November 2015 N°34

SCOR Papers

A Change of Paradigm for the Insurance Industry

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Abstract

In this paper we review changes in the insurance industry due to new risk-based regulations such as Solvency 2 and SST. The move from corporate management based on cash-flow to risk-based management is described and discussed through its consequences on capital management, economic valuation and the internal model. We discuss the limits and difficulties of Enterprise Risk Management and its effect on the organisation of companies and the role of actuaries in insurance. The risk/return relationship is becoming a central element of the company's management, slowly supplanting the traditional accounting view.

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1. Introduction

European insurance companies today are in the throes of preparing to implement the new Solvency 2 prudential rules, while Swiss insurers and reinsurers have been applying the Swiss Solvency Test (SST) for several years now. Both regulations are intended to be risk-based. However, discussions on the subject mainly concern the pertinence of the different measures proposed or the cost of upgrading the companies to fit Solvency II requirements. Contrary to the heated debates during the drawing up of risk-based solvency regulations, scant attention is paid today to the profound changes represented by these regulations in terms of corporate management.

The insurance industry has a long history and its contribution to the expansion of the European economies in the 19th and 20th century is significant. Today, it is essential to the healthy development of the economy. For many years, corporate management was limited to the management of cash-flow. As long as the premiums received and the financial returns exceeded the payment of claims and overheads, the company was considered to be profitable and thus solvent. The performance indicators derived from this approach were, and still are, the combined ratio (claims plus costs in the numerator, divided by the premiums in the denominator) in property insurance, and the technical margin (the ratio of gross revenue to premiums and financial returns) in life insurance. Even today, these performance measures are paramount in corporate communications and media coverage.

However, financial market pressure, banking regulations and the new risk-based insurance regulations, are leading to the gradual introduction of other performance measures such as return on risk-adjusted capital (RoRAC) and return on equity (ROE), all of which are related to the concept of the risk underwritten by insurers. This means not only knowing the positive cash-flow position, but also whether the return obtained on a given contract is commensurate with the risks incurred. The notion of capital thus becomes a central issue. This capital must be correctly evaluated and allocated to the underwritten business. This implies profound changes in both the mindset and organisation to meet these requirements. Life insurance companies were the first to introduce statistical methods to calculate their premiums based on mortality tables, which were already popular at the end of the 19th century. The actuarial calculation of premiums and insurance reserves became widespread and has continued to develop up until the present time. However, actuaries were usually confined to very narrow areas and did not participate directly in corporate management. They were asked to evaluate the reserve requirements and calculate premiums but were never asked for advice on the type of business to be developed or the return on the business underwritten.

The introduction of risk management into the management of insurance companies has completely changed the perspective and role of actuaries who are traditionally responsible for quantitatively evaluating the risks. Company managers must now pay attention to both the new performance indicators and manage the company's capital. Market pressure is reinforced by regulatory requirements to encourage companies to rethink their operating methods and business model. In this paper, we will explore some of the key features in this development and propose ways of improving it, based simultaneously on the experience of a large international reinsurer and on our understanding of the challenges ahead of the insurance industry.

2. Risk capital and its management

In the early nineteen-nineties, the notion of risk capital became prevalent in banks under the influence of the Basel Committee and the introduction of risk regulations. The notion was extended to insurance companies and other financial institutions shortly afterwards, at the beginning of the 2000s. Today, capital management is high on the agenda of corporate management bodies. Capital is seen as a guarantee to customers that the financial institution will meet its obligations up to a certain level of probability (generally 99% for banks and 99.5% for insurance companies). It is therefore not ancillary but represents the «commodity», as it were, used by companies to generate business and profits. As a result, it must be managed so as to optimise the company's performance. This means that its allocation cannot be treated as a peripheral issue; on the contrary, it must be at the very core of insurance business management, like that of banks (for further discussion in this respect, see for example in [Matten 2000] and [Bernstein 2007]).

Capital is used by insurance companies as a guarantee that they will pay the policyholder beyond the average claim for this type of policy but only up to a certain pre-determined limit which has a very low probability. The question that naturally follows is how much capital the company needs to cover the risks in its portfolio and within what timeframe? At this stage of our reasoning, it is useful to define two types of capital that will play an important

role not only in determining the company's solvency but also in managing its performance objectives. First, there is the available capital, C_e, which is sometimes called the economic capital on the company's balance sheet, and second, there is the minimum capital required by the company to cover the risks in its portfolio, called the «risk-adjusted capital», C_r. This capital corresponds to the amount determined by an actuarial estimation of the combined risk of the insurer's assets and liabilities. The company's solvency ratio, S, is then defined as:

$$S = \frac{C_e}{C_r} > 1 \qquad (1)$$

This ratio must obviously be greater than 1 for the company to cover its obligations and be solvent. The time horizon generally chosen is one year. This applies to both Solvency 2 and the SST. Here, we are going to discuss both the numerator and the denominator of S. This ratio is of paramount importance in determining an insurance company's solvency.

