SOLVENCY II – UNDERWRITING CREDIT RISK MODELS

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Abstract

This research project analyses the Solvency Capital Requirement (SCR) calculation models applicable to Trade Credit Insurance Underwriting Risk.

The current regulation, the Solvency II Directive (25/11/2009), is not restrictive in this regard and allows each insurer to use the model of SCR calculation which best suits its purpose, with the condition that it obtains authorization from the local regulator.

However, a Standard Formula is available, for those institutions that wish to use it, to evaluate SCR (with standard parameters or the company's own). This Standard Formula offers much greater simplicity in all aspects, and requires less documentation and evidence on the accuracy of the model.

This simplicity and ease of calculation has its downside, as presumably insurers only use internal models if they are able to reduce the SCR versus the Standard Formula. This is precisely the downside, the excess capital implied by not applying an Internal Model adapted to the Insurance Company's Risks.

In this paper we present a compendium of five different options or models of calculating SCR for Underwriting Risk in the Credit Insurance Business. The Standard Formula with standard parameters or with a company's own parameters. Internal Models derived from the Banking Model for Credit risk, Internal Models based on the generation of a large number of simulations of the Technical Income Statement and Internal Models based on the method of calculating the Claims Reserve.

To clarify, the model based on Bank Credit Risk implies using the model accepted for Bank Credit Risk. This model is defined in the *Basel II Directive,* and is specifically applicable to the banking business as an Underwriting Risk Model for the Credit Insurance line of business.

In the insurance business, the *Solvency II Directive (25/11/2009)* also defines a Credit Risk, which basically refers to third-party debtors of the insurance company, and is included in the counterpart sub-risk, specifically for Reinsurance balances.

When we carry out the SCR calculation based on a company's data for Underwriting Risk with each of the five models mentioned, it should not come as a surprise to find that these fall in a narrow range. This is the logical conclusion of using different empirically contrasted techniques to evaluate the same thing. However, and despite the complexity of each model, this may not happen, which would give us a clue as to what other aspects of the models, such as their calibration, the coefficients used, the correlations or risk mitigators, among many other factors, may be the cause of the disparity in values. In this sense, this research project aims to evidence the differences between the models, questioning certain aspects and suggesting possible modifications in order to better reflect the reality of the risks they measure, and as a consequence, open future lines of investigation.

On the other hand, and given the different ways the various models deal with Catastrophe Risk, (one of the sub-risks into which Underwriting Risk is divided), alternatives, and implicitly the obvious solutions, are posed for each specific model as a prerequisite to carrying out all the above.

Lastly, Solvency II considers a 12 month timescale. This means that the calculated SCR must be sufficient to guarantee the solvency of the insurer over this period. However, this also dictates that the SCR calculation must be coherent with ERM (Enterprise Risk Management) and in this sense, if the business model and/or the behaviour of the assumed risks represent a longer term view, the capital calculation model should also contemplate this peculiarity. Addressing the above, it becomes very difficult to defend the one-year timescale. In insurance business practice, the implementation of all types of policies demands a much longer term vision than one year, given that risk and capital management, among many other aspects, should be on par with availability and capabilities, and especially, with the business model and the ease or difficulty of access to capital markets. This is never carried out with a short term outlook. Additionally, the increase in natural catastrophes, with the corresponding increase in claims and the cost of reinsurance, also impacts on the need to embrace much longer time periods, so that the cyclical nature of these phenomena can be contemplated.

Together, the models analyzed are based on the hypothesis that, should an LGD (Loss Given Default) event occur, the business would fail and cease trading, unless its shareholders or external investors provide sufficient capital. It is highly questionable that this would occur, given that the shareholders may not be disposed to continue investing when they doubt if they will recover their capital or not, and when access to capital markets is going to be difficult, basically due to the excess they must pay or simply because of the lack of any offer or interest in entering the company. Obviously a multi-annual view would help to circumvent these issues.

All the topics dealt with are extremely complex, and this work aims to show the significant differences between the various methods, their pros and cons and especially their limitations, all of which may produce very different capital requirements. This implies, depending on the directionality of the local regulator, that if left uncorrected, insurers will be more or less solvent and in the reverse sense more or less competitive in terms of capital cost, depending on the method they use. This is not only undesirable, but steps should be taken to prevent it.

As a conclusion to the research project, the author is of the opinion that sufficient elements have been introduced for all these aspects to deserve a deep and exhaustive analysis, leading to the generation of a current of opinion that allows a wide consensus in terms of the method/s that best serve the reality of Trade Credit Insurance Underwriting Risk and if relevant, the modifications that should be proposed to overcome the limitations detected.

Background

Trade Credit Insurance is included within the so-called Property/Casualty Insurance products which aim to prevent and repair any economic damage that the policyholder may suffer as a consequence of its clients' insolvency.

In many cases the policyholder retains a part of his own risk, there being an excess which usually oscillates between 10% and 30%.

