financial crises by increasing requirements for better risk management and financial transparency by insurers. This global trend contributes to increased consumer protection through the introduction of capital adequacy requirements.

One of the main objectives of the implementation of Solvency II Directive was, *inter alia*, to ensure the capital adequacy of insurers operating in the European Union. This adequacy was to secure the operation of insurers without

compromising the interests of all subsidiaries, including the insured. While the European Union initiated the implementation of the Solvency II guidelines, other jurisdictions have embraced this example and implemented their own risk-based regulatory regimes. This thesis presents examples of many countries where capital adequacy systems are subject to constant review. This gives grounds to assume that insurance companies are less exposed to the risk of insolvency. The introduction of capital adequacy requirements actually significantly increases the protection of clients' interests, which was the motivation to undertake research on the capital adequacy of insurance companies and write this dissertation.

Capital adequacy relates to the amount of capital held and the capital requirements, which are measured using a standard formula in accordance with the Solvency II guidelines. The Solvency Capital Requirement (SCR) is determined by aggregating the individual risk categories. It should also be noted that not all risks to which an insurance company is exposed are covered by the Solvency Capital Requirement. Therefore, it is particularly important to review the standard formula as it will allow for the identification of elements that may not be appropriate to the specifics of a given insurance company's risk profile. Insurers may then consider building an internal model at this point, which will allow them to better tailor the Solvency Capital Requirement to the profile of their business.

The main purpose of this thesis is to provide a comprehensive presentation of the problem of insurance companies solvency and to examine the capital adequacy of domestic insurers operating on the Polish market. The capital adequacy of insurance companies is understood here as the compliance of capital requirements with the own funds and is achieved when the amount of eligible own funds of the insurance company ensures that the capital requirements under the Solvency II Directive are covered. Capital requirements under the Solvency II Directive correspond to the risk taken and the size of the business. The study presented in the dissertation covers the years 2016 to 2020, i.e. five consecutive years from the implementation of the Solvency II

guidelines in the European market. The specific objectives of the work, which includes a theoretical and an empirical part, are as follows: to explain and organize the concept of solvency and the theory related to the creation of the Solvency II Directive, to extend and complete the theoretical concepts with the results of empirical research in the field of capital adequacy, as well as to better understand the concept under study based on historical data of domestic insurance companies.

In addition, a number of research questions were identified, which were formulated as follows:

- (1) What factors related to the activities of insurance companies affect the solvency requirements under the Solvency II regime?
- (2) Whether and to what extent is it possible to influence the level of diversification of the standard formula?
- (3) How has the solvency level of life and non-life insurance companies in Poland developed since the introduction of the Solvency II system?

In connection with the last point, additional research questions were formulated, which were covered by the empirical study. They are as follows:

- (1) Do insurance companies in Poland form groups (clusters) in terms of similarity in the area of capital adequacy?
- (2) Is the insurance market diversified in terms of capital adequacy?
- (3) What are the dynamics of changes in this area?

This was the first research step, the work design stage, which was based on a review of national and international literature. The design phase consisted of a preliminary study and a research design phase. The preliminary study showed limited scope in the area of collective statements on the solvency of domestic insurance companies. In the research design phase, the research problems and their justification were formulated and hypotheses were defined. Quantitative methods were also chosen to achieve the research objective.

The study itself was then carried out, consisting of a literature review, a preparatory study and an empirical study. As part of the literature review, both domestic and foreign literature was reviewed. The study showed that the analysis of the capital adequacy of domestic insurance companies is particularly important due to the nature of solvency, as it operates as a system of interrelated vessels affecting customers, other market participants, shareholders, as well as the insurance companies themselves and the local supervisory authority. The research can be used for cognitive and theoretical purposes, but above all for practical purposes. The results of the survey can be used by the national supervisory authority, by insurance companies for comparative and competitive purposes, but above all by customers who have or are looking for insurance cover. The level of solvency of the insurer would then be an additional criterion determining the feasibility of insurance cover. The accumulated theoretical knowledge in the field of solvency and risk management can be used for further analyses in this research area.

In the first stage (literature review), literature criticism was used as a research procedure and analysis method. The method of literature analysis and criticism was applied to previously published scientific sources in order to collect and systematize basic concepts, identify factors influencing capital requirements, and obtain answers to the research questions posed. As part of the literature review and critique, the content analysis of secondary documents in written and digital form was used. The study consisted of the following stages: collection and selection of sources, analysis of their content, counting or graphical presentation of the results.