We will start with the economic or available capital, C_e. In the new solvency rules, it is defined as the company's current economic value, based on the assumption that it will not underwrite any more business the following year. That is, at instant t:

$$C_e(t) = V_e(A(t)) - V_e(L(t)) \qquad (2)$$

where V_e is the function giving the economic value of a variable. Here, the variables are A for assets and L for liabilities. This value differs from the economic value calculated by an investor when buying a company. To the value defined in equation (2), the investor would add a valuation of any future business the company is likely to underwrite and the resulting profits. As a result, V_e does not strictly represent the economic valuation. It is simply the conversion of an ordinary balance sheet into an economic balance sheet. V_e enables the C_e to be calculated from the different components of the balance sheet without any other consideration of the company's future than the interest rates to discount the cash-flows. We will not go any further into V_e which merits a paper of its own. We will now consider the definition of the denominator of equation (1), noting that the definition of C_e should be compared with that of the risk-adjusted capital, C_r. The available capital, C_e, must be adjusted when C_r is defined as it traditionally is in the theory of risk, that is, as a variation with respect to the mathematical expectation:

$$C_r = E[X] - \rho(X) \qquad (3)$$

where X represents the random variable, at time horizon Δt, of the change in the company's economic value (usually the sum of the random variables of all the risks of the assets, n_A, and liabilities, n_L, valued economically), defined as

$$X(t) = \sum_{i=1}^{n_A}(A_i(t+\Delta t) - A_i(t)) - \sum_{j=1}^{n_L}(L_i(t+\Delta T) - L_i(t))$$

and ρ is the risk measurement chosen, generally the Value-at-Risk (VaR) or the mathematical expectation of the losses over a certain threshold (TVaR). We have omitted for convenience the function V_e, which should be read implicitly. It should be noted that $X(t)$ is nothing other than the change in C_e at time horizon Δt

$$X(t) = C_e(t+\Delta t) - C_e(t)$$

It can therefore be seen that C_r and C_e are indirectly related and that the definition of one affects the definition of the other.

If C_r is defined by equation (3), equation (2) will not be sufficient to define C_e, i.e. to convert the ordinary balance sheet into an economic balance sheet in order to obtain the economic capital. To do this, the mathematical expectation of the profits for the time horizon considered must be added to the value considered:

$$C_e = V_e(A) - V_e(L) + E[X]$$

Not doing so would be like refusing the gift of a lottery ticket whose profits, even if they are low, are represented by $E[X]$. In this case, equation (3) becomes $C_r = E[X]$ *while* $C_e = 0$ (no pre-existing capital, only a lottery ticket), which would mean a solvency ratio of nil. On the other hand, if we accept that the economic capital C_e contains future profits, i.e. that

$$C_e = V_e(A) - V_e(L) + E[X]$$

the offer of a lottery ticket would be acceptable because the risk-adjusted capital would be offset by the equivalent available capital and the solvency ratio would therefore be equal to 1. This example shows the importance of having coherent definitions when calculating a solvency ratio.

In the case of Solvency 2, it could be thought that the problem is solved because the capital, C_r, is defined directly as the VaR at 99.5% of $X(t)$, and not according to equation (3). However, removing this expectation does not solve the problem at all – quite the contrary – because it is possible to reduce the capital requirements simply

by being optimistic about future income and therefore increasing $E[X]$. By a simple translation effect, the VaR, and therefore the C_r, will be reduced by an equivalent amount. Being over-optimistic about future profits has consequences. It means that C_r can be reduced by paradoxically increasing the company's risk level because the profit expectations are unrealistic. From a healthy risk management viewpoint, this simplified definition of C_r does not seem relevant. This paradox, however, has not been noticed by the European supervisory authorities. Although the SST's definition of C_r uses another risk measure (TVaR) with another confidence interval (99%), the same problem exists because it does not take the mathematical expectation of the profits into account.

It therefore seems that it would be better in terms of incentive to change the definition of economic capital according to: $C_e=V_e(A)-V_e(L)+E[X]$ and keep the definition of equation (3) for the risk-adjusted capital.