As throughout this paper various aspects directly related to the Bank Credit product will be mentioned, it is worth remembering the main differences between them:

- Credit Insurance generates Premium Technical Provisions and insufficiency of Premiums and Reserves with their own methods of calculation, not so Bank Credit.
- Bank Credits have an end maturity, normally greater than one year, especially above certain amounts, whereas Credit Insurance is basically an annual renewable contract cancel-able by either party.
- Should there be a change in the debtor's status (worsening of their credit rating), the Bank Credit continues unalterably with a pending debt of 100% of the credit less the amount amortized, while in Trade Credit Insurance, only the amounts related to the invoices sent to that debtor are affected, therefore opportune measures can be taken which range from recalculating the price, reducing the exposure limit and denying coverage on future sales.

According to Solvency II Directive, the calculation of Underwriting Risk SCR should take into account the following three sub-risks:

Premium and Reserve Risk
Cancellation Risk
Catastrophe Risk

The measure of the solvency of an Insurer is determined, according to Solvency II Directive, by calculating the SCR using the Standard Formula with standard parameters and additionally, when they exist, by one of the models presented.
In this last case, the SCR obtained using the Standard Formula aims to be a baseline reference, essentially for the regulator, allowing it to demand Additional Capital from the company when it is possible that the SCR obtained by the Standard Model is insufficient.

Obviously, this characteristic associated with the Standard Formula, the baseline reference for any Internal Model, can skew the perceived adequacy of the Internal model, to the extent that it is not properly calibrated.
The suitability of the calibration of the Standard Formula based on the use of historical data from specific countries (not the EU as a whole), in data from relatively old financial years, and on the use of the VaR (value at risk) method, means that presumably we can find a better "baseline reference".

The Internal Models referred to offer three alternatives, although the second and the third model respond to the same concept.

> Internal Models derived from the bank model of credit risk employ the Probability of Default (PD) measure and Loss Given Default as the basis for a system that, after generating a large number of simulations, assigns SCR a value which has a 99.5% probability of being sufficient to cover any adverse economic situation.
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> The models based on a future extrapolation of the income statement, are based on generating a large quantity of simulations and setting the SCR as the value which has a 99.5% probability of being sufficient to cover any adverse economic situation. These models include the Claims Reserve BE (Best Estimate) as the base data and therefore have the advantage that they are part of a very widely accepted method in the reality of the insurance business.

The models based on measuring the Claims Reserve BE in line with the requirements for calculating the BE under Solvency II, use actuarial procedures to complete the calculation of the adequacy with a 50% level of reliability. Data with a 99.5% level of confidence is immediately available. It may be claimed that they only measure the risk of the adequacy of the claims reserve, similarly to what happens with the banking model, but this is the precise risk, within the Underwriting Risk, that could lead an insurance company to a situation of insolvency.

Additionally, the way the concept of Catastrophe Risk is treated, which is already subjective in other insurance lines of business, represents an added difficulty as it mixes a large number of adverse economic effects including those attributable to the economic crises, without having a minimum of segregated information available for many, nearly all of these situations, which refer to the concept of "catastrophe".

Capital Calculation Models adapted to Solvency II

Credit Risk, as accepted in Solvency II is associated directly to three subcategories of risk:

Premium and Reserve Risk
Lapse Risk
Catastrophic Risk

In this regard, and especially in terms of the formula used to calculate SCR, there is a range of evidence from academics and official texts such as:

"The standard model for credit risk is the one defined in the Basel II standard approach. In order to limit the possibilities for arbitration of credit risk in quantifying credit risk, between banks and the insurance sector and vice versa, we follow the use that the bank regulator makes of the model as closely as possible, so that the capital load is calculated using an approach which is compatible with Basel II" *Sandström (2006) (page 155).*

Directive 200/138/CE on Solvency II, article 101 referring to the calculation of SCR, *Solvency II Directive (25/11/2010)* mentions Credit Risk separately from Underwriting Risk, in accordance with the above. However, articles 104 and 105, which refer to the Standard Formula, only mention Counterpart sub-risk and not generic Credit Risk.

Finally, and although the reference is a working paper, with no value for practical purposes, in Draft Implementing Measures, Level 2 (2010), section 2, from page 75 to page 95, the specific calculations for Non-Life Underwriting Risk are mentioned along with Catastrophe Risk for every Non-Life specialty with a clear reference within the group "Man-made Catastrophe Risk Sub-Module", a "Credit and suretyship risk sub-model" Art. 95 NLUR15 and Art. 102 NLUR22.

From the above we should understand that the legislator is assuming that the Underwriting Risk of the Credit Insurance line of business should be considered within the Underwriting Risk proper. The Standard Formula, as defined in the QIS5, Technical Specifications (2010) uses a simple model for calculating SCR based on a VaR versus the Volume of Premiums and Reserves. Companies have total freedom on how they base their Internal Models and in this sense it is as acceptable to use an approach such as the banking approach with PD and LGD, as it is to use the Underwriting Results Account, or the methods used to calculate the Claims Reserve.

This is transcendental because in practice the main global operators in the Credit Insurance business have shown that they are working on a banking-style model using PD and LGD, given that their day-to-day operations rely on both, which justifies that Risk Management, the calculation of Claims Technical Provisions and the Model are coherent. Although for those familiar with business practice, evidently economically detached from daily practice of the company, even when determining the sufficiency or insufficiency of premiums, models need to be coherent.