As part of the next stage, i.e. the preparatory study, statements and reports were prepared by the Polish Financial Supervision Authority (KNF), the European Insurance and Occupational Pensions Authority (EIOPA), its predecessor, the Committee of European Insurance and Occupational Pensions Supervisors (CEIOPS), the Polish Insurance Association (PIU) and consulting companies. This part of the study was aimed at analyzing international research

in the field of capital adequacy, identifying the variables analyzed, international trends in solvency, methods used and data sources.

The aim of the final stage, the empirical study, was to verify the hypotheses. For this stage, statements and reports prepared by the Polish Financial Supervision Authority were used, as well as reports on solvency and financial condition published on the websites of domestic insurance companies. The statistical method was used as the research procedure. This stage of the study included factor analysis, correlation analysis, variability analysis and cluster analysis.

The dissertation attempts to verify the main research hypothesis  $H_0$ , which reads as follows: Domestic insurance companies have sufficient own funds to meet the capital requirements of the Solvency II system, and they show a differentiation in meeting these requirements that allows them to be divided into groups. Auxiliary hypotheses were also formulated for this purpose:

$H_1$ : Domestic insurance companies have an adequate level of own funds to cover the Solvency Capital Requirement (SCR),

$H_2$ : Domestic insurance undertakings have an adequate level of own funds to cover the Minimum Capital Requirement (MCR),

$H_3$ : The Polish insurance market is diversified in terms of meeting capital requirements, which is reflected in the uneven clustering of insurance companies,

$H_4$ : Domestic life and non-life insurance companies are divided into 5-8 clusters in terms of meeting capital requirements.

The thesis consists of an introduction, four chapters, a conclusion and appendices. The purpose of Chapter I is to raise awareness of the role of solvency in the insurance sector and the importance of financial security in this sector. This chapter provides an overview of the concept of solvency of insurance companies in the world and, in particular, in the countries of the European Union, which is the cradle of the Solvency II system. It compares the Solvency I and Solvency II systems and reviews the risk categories associated with the activities of insurance companies.

The purpose of Chapter II is to present the characteristics of the Solvency II system, taking into account its origins and assumptions. It discusses the main elements of the standard formula and its alternative, the internal model. Against this background, the structure of the standard formula and its elements that affect the level of the SCR, such as the effect of diversification, aggregation, adjustments and specific parameters, are discussed. It also characterizes the Solvency Capital Requirement (SCR) and the risks of insurance companies that are not included in the standard formula.

Chapter III presents the definitions and assumptions underlying the identification of the risks included in the standard formula. A description of the risks is provided, as well as the method of measuring them in accordance with the principles of Solvency II. This chapter presents the requirements of insurance companies for individual risks and provides examples of simulations aimed at increasing the diversification effect of the standard formula. For all risk categories, an overview of management activities and good practices in risk management that may be helpful to insurance companies is also presented. It should be noted that Chapter III presents a comprehensive approach to the risks listed in the standard formula, describing quantitative and qualitative issues according to the following scheme: definition and assumptions, measurement and management methods.

The purpose of Chapter IV is an empirical analysis of the capital requirements of insurance companies operating in Poland in 2016-2020, taking into account: Solvency Capital Requirement (SCR), Minimum Capital Requirement (MCR) and Own Funds. This chapter also includes an empirical cluster analysis in terms of capital requirements. Before starting the study, preparatory analyses were carried out to verify the selection of variables.

The conclusion contains a summary of the considerations and presents the final remarks. An integral part of the thesis are the appendices, which contain detailed results of the analysis of the capital adequacy of insurers operating on the Polish market in the given period.

In the theoretical part of the thesis, the following research methods were used: the method of observation, the method of document study, the method of analysis and criticism of literature, the method of comparative analysis, as well as the method of synthesis, deduction, comparison and conclusion. In the empirical part, the following methods were used: the method of individual cases, the method of computer programming, the method of multidimensional data analysis and the method of statistical analysis. The data used in the empirical part were independently collected from the websites of individual insurance companies. This dissertation is a comprehensive approach to Solvency II risks from both a theoretical and practical perspective.

Solvency II was introduced because the existing Solvency I system needed to be modified. As mentioned above, the advantages of the new system include: the introduction of risk-sensitive capital requirements; the alignment with best practices in risk management; consistent standards and their application across the European Union; the consolidation of requirements for life, non-life and reinsurance companies; and the construction of the directive based on precise principles and guidelines. The concept of Solvency II (as opposed to Solvency I) has been modelled on the Basel II regulatory system for banks. However, the Solvency II system, by definition, takes into account the specificity of insurance and reinsurance activities, so the similarity with the banking system is limited.

