THE SOLVENCY II APPROACH ON THE CAPITAL CHARGE FOR THE NON-LIFE CATASTROPHIC RISK

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Abstract: *This paper addresses a current issue: the assessment and the establishment of the capital charge for the non-life catastrophic risk (cat risk) in terms of Solvency II Directive. Firstly we'll present several aspects on the conditions and the defining elements of Solvency II Directive implementation, by positioning us in the underwriting risk module, cat risk being a component of it. Nowadays the cat risk is a concern for the insurance companies and in order to have an harmonized legislation on the insurance industry for all Member States of the European Union this was a sensitive topic being presented various approaches regarding the methods used for determining the level of the capital charge. We'll present the main methods proposed in the Quantitative Impact Studies QIS4: standard approach, scenarios and personalized scenarios and also those proposed in QIS5: standardised scenarios and factor-based approach. Our purpose is to illustrate the situations when each alternative is most efficient to be used and also the steps taken from one quantitative impact study to another in order to have an accurate method of the cat risk assessment. Taking into account that these are standardised formulas, there are certain cases when the results are not consistent with the reality, especially for the insurers with a different structure of the insured portfolio, for example those having a large part of the insurance policies issued for a single line of business. In these cases it is recommended to use undertaking specific parameters (USP). Once presented these methods we'll offer an example for the calculation of the capital charge for the earthquake risk using standardised scenarios for Natural Disaster Insurance Pool (PAID). In order to achieve this goal we'll perform an analysis of the mandatory household insurance policies against natural disasters (PAD policies) in force in December 2013, these being grouped on CRESTA zones to determine the total insured value for each of the 41 zones in Romania. These values being calculated and using the technical parameters offered by an Annex of QIS 5 we obtained a value of around 227 million Euro for the earthquake cat capital requirement for PAID.*

Keywords: CRESTA zones; cat risk; Quantitative Impact Studies

JEL classification: G22

1. Introduction

The need for a unitary and integrated approach on Member States of the European Union is also present in case of the insurance market, being taken a series of steps for legislative harmonization of the insurance activity. In addition, in time have been observed weaknesses of the system, in these circumstances the requirements established by Solvency I Directive are no longer up to date. Therefore, a new regulatory framework has been introduced, respectively Solvency II Directive that imposed a new set of capital requirements, assessment techniques and also standards of reporting and governance. It is not easy to implement these requirements but rather a continuous process involving collaboration and permanent feedback between the parties involved: insurance companies, institutions specially established to assist and advise the European Commission on the implementation process. The new structure based on three pillars will be implemented on stages, there being noticed some similarities with the Basel II regulation for the banking industry but also differences. For example, the risk is approached differently, in case of Solvency II we can talk about an integrated approach of a portfolio of risks being also observed interdependencies between different types of risks. On the other hand, according to Basel II Accord the models are applied individually for investment risk, credit risk and operational risk. This approach on the capital requirements based on the exposure to risk is considered to be the main characteristic of Solvency II Directive, obviously higher risks involve higher capital requirements. (Hay et. al, 2011)

In this paper we'll focus on the regulation regarding the capital requirements for covering catastrophic risk. In the beginning we'll illustrate the structure of Solvency II in order to have a better image of our work within the extensive process:

Pillar1	Pillar 2	Pillar 3
Quantitative requirements	Management and Governance	Disclosure
Quantitative requirements, such as: SCR-Solvency Capital Requirements Underwriting risk *Non life cat risk sub-module*	Qualitative requirements Efficient risk management Own Risk and Solvency Assesment(ORSA)	Improved reporting Transparency for supervisors and the public

Figure 1: Placing the non-life cat risk in the structure of Solvency II Directive
Source: Authors' processing based on information provided by Lloyds and KPMG

As we can see in the figure above, our paper approaches the non life cat risk- a component often disputed due to the difficulty in establishing the value of the capital charge. The reasons why it is so difficult to find a formula may be the financial impact of a catastrophic event and also the specific of the risk portfolio of each insurer. In these circumstances a lot of work is needed to get a real assessment of the exposure to risk and finding a general formula that can be applied by all the insurance companies is very complicated to obtain.

2. The steps taken and the institutions involved in developing the methods for the capital requirements

The implementation of the Solvency II Directive is a difficult process, therefore even if in a first stage the European Parliament approved as application date January 1, 2013, this term couldn't have been respected, firstly being announced a delay until January 1, 2014. Neither at this date the application was not possible due to modifications made by a new legislative proposal, Omnibus II that brings a number of significant changes and whose publication in the Official Journal of European Parliament could not have been made before January 1, 2014. In these circumstances the term was again deferred to January 1, 2016.