Capital Calculation based on the Standard Formula.

Non-Life Underwriting Risk, in which Credit Insurance is included, is made up strictly of the sub-risks defined in Solvency II. The Premiums and Reserve Risks, Lapse Risk and Catastrophe Risk.

The standard formula brings together the three sub-risks taking into account certain correlations that are defined specifically in the regulations *Draft Implementing Measures Level 2 (2010)*, Section 2m Non-Life Underwriting Risk, module Art. 80 NLUR1, pg72).

Premium and Reserve Risk: The Standard Formula defined in the *Draft Implementing Measures Level 2 (2010)* uses a simple model based on a VaR over the volume of premiums and reserves, that is, SCR will be the value of the distribution of losses for a percentile of 99.5% in a one-year timescale for both.

Lapse Risk: Lapse Risk is understood as the risk that a substantial volume of policies will be cancelled or not, and the foreseeable effect of this on the companies' equity.

According to the specifications of QIS5 - Technical Specifications Summary (2010) (last stress test carried out up to the date of publication of this research) a method is used based on including three scenarios in the calculation of Technical Provisions: Down, Up or Mass, relative to the future development of premiums.

Catastrophe Risk: The standard formula contemplates two specific scenarios: The risk of simultaneous large claims and the risk of recession: Art 102 NLUR22 Draft Level II and Art 105/2 Solvency II Directive (25/11/2009)

Risk of Simultaneous Major Losses: Should consider the total of the exposures of the company's three largest clients in the net vision, deducting all the cover included in reinsurance and others. The effects of the calculation of SCR that the LGD represents in these cases is 10% of the amount insured.

Recession Risk: Should include the value of an unexpected or instant loss of a certain percentage of exposure without any deduction for reinsurance or other cover. However, a maximum calculable limit is established on the basis of premiums, depending on the value adopted in NetLoss Ratio.

Limitations: According to Carillo, (2005) in his article: *Basel II: A Critical Look*, the Standard Formula has opted for the use of Normal random variables, when the evidence is that the real data from Credit Risk presents leptokurtosis and asymmetrical distributions, The Standard Formula, as defined in *QIS5 Technical Specifications Summary (2010)*, uses a simple model based on a VaR over the Volume of Premiums and Reserves, that is, that the SCR is the Value of Distribution of Losses for a certain percentile. This method, which began with Market Risk and the assumption of Normality of Returns, when the distribution is not Normal, which is something which happens in Credit Risk , means it is only necessary to know one point of the probability distribution and this knowledge does not allow us to infer the behaviour of the above for extreme values. Additionally, when we leave the framework of elliptical distributions, sub-additivity is lost and the VaR of the portfolio may be greater than the sum of the VaRs of the sub-portfolios that make it up. This contradicts the intuition about diversification effects. Given this evidence, authors such as *Carillo (2005)* have recommended the use of better defined methods such as Tail Var, or the C

Var (Conditional VaR) defined as the mean value of the expected loss when it is larger than the VaR.

In terms of Catastrophe Risk, the standard formula, when considering Catastrophe Risk as a separate risk from Premium and Reserve Risk, assumes that the information referring to catastrophic events will be differentiable and therefore separable, such that no Double Accounting will exist between Premium Risk and Reserve Risk, which, given the typology of this type of risk and their close relationship, means that in practice it is difficult or nearly impossible to separate them. It also accepts the same 12 month timescale used in Solvency II, as opposed to direct experience which shows that catastrophic events happen over much longer time periods, decennial periods being the most frequent.

Both assumptions are, from a practical viewpoint, difficult to accept and in consequence, the calculations are closer to Solvency I than to the aim of Solvency II, which is non other than to bring the calculations closer to the true measure of risk incurred.

Calculating Capital using Internal Models

The following is a summary of three different methods of defining an Internal Model to calculate the SCR of the Credit line of business.

The first is presented below under the title of "Internal Models based on the proposals contained in Basel II for Credit Risk", and is founded on the models based on the "Losses of a Credit Portfolio", which are widely used in the banking sector and were developed under Basel II for Bank Credit Risk. It is also possible to argue that they have been calibrated to take into consideration the specific nature of Credit Insurance.

The second method, "Internal Models based on the Monte-Carlo simulation of the Income Statement" is based on the consideration that the Credit insurance business, being a line of business within General Insurance is susceptible to the application of the same methodologies as those used for various lines of business, evidently specifically adapted to their needs. One of these methods has consisted of the simulation by Monte-Carlo of the income statement. This method, which takes into account the main variables involved in the income statement and, as can be imagined, does not represent a great level of complexity nor the need to have large databases, has the advantage that it can be integrated as a risk management tool for the companies, as long as their focus, although initially centered on the short-term view of Solvency II (12 months), is easily extendible in the medium and long term by adding information on the value of the portfolios and clearly helping in insurers' strategic decision taking.

