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SUMMARY OF THE PhD THESIS

SOLVENCY II: SOLVENCY OF INSURANCE COMPANIES

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KEYWORDS

Reform, Solvency, Solvency system, Model for assessing solvency, Prudential regulation, Capital adequacy, Directive "Solvency II", Solvency capital requirement, Minimum capital requirement, Risk profile, Risk measures, Ruin, Probability of ruin, Value-at-Risk, Tail Value-at-Risk, Time horizon, Confidence level, Risks estimation, Monte Carlo Simulation, Bootstrap simulation, Extreme values, Technical reserves, Risk margin, Market consistent valuation, Standard formula, Internal model.

INTRODUCTION

The solvency of an insurance company may be defined, in the simples way as possible, as the ability of the insurer to honor his commitments.

Taking into account its importance, supervising authorities, rating agencies and insurance companies have developed and carried out, over time, several systems of evaluating solvency. The European debates the solvency of the insurance companies (Basel agreement 2), of the reform of international IAS-IFRS[1] accounting rules, and of the various projects in reforming the European domain of insurance.

Prospective analysis of solvency of the insurance companies assumes the existence of a consensus at the European level. The desire to have an uniform approach, in respect of the adequacy of capital and calculation of the solvency margin inside insurance companies, involves the compliance with international common rules that require the revisal of the regulation system and prudential supervision. This European context of fluctuation in insurance constituted for the regulatory authorities and the insurance industry the suitable opportunity to reform the entire prudential regime in insurance.

In the direction of this reformation, the European Commission, by the IAA[2] regulation committee in the insurance domain, launched in 2001 the *„Solvency II"* project, of which application is desired to be fully carried out at the entire European community level

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[1] Internatinal Accounting Standards - International Financial Reporting Standards: the new accounting standards applied, starting with 1st of January 2005, to all the rated companies that activate in EU.
[2] International Actuaries Association – www.actuaries.org. International Actuaries Association was started in 1968, being completely reorganized in 1998.

beginning with 2014. The new system of evaluating solvency, *„Solvency II"*, is intended both for general and life insurance companies, and for European reinsurance companies. The system must provide supervising authorities instruments and the required capacity of being able to prospectively evaluate the solvency of (re)insurance companies, it must take into account the entire exposure to risks of insurance, and also to enjoy a sufficient legibility in view of an appropriate information of customers and investors.

From the start of the project, in 2001, a series of works have been published on the topic of Solvency II, ranging from a less complex level that creates an overview on the project, such as Linder, U et al. (2004), CEA (2007), Butaci C. (2010a), to a much more complex level that covers some special features found on analysis in certain working areas of the project, offering alternatives, such as Schmeiser, H. (2004) or Schubert T. et al. (2007).

Using actuarial methods, insurance and reinsurance companies will be able to estimate, on average, how large will be the aggregated number of claims associated to an accounting year. If the number of real claims is larger than the estimated value, it is understood that the capital level, which the company will use in the account of obligations, will be greater. Given that this capital is intended to cover the risks to which the (re)insurance company is exposed to, the problem of capital adequacy is reduced to the problem of risk measurement that this capital must cover.

The recent actuarial literature has dedicated itself generously to stochastic shaping of the problem for capital allocation. May be remembered in this respect important works, such as Cummins, J. D. (2000) or Myers, S and Read, J. (2001), and more recent ones Laeven, R. J. A. and Goovaerts, M. J. (2004), Klueppelberg, C. , et al. (2004).

Directive 2009/138/EC „Solvency II" provides the determination of capital requirements on either a standard formula or on an internal model built by the company and approved by the regulation authority. The internal model, designed taking into account the total unit of variables with an influence on the company's solvency, will allow the simulation of the financial situation for an one year horizon, and also it will offer the measure of capital requirement which the company needs in order not to fall into bankruptcy (ruin) a year later, with a probability of 99.5 %.