Capital requirements under Solvency I were much simpler to calculate and were essentially aligned with the insurance company's accounting method (based on book values), and the system itself was much less complicated. However, this approach could not take into account the different risk profiles of insurance companies and new risk management practices. It was therefore only a matter of time before uniform rules were introduced in the European market. The new solvency rules, by introducing capital adequacy requirements, indeed significantly improved the protection of customers' interests.

The revision of the risks presented in the dissertation is particularly important in recent years, especially as the coronavirus pandemic and the war

in Ukraine, which began in 2022, have brought additional, previously unconsidered concepts to the palette of risks. For example, the new methodology for insurance companies identifies emerging risks, including: risks related to the natural environment; risks related to the development of knowledge and technology; geopolitical risks; and other risks affecting the global economy, such as a pandemic. Risks related to the natural environment have already been mentioned as risks related to air, water and soil pollution, as well as problems related to the quality of the environment (global warming, marine pollution) and other factors related to the environment that contribute to the occurrence of other risks, in particular, the risk of drought, floods. In addition, the Polish supervisory authority also lists risks related to the development of IT technology or artificial intelligence, which create cyber risks, the risk of power failure, the risk of significant disruption of Internet access, as well as technological changes that may lead to changes in the labor market. Among geopolitical risks, the Polish Financial Supervision Authority identifies risks related to economic and political changes that may affect the development of economic and social conditions. In addition, I would like to point out globalization, which strengthens mutual relations between financial institutions and contributes to the transfer of local financial difficulties to the global market, which may lead to a crisis in many sectors. Within this trend, issues related to the concept of sustainable development (ESG) have also been mentioned, including: the environmental factor, social responsibility and corporate governance. This is all the more so as a certain part of the risks is not included in the standard formula and is not quantified for the solvency requirement, which is also presented in this thesis.

This dissertation provides an overview of the risk categories to which the insurance company is exposed. In the literature on the subject, actuarial risk (also called insurance risk), market risk (also called systemic risk), credit risk (sometimes only counterparty risk) and operational risk have been mentioned.

However, it is very important to tailor the approach to the risk profile of each company. It should be noted that the classifications listed are neither mandatory nor limited to the risks indicated. Insurers must identify risks themselves, taking into account their own organizational dynamics. Over the years, many authors have identified the risks that are most typical of insurance activities or that have recently become more important. It is up to insurers to identify all the risks specific to a given insurer and to adapt the catalogue of risks to their business, since some of the risks to which insurance companies are exposed are not explicitly included in the standard formula and are not quantified for the solvency requirement. Risks not covered should be assessed on a case-by-case basis as part of the ORSA's own risk and solvency assessment. Firms should assess the materiality of these risks and, if they are considered material, firms should disclose this information in the SFCR report and provide it in a regular supervisory reporting - the RSR.

The Solvency II Directive distinguishes between the following types of risk in the activities of insurance undertakings: life, health, non-life, market, counterparty, operational and intangible. These risks have been included in the standard formula for determining the capital requirement. This thesis presents the definitions and assumptions underlying the determination of the requirement generated by these risks. The method of calculation has been approximated, as well as the analysis of the requirements from these modules for domestic insurers in the years 2016-2020. The thesis also presents simulations of the level of diversification that can be obtained for each of the modules. The last element is a review of management methods. The dissertation presents the methods of identification, measurement and evaluation, monitoring and control, and management activities for individual risk categories that may be of particular importance to insurers from the point of view of good practice or better risk management.

In response to the research gap defined in the introduction, it can be assumed that the work described in this paper is the first attempt in Poland to present the capital adequacy of all domestic insurance companies. The main

purpose of this work was to analyze the compliance of capital requirements (i.e. capital adequacy) with the Solvency II directives within five consecutive years from the implementation of the Solvency II system in the European Union.

This thesis analyses the nature and role of solvency. The analysis of the literature shows that this concept has evolved over the years and has become increasingly complex and dynamic, taking into account not only financial issues but also internal processes, the external environment and the regulatory changes. It has also been shown that solvency is a system of interrelated vessels, affecting customers, other market participants, shareholders and stakeholders, the insurance company itself and the local regulator.

In addition, it has been shown that countries outside the European Union have many solutions for the capital adequacy and solvency of insurance companies. Often, the creation of these systems was preceded by a series of local insurer failures. Supervisors are therefore monitoring the changes introduced in other countries, often taking formal steps to ensure the equivalence of the local system with the Solvency II Directive. The examples cited in this thesis show that the capital adequacy systems of many countries around the world are under constant review and new directives are being implemented.