We will not dwell any further on how to calculate the economic capital based on the ordinary balance sheet. The Solvency 2 rules are very precise in this respect (pages 49 to 57 of the Delegated Act of 10 October 2014 [European Commission 2015]). We will simply indicate certain issues that have not been resolved and which open the way to various interpretations that are presently under heated discussion. One of these is deciding which interest rate should be used to discount liabilities (Dacorogna 2012). At present, whether we are talking about EIOPA[1] or Finma[2], the supervisory authorities publish their own yield curves to be used by insurers to discount liabilities instead of choosing those deduced from the latest financial market values according to the «mark-to-market» principle. Another question is whether the available capital is really «available» under stress conditions. In other words, the liquidity of the means available to a company under stress is a subject of concern, leading regulators to classify bank capital from most liquid (first tier) to least liquid (third tier) with requirements concerning the proportion of capital covered by each of these classes. The treatment of dividends and deferred tax assets also cause controversy that we will not develop here.

Figure 1

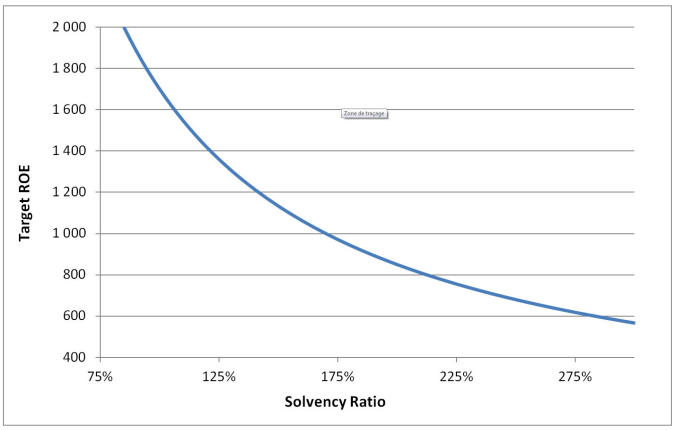


Illustration of the relationship between the company's target ROE (above the risk-free rate) and its solvency target

The lack of precision in defining the economic capital also applies to C_r. We saw earlier that the supervisory authorities did not choose a strict definition from a risk theory viewpoint; risk measure also differs from one system to the other (for a comparison of Solvency 2 and SST, see [Dacorogna and Keller 2010]). Apart from the strict definition of C_e in equation (2), the risk-adjusted capital, C_r, also depends on two other choices: that of the risk measure (VaR, TVaR) and that of the interval at which it is measured (99%, 99.5%). It would be much better if practices could be harmonised and the industry come to a universally recognised definition. Unfortunately, we do not seem to be heading in that direction on an international level given the present discussions between the American and European authorities on the subject.

Each company must nevertheless decide for itself how to optimally deploy its capital based on its own strategy and the method it has chosen to allocate its capital to different risks. To do so, insurers must adapt their practices while satisfying the requirements of the shareholders, the supervisory authorities, the rating agencies and the specific conditions relating to their business. The triangle of constraints constituted by profitability, solvency and market presence becomes the space to be optimised. These three constraints are interrelated of course and one cannot be determined without considering the other two. Whence the question: how much capital is needed to satisfy these different requirements? The art of capital management is to determine the amount required to give shareholders adequate remuneration while ensuring the company's stability and financial credibility. For this reason, the current tendency of insurers is to communicate publicly on both a return on equity (ROE) target and an interval for the solvency ratio defined in equation (1). These two objectives go hand in hand and cannot be defined independently of each other.

(1) The European Insurance and Occupational Pensions Authority / (2) The Swiss Federal Department of Finance

The equation derived in [Besson et al. 2008] gives us a simple expression that relates the target return chosen by the company to its solvency ratio, S:

$$T = \frac{\mu}{S}$$

where μ is the risk premium allocated to the industry by the market at a solvency level of 100%. An illustration of this equation is given in Figure 1 where we have chosen a μ of 1700 basis points above the risk-free rate. This high value is due to the fact that the market does not expect insurance companies to operate at this level of solvency but at a much higher level[3]. Finally, the insurance company's management must decide on the amount of capital needed for its strategy according to the variables T, μ and S, as explained in [Besson et al., 2009].

The management's task will therefore be to manage the capital so as to best satisfy the various insurance stakeholders, all of whom have contradictory viewpoints. They are rapidly described below.

1. The shareholders for whom the capital represents the value of their investment and would like to keep it as low as possible in order to obtain the highest possible return.