The research carried out within the present paper has been concentrated, mainly, around the following objectives:

- Analysis of the most important solvency systems applied in insurance;
- Evolutionary analysis of the European regulation and supervision regime in insurance;
- Comparative analysis of the prudentiality of the solvency systems by centering the comparison on Solvency II;
- Analysis of the judicial instrument of reform and the envisaged changes;
- Analysis of the risk measures Value-at-Risk and Tail Value-at-Risk, from the perspective of their use, by looking at the application features to the problems in insurance;
- Analysis of the standard formula for determining the capital requirement, from the perspective of the level of prudentiality, using the extreme values theory;
- Analysis of the most used calculation methods of the technical reserves, respectively of the risk margin, under Solvency II, and analysis of the impact of their application on the size of the general insurance companies on the Romanian market;

The research's results are based on the following resources:

- documents from the electronic archives of the institutions from the European Union level, involved in the reformation project;
- documents from the archives of the main solvency systems applied in different countries or unions of the world;
- literature, represented by books and representative articles, published at prestigious publishing houses and magazines in the country and abroad;
- quantitative studies, which I have drawn up starting either from the hypothetical construction of a portfolio of investments or the data from the run-off the triangle of prejudices of the ALLIANZ insurance company.

Beyond the joining of areas of finance and applied mathematics, the research carried out at the level of doctoral thesis required knowledge of computerized modeling of financial data. For the computerized modeling of the data, programming or computerized applications have been used such as: Matlab, Eviews, Excel, extremes, @RISK.

The present paper is structured on six chapters, intending, in a unitary construction, to comply with the objectives of the research, above exposed.

CHAPTER 1
ANALYSIS OF EVALUATION SYSTEMS OF SOLVENCY IN INSURANCE

Chapter 1 proposes an individual analysis of the most important solvency systems applied in the world. Analysis and exposure of those solvency systems are based on the research of many original documents, obtained from the electronic archives of supervising authorities under whose control the system is applied.

From this point of view, chapter 1 can be regarded, as a whole, as a result of a synthesis of the economic research. In the Romanian literature in the domain, I have not encountered a similar synthesis, and if we relate to the international literature, we can say that they are comparable results, such as Müller (1997), the KPMG report (2002), CEA (2005), or Sandström A. (2006), but which differ, both in form and content from the synthesis performed in this work.

In form, because the number of systems and the presented systems are not the same, and in content, because a research of the original documents from the archives allows the researcher to individualize the results of the research according to the pursued objectives. More than that, the solvency systems are improvable constructions, and therefore, from one year to another they can change their form, respectively their content. From this point of view, a research on documents carried out during 2012 will also include the most recent changes which have occurred in the analyzed system.

At the level of each analyzed solvency system, I intended to show the following: the structure of the respective system, analyzing models of the used solvency, surveillance's prerogatives, the calculation mode of the capital requirements, the risk profile set, either by the standard formula applied in the system's framework, or by the analysis on scenarios, if the system uses dynamic modeling.

CHAPTER 2
FROM SOLVENCY I TO SOLVENCY II

In *Chapter 2,* I intended to present an accurate picture of the complexity of the Solvency II reform project, putting together the involved institutions, the studies that have been carried

out, the results that were obtained, all presented in an evolution note on the two stages, in which the project was intended to be carried out. The first stage of the project has had the mission to develop the general structure of the solvency system. After the analysis of some research reports, Solvency II received a structure on three pillars (quantitative requirements, qualitative requirements, market discipline), while drawing on similar reform of the regulations in the Basel II banking sector. The second stage, very close to completion, has had the mission to develop and calibrate evaluation methodologies of the solvency.

The Solvency II project may be seen, both in a vertical representation, and in a horizontal representation. The vertical representation is given by the system's construction, on a three pillars structure. The horizontal representation is given by the adaptation of the Lamfalussy process in insurance. After the acquisition of this working process, the Solvency II project continued to be carried out on four horizontal levels. The first level attended with the development of the European Framework Directive regarding the solvency system, the second level intends to develop implementation methodologies, the third level elaborates surveillance guidelines, and the last level evaluates the compliance and the implementation at the level of the European economic space.