In the light of the analysis conducted, the research hypothesis that domestic insurance companies have sufficient own funds to meet capital adequacy requirements and that insurance companies in Poland are divided into groups (clusters) in terms of meeting capital adequacy requirements was positively verified. To this end, a one-dimensional analysis of data on the adequacy of insurance companies' capital requirements and a multidimensional cluster analysis were carried out. The study took into account the Solvency Capital Requirement, the Minimum Capital Requirement, own funds and gross written premiums. The analysis was carried out using the hierarchical Ward's method and the non-hierarchical  $k$ -means method, using the silhouette index to select the optimal number of clusters.

As a result of the analysis it was proved that insurance companies in Poland form groups in terms of similarity in the area of capital requirements, which was the purpose of the study. It was considered reasonable to divide the life insurance market into five clusters and the non-life insurance market into six clusters. In fact, insurance companies in Poland are unevenly divided into clusters in terms of the number of elements in a cluster. The market is dominated by some bets that form clusters with one element. The study showed that the insurance market is diversified and there is a certain dynamic of change. The cluster analysis allowed a deeper interpretation of the collected data.

The first part of the study shows that from the implementation of the Solvency II Directive until 2020, insurance companies in Poland adapted to the new requirements and met their capital requirements. The analysis shows that the Polish insurance market was sufficiently capitalized in 2016-2020. The average values of SCR coverage for the life insurance market remained at the level of 294-328% and MCR coverage at the level of 812-1108%. Such a high level of coverage proves that the companies are well capitalized and have a large surplus of own funds in relation to the level required by the Solvency II Directive. Similarly, in non-life insurance, the average coverage of the SCR by the own funds was 207-269% and the MCR - 572-672%. It should be noted that in the analyzed time horizon, all life insurers had an SCR coverage above the regulatory requirement of 100%. However, in the non-life sector, in 2016 one of the insurers - TUZ TUW - did not have SCR coverage by the own funds (SCR ratio equal to 73.60%) and was covered by the recovery plan of PFSA. In the remaining years (2017-2020), almost all insurance companies complied with the Solvency II standards. Only one non-life insurer - TUW MEDICUM - did not cover the MCR with its own funds. The same company was in the process of liquidation in 2019-2020.

The analysis showed that insurance companies in Poland are grouped according to their similarity in terms of capital requirements, which was the purpose of the study. It was considered reasonable to divide the life sector into five clusters and the non-life sector into six clusters. In fact, insurance

companies in Poland are unevenly divided into clusters in terms of the number of elements in a cluster. It has been shown that the market is dominated by some bets that form single-element clusters. The study showed that the insurance market is diversified and has a certain dynamic of change. One-element clusters were at the top of the best-capitalized companies on the life insurance market: PZU ŻYCIE SA and AVIVA TUnŻ SA without exception throughout the period under review, and since 2018 the third single-element cluster has been NATIONALE-NEDERLANDEN TUnŻ SA. In the non-life insurance market, there was only one single-element cluster throughout the period under review, formed by PZU SA. The listed companies are single entities because they differ in the amount of gross premiums written. In the life sector, these companies accounted for 44-60% of gross written premium in a given period, while in the non-life sector, PZU SA alone accounted for 29-34% of gross written premium in the years under review.

The two-element clusters were further classified. Life companies included in 2016 and 2017: NATIONALE-NEDERLANDEN TUnŻ SA and METLIFE TUnŻiR SA, whose gross written premium exceeded PLN 1,300,000, and NATIONALE-NEDERLANDEN TUnŻ SA and OPEN LIFE TU ŻYCIE SA, whose gross written premium exceeded PLN 1,000,000. Since 2018, NATIONALE-NEDERLANDEN TUnŻ SA has significantly increased its SCR from PLN 746,192 thousand to PLN 799,117 thousand, reaching the top and creating a one-element cluster. In the non-life sector, one of the two clusters was formed throughout the period under review: TUiR WARTA SA and STU ERGO HESTIA SA, whose gross written premiums were at a similar level - for example, in 2019 over PLN 6,000,000. In 2016-2019, another non-life cluster consisted of TUiR ALLIANZ POLSKA SA and AXA TUiR SA, later UNIQA TU SA. For these two insurance companies, the gross written premium also remained at a similar level of approximately PLN 2,000,000. The level of the gross written premium was a characteristic that determined the similarity of the clusters studied. The differences between the clusters were determined by the level of capital requirements and own funds.