Lastly, the third method, "Internal Models developed under the actuarial method and rules used in the calculation of Claims Technical Provisions through Global Stochastic Models" is based on techniques that are widely used in the calculation of the Claims Reserve Best Estimate by Global Stochastic Models and as they are fully integrated in the management of a large number of insurance companies, they represent a simplification and a general acceptation and understanding of the business model that Solvency II proposes.

Internal Models based on the proposal contained in Basel II for Credit Risk

This model was developed for the quantification of bank credit risk, and is based on a series of common elements or ingredients in bank loans and credit insurance.

These elements are:

- Exposure to Credit – with its limits, coverage, etc
- The Probability of Default (PD) derived from the credit rating, whether of internal or external origin.
- The Loss Given Default (LGD), calibrated specifically according to the experience of each product.
- The mechanics of the model, the correlations between risk and policyholders or lenders.

The basic mechanics of the models implies an extensive Monte-Carlo simulation of the development of LGD and their economic consequences, configuring the function of density of losses and consequently the expected loss, the distribution tail up to 99.5% covered by SCR and excess above that 99.5% which represents the acceptance of a probability of ruin of 0.05%

The adaptation of a banking model to the specific nature of insurance was performed, considering amongst other things, that a substantial amount of the risk is ceded to Reinsurers, that there are different reasons for the losses, that the insurer may re-underwrite the risk at any time, and on occasions the client self-insures a substantial part of the risk, and that there are extra conditions, such as the requirement that the insured party manages credit prudently. Additionally, this type of model supposes the acceptance that the catastrophic scenarios or events and their consequences are implicitly accepted in contra position to what is defined in the standard formula.

In a basic but complete view, the model progresses through the following steps:

1.- Aggregation of Buyer level risk exposures:
The Buyer is the company, (usually a company, though it may also be an individual) to whom the insurance company has granted credit for those clients in its/his portfolio, granting ratings and maximum levels of cover for each.
The Client is the company to which the buyer of the credit insurance sells a a product or service which is supplied before payment and therefore the buyer of the credit insurance wants to be covered against the risk of having delivered the goods or services and the Client not paying on the agreed date.
The management of Buyer Risk is carried out as an integral part of the control processes of the activity of insurance companies. So having information on the total amount of credit granted in real time to the buyer is vital for managing a credit portfolio. Its aggregation by sectors, geographic areas etc. into however many segments are considered necessary, will allow for a correct analysis and knowledge of the behaviour of the portfolio.

2. Obtaining the Buyer Rating:
Obtaining the Buyer Rating is a basic parameter which will assist in determining the PD at buyer level. It is an arduous task often made difficult by issues in obtaining the financial information needed to elaborate it.
However, there are various elements that can help us determine it. Basically they can be separated into three groups:
1) Companies that have a Rating from any recognized agency such as Standard&Poor's. 2) Companies that, while having a Rating, their rating is obtained through public information, or their rating is below a certain threshold and requires extra analysis or search for information. 3) Companies out of reach of the Ratings agencies have developed an Internal Buyer Rating which is one of the most complex systems of client classification that exists in the arsenals of insurance companies.

Fourthly, without impairing that in each market reality it is possible to create new ways and calculations to assign ratings, it is necessary to include country risk as an element, which in the case of exports, conditions the levels of rating, including in some case overwhelmingly so, over what is provided by the financial information if it is available. These processes of assigning a rating are exceptionally agile and very close to the day-to-day reality, both in terms of economic information, and any other type published.

Lastly, and in terms of the normalization of all these levels of rating, the insurance companies and specialized businesses normalize and unify all and each of these other ratings in one single rating by their own internal IT processes for extensive use in underwriting and assigning credit or coverage limits.

Method of obtaining the Internal Buyer Rating (IBR): The IBR determines the probability of default (PD) of buyers over a one-year timescale. In this context, the probability of default includes an insolvency that may occur for whatever cause including those due to third parties.

Depending on the information available, three sub-models are used to determine the IBR: 1) A model with complete financial information from the Balance Sheet and the Income Statement of the client company - (FIM= Financial Information Model). (2) Model with partial or incomplete financial information, Balance sheet available but not the Income Statement of the client company. - (LFIM Light Financial Information Model). (3) Specific models based on non-financial information, including the risk characteristics of the region, the legal structures, antiquity of the client company, etc. (NFIM= Non Financial Information Model)

Additionally, underwriters may include and/or influence the Rating, improving and worsening the rating from their own experience or opinion.

A widely accepted standard of evaluating the rating takes the values from 1 to 99 with 1 corresponding to the best rating and 99 to the worst rating. Additionally, the value 100 is reserved for when completely adverse information is available such as when the client has effectively suspended payments or is in receivership.