Given the aspects presented this process involves collaboration, therefore we'll present the main institutions playing an important role especially through consultancy offered to European Commission since 2004:

- CEIOPS-Committee of European Insurance and Occupational Pensions Supervisors that functioned until the end of 2010, from January 1, 2011 being substituted by:
- EIOPA-European Insurance Occupational Authority- an European supervisory body with extensive powers.

This change is part of the reform of the European supervisory architecture, by creating EIOPA being realized a framework for more secure financial services.

CEIOPS had an extremely important role during the development of the regulatory framework, a major result being represented by the five Quantitative Impact Studies (QIS)

- QIS1 – conducted at the end of 2005 aimed testing several hypotheses for the prudential level of technical provisions.
- QIS2-represented a first step for the calculation of Solvency Capital Requirements (SCR), Minimum Capital Requirements (MCR) and the assessment standards. When it comes to catastrophic risk we mention that in this study only natural catastrophes were considered and not those technical ones.
- QIS3 – the main aspects monitored being: obtaining additional information on the applicability and the calculations involved, the alternatives tested, quantitative information about the financial impact on balance sheet if the information from QIS 2 are considered, testing these specifications for insurance groups.
- QIS4, conducted between April-July 2008. Catastrophic risk, the insurance premium risk and the reserve risk were included in the non-life underwriting risk. It was the first time when Romania participated.
- QIS5 is the last study realized in order to develop the standard formula that will be applied to determine SCR for all European insurers that have no internal model.

In the next part we'll focus on the technical specification and methods proposed in the studies QIS4 and QIS5 as regards the non-life cat risk module, taking into account earthquake risk, this having a great impact in case of occurrence in our country as stated in Annex L.4 of QIS 5.

3. Methods for calculating the capital charge for cat risk proposed by QIS 4

As a part of the non-life underwriting risk the catastrophic risk is defined as the risk of loss, or of adverse change in the value of insurance liabilities, resulting from significant uncertainty of pricing and provisioning assumptions related to extreme or exceptional events. (Solvency II Directive, Art. 105 2 (b))
A first version proposed for determining the capital charge for the non-life catastrophic risk was offered by QIS4, three different alternatives being proposed, one of these methods being optional.
We'll realize a comparative analysis of the methods presented in each study. Firstly we'll stop on the methods proposed in QIS4:

- *Standard approach*

$$NL_{CAT} = \sqrt{\left(\sum_{t\neq 3,4,10,12} (C_t \times P_t)^2 + (C_3 \times P_3 + C_{12} \times P_{12})^2 + (C_4 \times P_4 + C_{10} \times P_{10})^2\right)}$$

Where NL_{CAT} represents the capital charge for the non-life catastrophic risk, C_t- represents a factor that has a different value for each line of business, these values being presented in the technical specification, P_t- net written premium for each line of business during the forthcoming year.

- Scenarios

This method is recommended to be used when the data representing the input are available; in these cases the standard approach is replaced. Also, the regions that are covered by the insurance policies issued by an insurance company are also important in order to take into account all the scenarios, for each zone. In Romania this method could not be used in 2008 due to the fact that no regional scenarios were available for our country. Regional scenarios were provided by local supervisors from: Austria, Belgium, Czech Republic, Denmark, France, Germany, Hungary, Italy, Iceland, Lithuania, Malta, Norway, Poland, Portugal, Slovakia, Slovenia, and Sweden.

$$NL_{CAT} = \sqrt{\sum_i CAT_i^2}$$

CAT_i represents the cost of the catastrophe i, being taken into account only those catastrophes that exceed a threshold, which is 25% of the cost of the most severe scenario.
If the results obtained by applying one of these methods are considered irrelevant for an insurance company, there is the possibility to choose another method, this being optional:

- Personalised scenarios

In this case companies must provide information about the reason why they decided to use a particular scenario, these being chosen taking into account the geographic concentration and the classification of the exposed portfolio for each line of business. Also, catastrophic scenarios are defined by considering the impact of a single event, but while the covered period is one year the probability to be registered more events exists, each affecting different reinsurance contracts. Therefore it is important to simulate the impact of various events.