At the end of Chapter 2, I conducted a comparative analysis, which proposes a comparison between Solvency II and other systems presented in Chapter 1, trying to present the compared prudentiality level and certain influences that can be identified in the Solvency II level, coming from other systems. From this point of view, the result of the comparative analysis strengthens the quality of the research from Chapter II . The innovative side of this last exposure is given by the moment in which it is made. In the past, such an exposure was only hypothetical, because Solvency II, either it did not exist, or it did not have a fixed content to allow the comparison.

CHAPTER 3
RISK MEASURES USED IN EVALUATION OF THE SOLVENCY IN INSURANCE

Chapter 3 proposes a synthesis, in an unitary form, of the most current approaches in the literature, concerning the measurement and modeling of the risk in insurance, linked to the ruin probability of the (re)insurance company. The research carried out for this chapter is

based on the most important works and articles presented in the context of international conferences or published in prestigious international publishing houses and magazines.

First theoretical developments regarding the analysis of ruin probability dates back to the beginning of the XXth century, and it is owed to famous Scandinavian actuaries Harald Cramér and Filip Lundberg. The integration of the concept of ruin probability in finance and insurance has developed along with the development of modern theory of risk measurement, in which the coherent risk measure conceptualized by Artzener et al. (1999) represents a point of reference.

Attaching the concept of risk measurement to the problems of financial institutions, as a whole, it has been a strong theme debated in the literature of the last years, from these studies Darkiewicz et al. (2003), Acerbi, C. (2004) can be quoted. In insurance domain, on risk measure theory, have been designed various approaches to be used for both tariffing the insurance contracts, and, especially in recent years, for determining the capital requirements (Goovaerts, M. J. et al (2003), Dhaene, J. Et al(2004), Partrat, C. , Besson, J. -L. (2005).

CHAPTER 4
METHODOLOGICAL ASPECTS OF THE IMPLEMENTATION OF THE VAR AND TVAR MEASURE IN INSURANCE

Chapter 4 proposes a combination of theories and procedures for estimating the risk of loss for the problems in insurance consisting with the European Directive Solvency II, and it analyzes concrete quantitative aspects to apply risk measures to the problems of insuring risks. Similar approaches can be found in the international literature, in the works of Ufer, W. (1996), Fedor, M., Morel, J. (2006), Planchet, F., Thérond, P. (2007). All these approaches are independent of the "Solvency II" European Directive, which was published in final format only in 2009. The idea of designing Chapter 4, and of quantitative research carried out in paragraphs 4.2 and 4.3, comes from studying the "Solvency II" Directive. In this way,

Art. 101. paragraph. (3) of Directive no. 138/CE/2009 says:

" The Solvency Capital Requirement shall be calibrated so as to ensure that all quantifiable risks to which an insurance or reinsurance undertaking is exposed are taken into account. It shall cover existing business, as well as the new

business expected to be written over the following 12 months. With respect to existing business, it shall cover only unexpected losses. <u>It shall correspond to the Value-at-Risk</u> of the basic own funds of an insurance or reinsurance undertaking subject to a confidence level of 99,5 % over a one-year period",

and

Art. 122. paragraph. (1) of Directive no. 138/CE/2009 says:

Insurance and reinsurance undertakings may use a <u>different time period or risk measure</u> than that set out in Article 101(3)…".

In other words, standard model will use the Value-at-Risk risk measure (VaR), presented in detail in chapter 3, and if a (re)insurance company will want to develop an internal model, then it will be able to use other measure than VaR. Hence it results that, on the one hand, the need of research carried out in chapter 3, where other measures applied in insurance are presented, on the other hand, choosing as an alternative measure the Tail value-at-risk measure (TVaR), it results the importance of research of some concrete quantitative aspects for the application of the two measures in evaluating the risks in insurance.