This system of provider rating has extra warning signs, for each new input of information relevant to the system, or even the opposite extreme applying rules of expiry for the rating due to lack of information outside a prudent time period. Obtaining the IBR for each client is included in the FIM, LFIM, NFIM Information Model, and is supported by the application of a "Model of Credit Risk Measurement" of which multiple variants exist with a large bibliography in this regard. For a summary see: *Saavedra García (2010)*

As an example, the Credit Risk Evaluation models can be divided according to *Galicia (2003)*, into:

Traditional models based on the fact that the factors that should be considered when deciding whether to grant credit or not which are named "the five Cs of Credit": (Capacity, Capital, Collateral, Character, and Conditions). As an example, in 1968 Altman defined a model based on the various coefficients applicable to each of the five ratios he considered: (1) Productive Capital/Total Assets. (2) Retained Earnings / Total Assets (3) EBIT/Total Assets (4) Market value of the shares/Book value of the Debt, and (5) Sales/Total Assets).

where for >2.99 there is considered to be no risk of Default

for a value <1.81 it is thought that a certain default risk exists.
for a value between 1.81 and 2.99 both cases could occur

Modern models that include various models such as the KMV model, the Merton model based on Black&Scholes, the Credimetrics model by J.P. Morgan 1997b, the Credit Risk + Model by J.P. Morgan 1997a, the model of return on capital adjusted to risk by Faikenstein 1997, or the CyRCE model, the Logit and Probit models, models based on neural networks, etc.

The basis for all these models is converting financial and non financial information into a certain number of elements and/or relationships or ratios. These elements are used to estimate the IBR (Internal Buyer Rating) and to assign a certain PD, within a 12 month timescale.

4. Method for calculating the LGD.
As mentioned before, the LGD describes the part of the each clients' exposure that will be lost in the case of non-payment, or that will not be recovered in the case of a default.
In terms of credit insurance, LGD generally covers a short time span and is directly in contact with the reality of the market. Therefore it can anticipate problems with certain clients. This allows the exposure to be managed more dynamically through a review and analysis of the financial statements and certain market indicators, adequately managing the limits of cover and drastically reducing the risk as soon practicable when faced with any indication of deterioration. An approach for the measure of LGD for the credit insurance business should consider the ability to define an exposure limit 12 months in advance , before a client defaults on another client.

Calculating LGD: A scenario is established which considers certain bands of exposure similar to economic bands: From 0 to €10,000, from €10,000 to €20,000, from €20,000 to €50,000, ……., from 2,000,000 to infinite.
In each exposure band the LGD distribution model is introduced such that it expresses the severity for each band of exposure. In order for the process to be consistent, the LGD should be calculated at client level in the same way as with PD.

5.- Correlations for the simulation of losses: At this point it is necessary to join the PD derived from systematic risk to the LGD and to do this we use the correlations. The development of an internal correlation model requires a large amount of historical data which is difficult to obtain. Instead, some of the large operators in the credit insurance business at a global level, grouped together under the umbrella of ICISA, are using the model of correlations developed by Moody's KMV and entitled “MKMV Default Correlation Model” (http://www.moodysanalytics.com/)

The MKMV model uses the Merton Default Model, based on the Black&Scholes formula in which the probability of default is equal to the probability that the assets of the client are lower than its responsibilities. The KMV-Merton model is an application of classical financial theory but works well in the forecast depending on how realistic the assumptions are. The model is not complex and it uses a structural model which requires a series of assumptions. The model assumes that the underlying value of each company is a geometric Brownian movement and that each company has issued a single zero coupon bond. The MKMV model contains two types of parameters, the Beta, which describes the relative dependence of the client on the state of the macro-economy, and the R squared which is a factor per client that describes the strength of the global correlation and has been adapted to the credit business separately for large and small exposures.

6.- The last step is to simulate the losses of the portfolio at 12 months, which is done by applying the Monte Carlo method a sufficiently high number of times, simulating scenarios and analysing the behaviour of the portfolio.

Given the magnitude of the calculations, and the number of scenarios predicted, simplifications are necessary to allow the use of aggregates and therefore should comply with the requisites for the homogeneity of risk. At the same time, these aggregates should allow us to extract the information necessary to manage risk and capital requirements correctly. Therefore, it is useful to obtain results which refer to countries, economic sectors, sub-sectors, specific portfolios, amongst others.

This method consists of randomly and slightly modifying the level of default for each segment and applying the respective correlations, thus obtaining an expected loss value for each of the scenarios studied, generating the corresponding loss distribution function over a time horizon of the next 12 months. The value of 99,5% probability of occurrence will be the one we assign as SCR.

Due to the sub-additivity effect caused by the correlations between the various segments, the desire to have the SCR for specific segments as integral parts of the overall calculated SCR implies the use of Capital Allocation techniques.

In the simulations carried out it is important to highlight that if all the events to which we are exposed are included, in other words, if the modification of the levels of default is sufficiently large or if it simultaneously covers a wide number of segments, the hypothesis implies that catastrophic scenarios are being included. Their segregation as established in the Standard Formula, would imply establishing certain restrictions on the generation of scenarios and would represent an important increase in the level of complexity of the model.

Limitations: This type of model is complex, both in its theoretical construction and from the management perspective. It requires a significant allocation of human and material resources, especially for maintenance and contrasting hypotheses. However, this type of model, depending on the speed with which the information is reflected, and unlike other models, incorporates a very important anticipatory effect of economic crises since the loss simulations are performed with the latest known information from the companies and their PDs, which in complicated situations obviously suffer and move their expectation of worsening economic conditions to the value of the Maximum Expected Loss. In this sense, a limitation or danger of the model is the volatility of SCR in adverse situations, leading insurers to situations including insolvency, something which in the worst cases need to be explained.