It was observed that insurance companies rarely migrate from one cluster to another, the allocation for most insurers being constant over the years. In the case of the life sector, the companies that changed clusters most often were METLIFE TUnŻiR SA (which moved from cluster 3 to 4, meaning it was placed in a cluster with lower capital requirements), TU ALLIANZ ŻYCIE POLSKA SA, PRAMERICA ŻYCIE TUiR SA (later UNUM ŻYCIE TUiR SA) and COMPENSA TU na ŻYCIE SA changed cluster 5 once in 2016, remaining in group 4 for the remaining years. AEGON TU na ŻYCIE SA often moved between clusters 4 and 5. VIENNA LIFE TU na ŻYCIE SA Vienna Insurance Group dropped from 4 to 5. In the non-life sector, PKO TU SA was classified to clusters 5 and 6, similarly TU Europa SA was in cluster 4 in 2016 and 2017, while in the following years it was in cluster 5. GENERALI TUSA remained in cluster 4 and in 2020 it moved to cluster 3, similar to COMPENSA TU SA Vienna Insurance Group. Both companies changed the cluster to better capitalized companies, similar to GOTHAER TU SA (later WIENER TU SA Vienna Insurance Group) and TUZ TUW.

In order to confirm the correctness of the classification obtained, an analysis of the measure of the correctness of the clusters was carried out. According to the literature, the Global Silhouette Index (GSI) is one of the tools used to assess the correctness of clustering. To calculate the GSI index, individual body indices that have already been calculated should be used. The total body index (GSI) can take values in the range  $[-1, 1]$ , and the GSI value should be interpreted as follows  $GSI > 0.7$  - strong structure of the groups obtained,  $0.7 \geq GSI > 0.5$  - correct grouping structure,  $0.5 \geq GSI > 0.25$  - weak clustering structure and  $GSI \leq 0.25$  - no clusters in a given set. In the case of the life insurance market, the GSI was 0.508 and for the non-life insurance market it was 0.532. Both results indicate the correct structure of the grouping performed. Cluster analysis allowed a deeper interpretation of the data collected.

At the same time, the analysis of the capital requirements of insurance companies in 2021-2022 should be indicated as an area for further research, given the impact of phenomena such as the COVID-19 pandemic, an increase in inflation or an increase in interest rates, which have a significant impact on the risk profile of the insurance company and its requirements, and the reduction of own funds, in particular by increasing costs, increasing the mortality and morbidity risk for the life insurance market, or reducing the valuation of bonds.

Furthermore, in the area of further research, cluster analysis itself and its applications can also be indicated. This method, as part of machine learning, is widely used in data analysis, and it would be particularly important to indicate its range of applications in the activities of an insurance company, including in the process of product development, insurance portfolio analysis, the sales process, as well as in the company's internal processes, such as fraud detection or claims tracking and monitoring. Another area of research related to solvency and financial security is the new resolution system for insurance companies. In 2023, representatives of the European Parliament, the Council of the European Union and the European Commission will begin and the European Commission will start consultations on the new Insurance Resolution And Recovery Directive (IRR-D)<sup>1</sup>.

As mentioned in this paper, the Solvency II system is designed to protect the insurance market from insolvency, including ensuring coverage of losses that may occur with a frequency of 1 in 200 years. These rules are based on the prudent valuation of liabilities (BEL), which is designed to secure future liabilities, and the additional risk margin (RM), which is designed to ensure that, in the event of the insolvency of the insurance company, the own funds are sufficient to pay the insured. However, the Solvency II regime does not provide 100% protection against the insolvency of an insurance company. EIOPA reported in its 2021 report<sup>2</sup> that 219 European insurers had failed or were at risk

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<sup>1</sup>[https://finance.ec.europa.eu/publications/insurance-rules-review-encouraging-solid-and-reliable-insurers-invest-europes-recovery\\_en](https://finance.ec.europa.eu/publications/insurance-rules-review-encouraging-solid-and-reliable-insurers-invest-europes-recovery_en)

<sup>2</sup><https://www.eiopa.europa.eu/sites/default/files/publications/reports/eiopa-bos-21-394-failures-and-near-miss-database-report.pdf>

of failure in the last 20 years. The IRRD will aim to limit the impact of insurance companies' financial difficulties by introducing restructuring rules based on those already implemented in the banking system. The aim is to improve the protection of customers, victims and the financial sector<sup>3</sup>. But will the new directive ensure continuity of cover for customers and certainty of payment for victims, and will it not place an excessive burden on insurers? Will its provisions not conflict with the Solvency II standards? The insurance resolution system should be ready for implementation in Poland in 2025, when it will be important to examine the new directive in comparison with the Solvency II standards. The resolution system in relation to Solvency II is worth highlighting as an area for further research on the solvency and financial condition of insurance companies.

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<sup>3</sup><https://www.insuranceeurope.eu/publications/2785/key-priorities-on-the-eu-insurance-recovery-and-resolution-directive>