2. The policyholders and the supervisory authorities who defend them want to obtain the highest possible insurance capital because it guarantees payment of the liabilities contracted with the company.

3. The rating agencies who conduct an assessment of the financial health of insurance companies to ensure that their credit risk is sound. They expect the company to have sufficient capital to deserve its rating but they also check on its profitability.

4. The management and staff who use the capital to generate the company's profits and also must satisfy the requirements of all the other insurance stakeholders.

Constant balancing is the daily lot of modern companies seeking to adapt to new market conditions and benefit from the new rules governing the insurance sector, while developing their business over the long term.

3. Economic valuation

The basis for evaluating the capital and risks of the insurance industry is the economic valuation of the company's assets and liabilities. We have just seen that the available capital is defined in the Solvency 2 rules as the difference between the economic value of the assets and liabilities, equation (2). The economic valuation of assets is fairly simple provided they are being valued in sufficiently liquid markets. In this case, determining the economic value means finding the market price of the assets concerned. In accounting jargon, this is known as «mark-to-market». However, the situation becomes complicated when assets have to be valued in markets with low and even non-existent liquidity. This is the case for certain derivative products that are traded in over-the-counter markets, or structured products such as CDOs (Collateralized Debt Obligations). During the 2008/2009 financial crisis, some of these assets no longer found buyers and the institutions that owned them or sold them to State-owned funds were forced to value them according to models based on underlying asset prices. It is the famous «mark-to-model» that enabled the savviest, such as Goldman Sachs, to slip through the net.

We have just mentioned the difficulty in valuing non-liquid assets. The problem is increased by a factor of ten when it comes to insurance liabilities which are not usually traded on the market[4]. This was the subject of numerous discussions during the implementation of Solvency 2. To understand what is involved, it is important to briefly review the valuation of insurance liabilities. The two main principles are as follows:

1. The existence of liquid markets for assets and therefore of verifiable information on their prices.

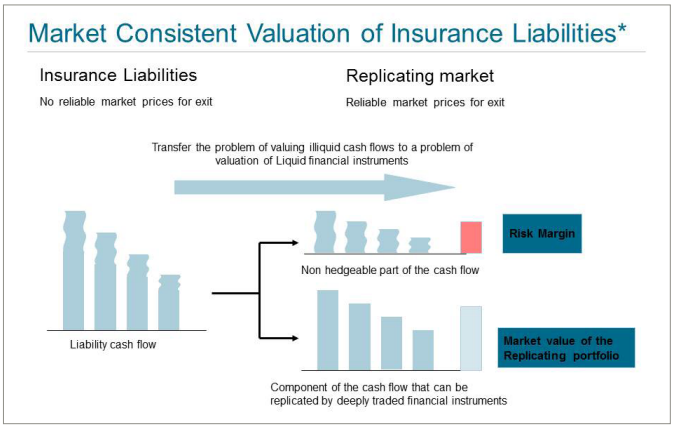
2. The law of one price or single price law which says that: «whatever the future state of the world, two financial instruments with identical cash-flows will have the same market price».

If it can be applied, this law means that the price of a financial instrument can be easily estimated by finding a combination of liquid instruments that together reproduce the cash-flow. This is the idea of the replicating portfolio whose origin lies in an article published by the Swiss mathematician Euler (Euler, 1767) who used this type of argument to discount life annuities. This approach actually consists in shifting the problem of

(4) Certain insurance liabilities, such as natural catastrophe and pandemic risks, now have a bond market but they only concern a very small percentage of the risks insured / (3) We prefer to qualify this high figure even though certain bank managers announce profit targets of 25% without blinking an eyelid

how to determine the value of an instrument without a market, such as insurance liabilities, by looking for liquid instruments whose market prices are easily accessible and reliable, and for which information can be obtained directly. It would work perfectly except that insurance liabilities are subject to violent stochastic variations resulting in considerable uncertainty as to the final result of a policy. These variations do not have any negotiable equivalents on financial markets. The risks related to these cash-flows therefore need to be evaluated and a risk margin introduced that will be added to the value of the replicating portfolio. The risk margin is defined as the cost of the capital that the owner of the liabilities will need to immobilise up until expiration of the policy in order to offset fluctuations not covered by the replicating portfolio.