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4. QIS5 approach on catastrophic risk

The fifth quantitative study made a series of changes regarding the non-life catastrophic risk sub module. Primarily we refer to the progress made in case of scenarios approach, being proposed an aggregation of the risk on CRESTA zones (Catastrophe Risk Evaluating and Standardizing Target Accumulations)- a standard for the insurance industry, being considered not only the type of the risk but also the correlation between countries and between different zones of the same country. It was also introduced the idea of using internal models, to model the catastrophic risk, in these cases the standard formula being replaced. (Simons et. al, 2010, p. 3)

Once QIS 5 was finished it represented an important step towards the development of the calculation methods used for determining the capital charge for catastrophic risk. In this study are presented two methods:

- Standardised scenarios

For the development of this method CEIOPS decided to create a working group called Catastrophe Task Force (CTF). It was established at the end of 2009 among the members being found: Swiss Re, Lloyds, Munich Re, Willis, RMS, Guy Carpenter. As a result of the collaboration between all these parties involved were developed scenarios for different types of natural catastrophes: windstorm, flood, earthquake, hail and subsidence. The selection of the risks was based on the occurrence probability of events and the potential impact. If circumstances require companies have the possibility to include other risks through alternative methods.

This method does not take into account the classification on lines of business, this being replaced by the classification depending on the type of the risk. Also, the exposure is determined for CRESTA zones, each country having a number of such zones. There is a standard formula for all types of natural catastrophes:

$$WTIV_{ZONE} = TIV_{ZONE} * F_{ZONE}$$

Where $WTIV_{ZONE}$ represents geographically weighted total insured value by CRESTA zone; TIV_{ZONE} is the total insured value by zone in certain cases being composed of the weighted sum of total insured value for different lines of business: fire, motor, marine, this classification being necessary to reflect the real impact on other lines of business; F_{ZONE} is a relativity factor for each zone of a country.

Once determined the value of $WTIV_{ZONE}$ the next step is the calculation of the capital charge for catastrophic risk:

$$CAT_{peril-contry} = Q_{country} * \sqrt{\sum_{r \times c} AGG_{r,c} * WTIV_{zone,r} * WTIV_{zone,c}}$$

$CAT_{peril-contry}$ represents the estimation of the cat capital charge for a specific country, $Q_{country}$ –the market factor, its value being offered for each country and peril in Annex 2 of Catastrophe Task Force Report, $AGG_{r,c}$- rows and columns of the aggregation matrix AGG by country, also available in a excel file called *parameters for non life catastrophe*, $WTIV_{zone,r}$ $WTIV_{zone,c}$- geographically weighted total insured value by zone.

Once determined the value of the catastrophe capital requirement for non life risk at peril level the next step is to aggregate these results:

$$NL_{CAT} = \sqrt{\sum_{peril,i,j} Corr_{peril,i,j} * CAT_{peril,i} * CAT_{peril,j}}$$

NL_{CAT} representing the catastrophe capital requirement for non life risk under method 1, $corr_{peril,\ I,j}$- correlation between perils i,j, $CAT_{peri,i,j}$- catastrophe capital requirement for each peril.

- Factor-based approach

For companies that decide to use the standard formula the choice of the method 1 is encouraged, respectively standardised scenarios, the factor based approach being recommended to be used only if there is no possibility to determine the capital charge by applying the first method.
This approach is a simplified version of the standard formula. The underlying assumptions are: the factors represent a single event and before being applied a classification of the premiums on lines of business is required. The gross written premium is taken into account and also gross factors.

$$NL_{CAT} = \sqrt{\left(\left(\sqrt{\sum_{t=1,2,3,5}(c_t \times P_t)^2} + c_{11} \times P_{11}\right)^2 + \sum_{t=4,7,8,9,10,13}(c_t \times P_t)^2 + (c_6 \times P_6 + c_{12} \times P_{12})^2\right)}$$

P_t- estimate of the gross written premium during the forthcoming year in the relevant lines of business which are affected by the catastrophe event, c_t-are the gross factors by event and applicable to all countries.
These two methods presented are independent; therefore in case both are applied the results should be aggregated:

$$NL_{CAT} = \sqrt{\left(NL_{CAT\_method1}\right)^2 + \left(NL_{CAT\_method2}\right)^2}$$

For an appropriate risk management companies are encouraged to calculate USP-Undertaking Specific Parameters, this leading to a better assessment of the underwriting risk. In this case there are two possibilities: these parameters to be developed by the company or to choose for stochastic models offered by companies specialized in cat risk modeling, reinsurance brokers. However it is quite difficult to develop such a model and often is decided to use a partial internal model.
Once presented the existing models for determining the capital charge for non-life catastrophic risk we intend to estimate the value of earthquake cat capital requirement for an insurance company.