For the achievement of the research's aim, a hypothetical portfolio of investments was built, specific to an investment program with moderate risk, relative to which the quantitative research was made. The research's results were materialized in demonstrating some particular quantitative aspects of the application of VaR and TVaR risk measures in insurance, as well as in compiling a practical guide, with minimal rules, of choosing estimation methods, in accordance with the particularities encountered in insurance practice, and with the new regulations introduced by the Solvency II system for capital adequacy. The guide refers in the first part to the calculation of the risk margin, from the technical reserves, and in the second part to the calculation of the solvency capital requirement.

CHAPTER 5
EVALUATING THE LEVEL OF PRUDENTIALITY IN SOLVENCY II ON THE BASIS OF EXTREME VALUES THEORY

Chapter 5 is designed for me to answer the following question: *Is there an adequate quantitative expression of the concept of prudentiality in insurance?* The answer was YES,

and the arguments are based on extreme values theory applied in insurance. In essence, to evaluate an extreme quantile, which represents the potential loss of an insurance company, will be used techniques specific to „theory of extremes", which has developed in the early 1970s through the works of Pickands (1975) and Hill (1975), and more recently the works of Smith (1987), Dekkers and Haan (1989) are noted. These results were quickly caught up and applied in finance and insurance (cf. Embrechts and al. (1997).

The issue of regulation and deregulation in insurance is one disputed every time when the reformation of the regulatory system is brought up. If we imagine an axis, having at one end the lowest level of regulation, and at the other end the highest level of regulation, then the concept of prudentiality would find its optimum level somewhere between these terminals, a level, which is of course adaptable depending on the nature of the changes in the insurance market. Studies, such as Grabowski, H. et al(1989), Harringtons (2004), are pronounced on this theme by trying to set the opportunity of intervention on the insurance market.

Solvency II incorporates well enough the scientific researches in the field, proposing along with the standard formula for the calculation of the solvency capital requirement (SCR) and incitative conditions, addressed to the management of the insurance and reinsurance companies, strengthening the quality of the internal process of risk management, thus achieving a compensation of the quantitative level of prudentiality with the qualitative one, the final aim being always the protection of the insurants.

Based on the quantitative study, in this chapter, I have presented that prudent decisions in estimating the capital requirements in insurance involve the allocation of capital requirements superior to those which are regulated by Solvency II, by applying the standard formula. A possible explanation comes from the fact that the Solvency II system proposed to compensate for a lower level of capital requirement with a superior quality of internal risk management, obtained through incentive conditions. However, in the conditions in which the value of the solvency capital requirement (SCR) will be calculated with the standard formula standard in the normality hypothesis, no insurance company will be incited to develop and to carry out a complete internal model, because the standard formula offers the version of a lower level of SCR.

CHAPTER 6
THE ADEQUACY OF CAPITAL UNDER SOLVENCY II

Chapter 6 is dedicated to the undertaking which the insurance and reinsurance companies will follow under Solvency II, to adequate the capital. For a (re)insurance company, the adequacy of own capital means to determine, observing the regulations of the new solvency system, the following measures: the best estimation of technical reserves, which include the risk margin, the solvency capital requirement (SCR) and the minimum capital requirement (MCR).

In the undertaking of adequacy of own capital, a great interest is granted to the estimation of the technical reserves with risk margin, a component, which in total liabilities, represents the main balance. In accordance with Solvency II, technical reserves of the (re)insurance companies will have to be determined by at least two different methods. Usually, they will be either one deterministic and one stochastic, or both stochastic. The most prudent measure will be kept. The most used methods, of those admitted by the European Commission, are the Chain Ladder deterministic method and its stochastic version designed by Thomas Mack (1993,1999). More recent developments, which are used, in particular, to determine the technical reserves in the internal methods, are the Thomas Mack method (2008) and the version Bootstrap Ladder Chain adapted by England and Verrall (2002).