Moreover, these models, tailored to the insurance industry from their previous implementation in banking, assume statistical behaviours and market standards, such as certain distribution functions and types of correlations, that have not been tested or proven in credit insurance. As noted in other chapters, the establishment of a clear and consensuated method for the insurance sector that serves as a "baseline reference", would allow an assessment of the results of these models, in all their variations, without the need for extensive methodological testing, company by company, even in stressed situations.

Internal models based on the Monte-Carlo Income Statement simulation.

The Monte-Carlo simulation of the Income Statement commences with historical information from the income statements of the company, line of business or geographic area, on each of the

items that compose it, and at this point are of vital importance in ensuring the necessary coherence of the information on which the model will be built.

The underlying idea is to generate, from the distribution functions of the variables involved in determining the results and the correlations between them, a sufficient number of simulations of the results of the company that allow us to find the value of the maximum expected loss or what is the same, the maximum expected negative result in one in 200 years, or in other words with a 99.5% confidence.

Normally, the items considered most relevant are earned premiums, loss ratio, the cost of reinsurance and all expenses and commissions to agents. Additionally, and in order to adequately pose the hypothesis on which to establish the future behaviour of the above variables, it is necessary to have additional information such as, the number of policies, the number of claims reported, number of outstanding claims, inflation, interest rate curve, etc, depending on the case.

To perform the Monte-Carlo simulation, hypotheses are proposed on the behaviour of random variables that allow the calculation of the account. These hypotheses must be adequately justified, although in specific cases, expert judgment, or the use of market parameters may prevail over certain behaviors of any of the variables.

Another important aspect to consider is the degree of correlation between variables. The application of Copulas will allow us to determine the multivariate behaviour that reflects the dependence between marginals. Also, for each variable on which we make hypotheses of time behaviour, we must support them by including the historical information used, the type of extrapolation and the statistical method used to capture the evolution expected for that variable.

Finally, the number of simulations to be performed must be determined after analyzing the sensitivity of the SCR calculated with a different number of simulations.

For the calculation of the SCR, as already indicated, we will perform a sufficient number of simulations (previously tested as appropriate) using the Monte-Carlo method, and we will obtain the value of the LGD with a 99.5% degree of probability according to the indications of Solvency II, and this amount will be the capital required to cover those losses, ie the Underwriting SCR.

Catastrophe Risk: This method may take into account the segregation of historical data referred to as Catastrophic from the definition of clusters and their associated cost. This implies the need to define breakpoints for some of the variables considered, and even introduce some new variables to allow them to be quantified. In terms of the Credit Insurance business, history has demonstrated that unlike other branches of General Insurance, the concept of Catastrophe reinvents itself year after year, but with a common denominator, Default, and therefore this method could be developed separately or implicitly in Catastrophe risk.

Limitations: This type of method, applied to the Credit Insurance line of business, requires the definition of a model based on the company's_internal parameters. If anything characterizes the Credit Insurance line of business, it is its relationship with the wider economy, with specific exposures, sector by sector and country by country. This is important, because any negative element at an economic level whether by sector, national or global, will impact the company more or less immediately.
It is for this reason that this method could be called "isolationist", versus the possibility of incorporating, as explanatory elements, the evolution of premiums as well as the evolution of

claims, external variables that contribute a certain degree of variability to the model versus situations of stability or economic crisis. *Rodriguez Villegas (2007)*

In connection with the above, and as an example, considering fluctuations in the GDP of each country, or national rates of insolvencies in the internal model would strengthen the solvency of insurers, not only in line with expectations of recent results, but it would also incorporate external expectations that are extremely relevant to solvency.

Internal models and the method developed under actuarial rules, used in the calculation of technical provisions for claims by Global Stochastic Methods. Although the stochastic methods of calculating the claims reserve are not used in practice to calculate SCR, a line of future research should focus on its applicability due to its wide dissemination and use, its integration in daily practice in many insurers, its apparent simplicity and, virtually no implementation costs, notwithstanding all the advantages it represents at the level of supervisory authorities.

Accordingly, it would be an alternative to calculate SCR that was fully viable, affordable, and especially understandable in the insurance sector.

EIOPA's report on the results of QIS5, EIOPA, 2011 QIS5 Report (p.60) mentions that companies, mostly have reported that they have no plans to improve the methods that they have been using to calculate the Claims Reserve BE, except to include the effect of inflation. However, participation in QIS5 has meant making the transition from deterministic methods to stochastic methods, and in this sense the most commonly used by the industry are currently:

Chain Ladder Techniques based on claims paid, incurred or the number of claims.
Bornhuetter-Ferguson Techniques based on claims paid or incurred.
De Vylder Technique, least squares.
Stochastic such as: Bootstrap or Mack methods.
Frequency and Severity Analysis.

Referring to stochastic methods, and although some of them agree in estimating BE of Claims Reserve with the classic chain-ladder (deterministic), it is clear that their use is advantageous in that they provide precise measurements of the estimated Claims Reserve.