5. Estimating the earthquake cat capital requirement for the National Disaster Insurance Pool of Romania

Based on the aspects presented, we'll estimate the earthquake cat capital requirement for the Natural Disaster Insurance Pool of Romania (PAID). This is an insurance and reinsurance company established in 2009 having 12 insurance companies as shareholders. The policies are issued by each insurance company that is a part of the National Disaster Insurance Pool, all of them being responsible for the sales process of the insurance policies against natural disaster (PAD). The Natural Disaster Insurance Pool is a public-private partnership, a part of the reinsurance program against natural disasters.
The PAD policies are issued for two types of buildings, depending on the construction materials used:

- Buildings type A: the insured value is 20.000 EUR and the insurance premium is 20 EUR for each and every household
- Buildings type B: the insured value is 10.000 EUR and the insurance premium 10 EUR for each and every household

Data and methodology

In order to estimate the earthquake cat capital requirements were taken into account all the policies issued by PAID in force at the end of 2013, data being obtained from the official site of the National Disaster Insurance Pool. These values were grouped on CRESTA zones. An impediment was represented by the lack of information regarding the distribution of the policies for each type of buildings. The scenario considered was that all the policies are issued for households type A.
The method used is that of personalised scenarios. So we'll determine the following values:

$$WTIV_{ZONE} = TIV_{ZONE} * F_{ZONE}$$

$$CAT_{earthquake-Romania} = Q_{Romania} * \sqrt{\sum_{r \times c} AGG_{r,c} * WTIV_{zone,r} * WTIV_{zone,c}}$$

The meaning of the terms used in this formula was explained in the first part of our paper.
Results
Romania is divided into 41 CRESTA zones, in the table bellow being presented the situation of the PAD policies in force at the end of 2013:

Table 1 The number of the PAD policies in force at the end of 2013 for each CRESTA zone

CRESTA ZONE	PAD policies(number)	CRESTA ZONE	PAD policies(number)
01 Alba	7304	26 Hunedoara	10255
03 Arad	15678	27 Ialomita	7497
04 Arges	18544	28 Iasi	26722
05 Bacau	23657	29 Maramures	11020
06 Bihor	15788	30 Mehedinti	5990
07 Bistrita-Nasaud	7288	31 Mures	11721
08 Botosani	6999	32 Neamt	14370
09 Braila	11622	33 Olt	8391
10 Brasov	23229	34 Prahova	36002
12 Buzau	15181	35 Salaj	4068
13 Caras-Severin	9199	36 Satu Mare	8308
14 Calarasi	7565	37 Sibiu	14450
17 Cluj	20022	38 Suceava	18471
18 Constanta	39130	39 Teleorman	9220
19 Covasna	6074	40 Timisoara	35008
20 Dimbovita	12695	41 Tulcea	7998
21 Dolj	18051	42 Vaslui	9245
22 Galati	24322	43 Vilcea	11168
23 Giurgiu	7605	44 Vrancea	15194
24 Gorj	6815	45 Bucuresti	169225
25 Harghita	5227	TOTAL	736318

Source: Authors' processing based on data provided by paidromania.ro

As we can see in the table above at the end of 2013 a number of 736318 PAD policies were active. 518100 have been issued for households located in urban areas (70,36%) and the rest of 218218 (29,64%) for those from rural areas. There can be observed only 9 cases where the number of the PAD policies from urban area exceeds the total policies covering households from rural areas: Giurgiu(60,89%), Vrancea(58,92%), Dimbovita(58,43%), Buzau(56,74%), Suceava(55,89%), Gorj(53,09%), Calarasi (53,09%), Teleorman(51,3%), Ialomita(50,78%).
In Romania the value of the total households covered by a mandatory insurance policy (PAD) is around 8,66%, the highest values being recorded in: Bucharest (18,15%), Constanta(14,36%), Timisoara(12,78%) at the opposite site being Harghita(3,93%), Slaj(4,06%) şi Botosani(4,09%).
We couldn't obtain information about the number of households type A and B covered by a PAD policy for each CRESTA zone, the information available is that in Romania 84,3% of active PAD policies are issued for households type A and the rest of 15,7% for households type B.
Based on this information we can determine the geographically weighted total insured value by CRESTA zone:

$$WTIV_{ZONE} = TIV_{ZONE} * F_{ZONE}$$

The relativity factor takes values between 0 and 5,2. The CRESTA zones with the smallest relativity factors are the zones less exposed to earthquake risk. If we take into account a classification based on the exposure to earthquake risk of the counties in Romania in three zones A, B and C, those from C zone being the most vulnerable, as expected in case of zone A we can find the smallest relativity factors. The highest value of the relativity factor is recorded for Vrancea zone, this area being known as the most important seismogenic zone in Romania. In Figure 2 can be observed the extreme values obtained for the geographically weighted total insured value by CRESTA zone: Bucharest is the first due to the large number of PAD policies in force in this area and also the relativity factor associated has a relative high value of 1,9. We want to mention that Bucharest is the CRESTA zone with the greatest number of households covered by a PAD policy, 18,15% of the total number of households being covered by the mandatory insurance policy against natural disasters.

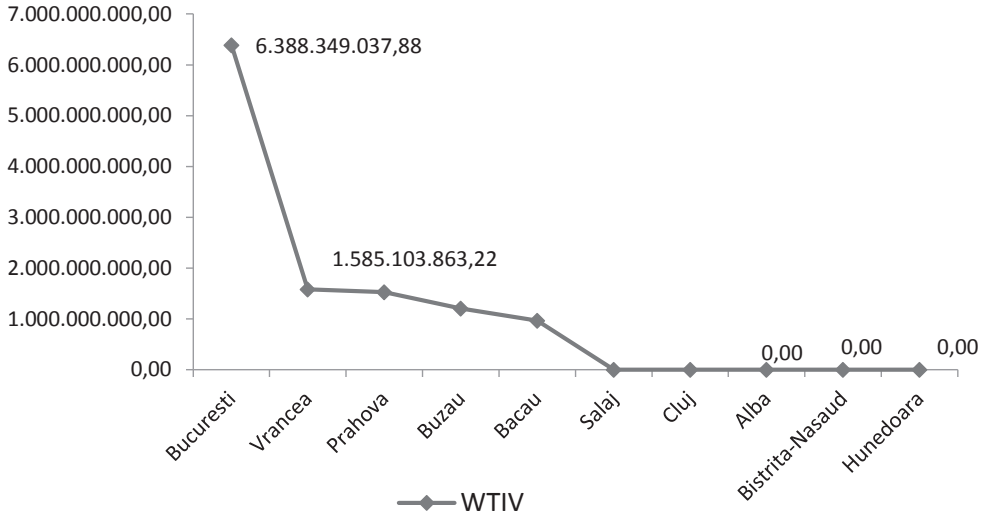

Figure 2: The geographical weighted total insured value by CRESTA zone (EUR)
Source: Authors' processing

Once determined WTIV, we can estimate the earthquake cat capital requirement, using the data from the aggregation matrix. The market factor $Q_{Romania}$ is 1,7%. It has a relatively high value due to the Romania's exposure to earthquake risk.

$$CAT_{earthquake-Romania} = 1{,}7\% * \sqrt{\sum_{r \times c} AGG_{r,c} * WTIV_{zone,r} * WTIV_{zone,c}}$$

$$CAT_{earthquake-Romania} = 1{,}7\% * \ 13.358.024.760{,}92 = 227.086.420{,}94$$

The estimated value of the earthquake cat capital requirements in case of Natural Disaster Insurance Pool is 227 million Euros.

6. Conclusions

Based on the aspects presented we can conclude that the estimation of the capital charge for catastrophic risk is not a simple matter but rather one of the most discussed and analyzed subject due to the major impact of these extreme and rare events.

According to the results obtained in QIS5 European insurers should allocate about 25% of the entire capital at risk to catastrophic risk.

Improvements from QIS4 to QIS5 are represented by the development of the personalised scenarios and also the classification of the total insured value on CRESTA zones. Also, the method of USP-Undertaking Specific Parameters is encouraged to be used. We find that an important role in determining the capital needed by an insurance company to cover its exposure to earthquake risk is played by the companies specialized in catastrophe modeling.

Once determined the capital charge for catastrophic risk the next step is choosing the best solution for covering against catastrophes: a reinsurance contract or alternative transfer solutions, such as catastrophe bonds.

For our country the total value of the capital charge for the non-life catastrophic risk is represented by the aggregation of the earthquake cat capital and the flood cat capital.

Our paper can be seen as a first step for determining the capital requirement for non-life catastrophic risk in terms of Solvency II Directive. This study can be developed for other insurance companies and also for the flood risk.

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