Romanian insurance market is comprised in general insurance companies. In accordance with the timetable for the implementation of the „Solvency II" European Directive, starting with 2014, following the entry into force of the directive, insurance companies in the European Union, with an income level of subscribed gross bonuses greater than 5 million Euros, will be required to establish the capital requirements in accordance with the provisions of this Directive. In the last part of Chapter 6, I analyzed the measures of estimating technical reserves using provisioning methods detailed rules for the estimation of technical reserves using the Chain Ladder and Mack provisioning methods, in accordance with the „Solvency II" European Directive, and I identified, from the application particularities, the implications on the size of the Romanian general insurance

companies. For this quantitative study, data from Allianz insurance company have been used.

CONCLUSIONS

From an analysis based on the original documents of the electronic archives of the most important solvency systems applied in different countries in the world, I discovered that Solvency II is a state-of-the-art system integrating both approaches based on risk factors and dynamic approaches based on the analysis of scenarios.

By comparing the level of prudentiality, captured by the Solvency II standard formula, with similar formulas from the other solvency systems applied in insurance, I have highlighted a small superiority of the Solvency II system, materialized, especially, through the integration in the standard formula of the benefits of diversification on several levels.

By examining the construction mode of the Solvency II standard formula, I have found that the captured prudentiality level, for the calculation of the solvency capital requirement, has two components, a qualitative one, given by the integration of the incitative conditions of improving risk management, and a quantitative one, expressed by the integration in the formula's construction of the newest quantitative scientific approaches regarding the evaluation of financial risks.

Regarding the adaptation and application of the VaR and TVaR measure to the problems in insurance, to adequate the capital by determining the capital requirements, I have been able to find the following concrete quantitative aspects of application:

- Historical and analytical methods prove to be ineffective to apply them in the insurance domain;
- For the accuracy of estimation through the Bootstrap method it is recommended that the length of the data history to be at least of 4 years;
- This means that as the time horizon increases, the estimation by the Bootstrap method becomes more and more unstable, and procedural risk of simulation is more pronounced for Bootstrap simulation compared with Monte Carlo simulation;
- The scaling estimation is not recommended to be used in insurance;
- Monte Carlo method becomes stable for the VaR estimation with an exact decimal starting with 20000 simulations;

Is certain that a regime of prudential solvency should find the optimum partition between qualitative and quantitative prudentiality. As a starting point in finding the optimum partition, I was concerned to find the adequate quantitative expression of prudentiality in insurance. In this respect, I showed that such an expression is possible, if you appeal to the rare event theory, which is well-known in the financial literature, as being an efficient way of determining the ruin probability in insurance.

I came to the conclusion, that the prudentiality level, captured by the Solvency II standard formula, underestimates the exposure to risk of the insurance companies, and from this perspective, the capital allocation using the estimation methods based on the rare events theory, represents an approach much more appropriate with the actual exposure to the risk of an insurance company. Therefore, in the actual working hypothesis of the Solvency II standard formula (especially due to the normality hypothesis), I concluded that no insurance company is incited to carry out a complete internal model of capital allocation.

The most commonly used methods for the determination of technical reserves for claims are: Chain Lader standard method and the Mack stochastic method. For the calculation of the risk margin, the European Commission ventures two estimation methods: the quantile method and the cost of capital method(COC). The last quantitative study, carried out in the present paper, allowed me to analyze the particularities of applying the provisioning methods small insurance companies.

I have found that the small Romanian companies can be disadvantaged by the large ones, because they will not be able to use, in full, the facilities offered by the modern provisioning methods, and on the other hand, they will not be able to benefit, equitably, from the improvement of the internal process of risk management. A general solution, for the Romanian insurance companies, is to try a coagulation, with the idea of increasing the size, by merger or absorption, phenomenon that is not foreign on the Romanian insurance market in the past few years.

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