Under Solvency II, the value of the Claims Reserve must be equal to the BE of the Claims Reserve plus a risk margin, which in any case is an increase of BE, whether according to the model itself or a percentage increase referring to Claims Reserve itself or other parameters that are considered more appropriate.
So the SCR for Reserve Risk could be thought of as the Best Estimate for Claims Reserve (99.5% percentile) minus the Best Estimate of Claims Reserve (50% percentile), minus the risk margin.

From a strictly calculation viewpoint, this method should not represent any inconvenience if we analyze the risks individually, allowing subsequent aggregation as in the other applicable methods and, as its name suggests, it must be completed by adding the SCR of the other risks which the Underwriting Risk under Solvency II involves, and are not supported by the calculation indicated, whether calculating Premium Risk, Cancellation Risk or Catastrophe Risk.

The application of this genuinely insurance method is based on the large differences that characterize the Insurance Credit product compared to Bank Credit, among which the most apparent are the following:

a) The existence of Technical Provisions for Premiums, Premium failure and Claims, with their own methods of calculation, and risk mitigation techniques such as Reinsurance.

b) The bank loans are granted with an end maturity, usually greater than one year, especially above certain amounts, compared to Credit Insurance which is basically a renewable yearly contract and reportable by either party.

c) Should the debtor suffer any changes (worsening of creditworthiness), bank credit remains unchanged with a debt equal to 100% minus the amortized loan, while in Trade Credit Insurance only the amounts committed with invoices sent to that debtor are affected, being able to take any action deemed appropriate, from recalculating the price, reducing the exposure limit or even denying coverage for future sales.

Finally, note that, as it deals with measuring the risk that the insurance company can meet its commitments for claims, in a 99.5% probability scenario, and we are using this method to set the same scenario to 50% to calculate the BE of the Claims Reserve, it does not seem unreasonable, a priori, to assume that the use of the same method provides additional consistency and simplicity over any other method.

Very briefly, the calculation of the Technical Provisions for Claims or Reserves under a simulation model represents obtaining the predictive distribution of future payments for claims, which breaks with the required one year time frame established by Solvency II. It must be remembered that Basel II already sets the SCR level based on existing credit in the portfolio without explicitly defining a timescale. But if incorporating an SCR were really crucial based on an expected evolution of premiums and claims in the next twelve months it would not add a great deal of complexity to the model.

Regarding the treatment of Catastrophe Risk, this method, as defined above, may take into account the segregation of the historical catastrophic data from the definition of clusters and their associated cost. This implies the need to define breakpoints in some of the variables under consideration, and even introduce some new ones to allow their quantification.

In terms of the Credit Insurance business, history has demonstrated that unlike the other branches of General Insurance, the concept of Catastrophe reinvents itself year after year, but with a common denominator, Default. Therefore, this method could be developed considering catastrophic risk separately or implicitly.

Limitations: As noted above, the use of the method of calculating the BE of the Claims Reserve as an Underwriting Internal Model is not complete from the purists' perspective, as considerations such as the effect of cancellations or changes in the volume of business would not be covered. However, insurance practice has demonstrated that no insurance company has filed for insolvency, within the scope of Underwriting Risk, for reasons other than insufficient Claims Reserve. Therefore, the assumptions made in the definition of the Standard Formula seem entirely acceptable, and more studied, which consider this and any other potential lower risk, including the calculation of a surcharge based on premiums or reserves, as sufficient.

In this respect it is necessary to note that, unlike what happens with the other models, the advantage of the lower economic and implementation costs of this model is that these methodologies are now fully implemented and tested and embedded in the management of

companies. Taken to the extreme, adapting to Solvency II with this type of model could be performed in a better timescale and with much higher quality than what is currently foreseeable.

As mentioned in the previous paragraph, the inclusion of an external parameter to the activity of the insurer, that relates the level of reserves (the BE) with macroeconomic developments to include possible catastrophic scenarios is missing, as it is in the model based on income statements, *Rodriguez Villegas (2007)*

Additionally, and for risks located in Spain, we need to consider the role of the *Consorcio de Compensación de Seguros*, as when faced with unmeasured situations, it responded to the crisis in the 2008 financial year and beyond, by providing reinsurance cover precisely focused on providing liquidity and to cover credit insurance companies' peaks of claims given the significant deviation of the Combined Ratio.

Considerations on the time frame of 12 months referred to in Solvency II versus a Multi-annual approach.

The Solvency II Directive (25/11/2009), makes clear that the calculation of capital must state a time frame of one year and consequently all the models developed for the purpose of calculating the SCR have taken this as temporary reference hypothesis. However, it also says that the calculation of the SCR should be consistent with the ERM (Enterprise Risk Management) and in that sense if the business model and/or the behavior of the risks assumed to represent a broader term vision, the calculation model of capital must also consider this peculiarity. Given the above, it is hardly foreseeable from the viewpoint of managing an insurance company and especially if it comes to risk management (ERM), defend the one-year timescale. Normally, the implementation of all policies, requires a longer-term vision that year, and that the risk management and capital management among many others, should be commensurate with the availability, capacity and ultimately the model business, and in any case this is done with a short-term vision.

Also, in the *Solvency II Directive (25/11/2009)*, and request authorization to the regulator for the use of internal models, indicates the need to demonstrate their use in practice and proper management of risk referred according to the development of the selected model . In this sense the ORSA (*CEIOPS - ORSA 2011*), is configured as a basic element in the process of documentation and evidence of risk management.

If we combine both requirements, the timescale of 12 months, with the need to demonstrate the proper management of risks, as indicated normally covers a longer timescale, we have a situation that will generate some conflict as far that some of the assumptions used to define this base timescale to 12 months have begun to crumble and all with a consequent increase in capital requirements.

In addition, the current global economic situation, arising from the summer of 2007, with the negative effect on capital markets allows us to glimpse that adequate ERM should refer to a longer timescale, ensuring the solvency of the institutions not only in the short term, but also in the medium and even long term. This not only affects risk assessment and underwriting policies, but it greatly affects the valuation of the assets of insurance companies, obliging in many cases to establish policies that ensure the return of capital and/or a correct evaluation of business strategies and business capital model must go and be absolutely consistent and on par at the cost of a significant decline in interest margins.

Moreover, the increase in natural disasters, with a consequent increase in claims and cost of reinsurance, also highlights the need to cover much longer timescales, such that they can contemplate the cyclical nature of these phenomena.

Finally, the requirements of *Solvency II Directive (25/11/2009)*, in terms of transparency with the markets and regulators also affects both business strategies and the capital model which must be matched and totally consistent.

The Capital calculation models we have been analysing (standard formula and internal models) are based on the assumption that in the event of a LGD, the company would fail if it did not have sufficient own or third-party equity to continue to cover the SCR. The reality, following the current financial crisis has made clear that the availability of own or third part capital, is no longer satisfied. Neither the shareholders are willing to continue investing, given the doubts on whether they will recover or not their capital, nor is access to the capital markets easy, in essence because of the premium to be paid, or simply the lack of supply and interest in joining the business.

Moreover, the definition of a multi-annual model helps the management team make the business model coherent and the definition and implementation of business strategies over a medium term timescale at least, with risk management and solvency requirements.

To illustrate this, it is important that insurers are willing to answer questions such as:
How many years, with catastrophes and adverse development of the capital market can the company bear with a certain level of confidence without resorting to external funding?
How much capital does the company require to survive the next five years without resorting to external funding?
How much capital is needed today for an insurance company to cover all potential simulated losses it will incur during the period of simulation considered (n years) without accessing the capital market at any time during this period, for a certain strategic line? or modifying a particular strategy?

All this leads us to one of the most important activities for managers of insurance companies which is to ensure an adequate structure of risk selection policies and strategies in line with capital availability and strategy. This will only be possible if we work with a medium to long-term approach, rather than the 12 months allowed by Solvency II. According to *Diers (2011)*, this multi-annual vision requires changes to the models, affecting mainly the consideration of the LGD, which is considered cumulatively throughout the period covered, instead of 12 months, 5 years in this proposal, regardless of the model chosen for the various risks of the company, and that obviously will tend to increase the capital requirement, although consistency with the investment policy, to cover this longer time horizon, can help to compensate for this given the penalty that the investment to maturity represent versus SCR.

In terms of adaptability of the models we have tested with this new timescale, it is noteworthy that the model based on the income statement does not require any change since one of its current uses is the calculation of the value of portfolios, for which time frames are considered that reflect the maximum duration of the policies. The Claims Reserve Best Estimate model, depending on how deeply you want to consider the sub-risks Premiums and Cancellations, does require any additional adaptation either beyond incorporating the sub-risks of Premiums and Cancellations.

Conclusions

Throughout this summary, relevant issues have been presented and discussed regarding the options for calculating the SCR for Trade Credit Insurance. The rules that underpin the various models have been seen along with their complexity, both from a strictly calculation perspective, as well as from the viewpoint of information collection and collation. We have also seen the different treatment of Catastrophe Risk in each model. Progress has been made, in terms of the evidence and assumptions of the standard formula, that this may not be the best "baseline reference" for the value of the SCR. A new feature has been introduced which is the method of calculation of claims provisions using stochastic models as an alternative to the Internal Model contrasted enough and accepted by companies and not debatable in terms of their consideration of it as a "baseline reference".

We have also seen, in terms of the timescale, the need to focus the solvency of companies on a timescale longer than one year. It could be defined as an author recommending the consideration of a five-year timescale, while leaving the responsibility for the calculations in the hands of the insurance companies. Accepting an individual proposal for each insurer would require prior justification, provided that this were justified by the period of execution of its different strategies, basically in Risk and Capital. In any case, the annual timescale does not seem the best possible scenario.

All the topics approached are highly complex and the present work aims to show the significant differences between the various methods, their pros and cons and especially their limitations, and that they can produce some very different capital requirements. This means, depending on the discretion of the local regulator, if not corrected, banks will be more or less solvent and in the reverse sense, more or less competitive in terms of cost of capital, depending on the method they use, which not only is undesirable, but they must do everything possible to avoid it.

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