Figure 2



Diagrammatic representation of the economic valuation approach to insurance liabilities.
Inspired by P. Keller's presentation

Figure 2 is a diagrammatic representation of the valuation process for insurance liabilities. It shows that the problem can be divided into two parts. First, choosing the instruments that will make up the replicating portfolio and second, correctly evaluating the remaining risk once the choice has been made. Only then can insurance liabilities be valued correctly. A discussion between the insurers and the supervisory authorities recently concerned the first point (choice of assets) without considering its consequences on the second point (risk margin). The three choices examined by the EIOPA with the insurers' help were:

1. Using the risk-free rate for replicating portfolio instruments,
2. Adding a premium to the risk-free rate for the lack of liquidity of these liabilities in favour of the insurer who holds them,
3. Adjusting the discount rate to the assets actually owned by the insurer.

The first solution implies that the credit risk has been eliminated from the cash-flow risks to be evaluated. The second implies that the insurer owns instruments with low liquidity, which in turn implies an additional risk if the company has to liquidate its assets to pay for claims. Strictly speaking, the third implies that an asset default risk should be added to the liabilities risk, which of course is not considered by EIOPA and the advocates of the other two solutions.

We have just seen above, but also in Figure 2, that the whole object of the exercise is to find instruments that are liquid and whose price can be used as a negotiating tool. This is obviously not the case for the last two solutions proposed by EIOPA and the insurance companies. Theoretically, the replicating portfolio does not necessarily contain only risk-free rate instruments. However, since the risk cannot be covered by the market, it must be added to the risk premium. Generally speaking, if the valuation is carried out strictly, the value should not change to any significant extent. It would simply be divided up differently. The riskier the instruments, the lower the cash-flow price of the liabilities will be, but the risk margin will be higher to take the asset risk into account. The problem with the current discussion on replicating portfolios is that the question of re-evaluating the risk margin has not been broached. By only considering the replicating portfolio, the value of the liabilities is reduced because they are not valued correctly. These devices are used by the supervisory authorities and the insurance industry to offset the low interest level and to fight the pro-cyclical effect of the regulations. Yet there are other more natural methods that would not consist in «blaming the thermometer for the fever» so to speak. We proposed one such method in [Besson et al. 2010] which would simply consist in being more flexible about the threshold at which the capital is measured (VaR) during a serious financial crisis.

Certainly economic valuation comprises unresolved problems, the first being the one we have just discussed, that is, the definition of assets in the replicating portfolio, while the second is related to the definition of risk margin. The risk margin is defined as the cost of capital that must be held until extinction of the contract's cash-

flows. Here again, two ingredients must be defined: the unit cost of capital which is arbitrarily fixed at 6% by Solvency 2 and the SST, and the capital needed at each stage of payment. This second ingredient also raises controversy. For a study and in-depth discussion of the definition and calculation of capital costs, please refer to Auerbach's original article [Auerbach, 1983], which lays the foundations of the problem and underlines both the difficulties and the limits involved. In principle, the capital required to guarantee payment not only depends on the underlying risk but also on the benefits of diversification offered by the insurer's portfolio. The same contract would have a different value depending on which portfolio it belongs to. This would be a problem for accountants who would want to apply the same sort of valuation to the company's liabilities - this would contradict the accounting principle of making sure that balance sheets can be compared. The same contradiction can also be found in the Solvency 2 regulations which require that companies calculate the risk margins for each legal entity and do not allow re-insurers the diversification benefit of their portfolio as a whole, for example. This difference can be very significant in the case of reinsurance. For SCOR, for example, it means hundreds of millions of euros (Dacorogna et al. 2011) to be deducted from the available capital.

Another problem, which is rarely broached and remains unsolved, is the allocation of capital to the different stages of cash-flow payment. Non-life actuaries are usually capable of correctly estimating the capital needed to cover the contract up to ultimate, but the breakdown of capital over the course of time is not easy. In the absence of a general method, it is often calculated approximately using a simple formula. If Monte Carlo methods are used to estimate the ultimate risk, the remaining capital should theoretically be estimated at each stage of payment. This would mean simulation calculations within the simulation, which is obviously not tractable for payments that frequently extend over several years. Rough approximations are therefore generally used to calculate the breakdown of capital over the course of time and estimate the risk margin without having to carry out complicated calculations. Progress should be made in this respect in the next few years. By defining classes of stochastic processes to develop cash-flows, it should be possible to stick closer to reality and avoid some of the difficulties involved in the economic valuation of insurance liabilities (Dacorogna et al. 2015).

Despite all these obstacles, the economic valuation approach remains central to the new paradigm which has been established in the insurance industry and is not going to disappear any time soon. Opposition is currently focussed on the weaknesses of the method while ignoring the progress it represents in a more realistic valuation of insurance business, and business in general, because it includes the notions of time, risk and market as vehicles of information.

4. The internal model to assess capital needs

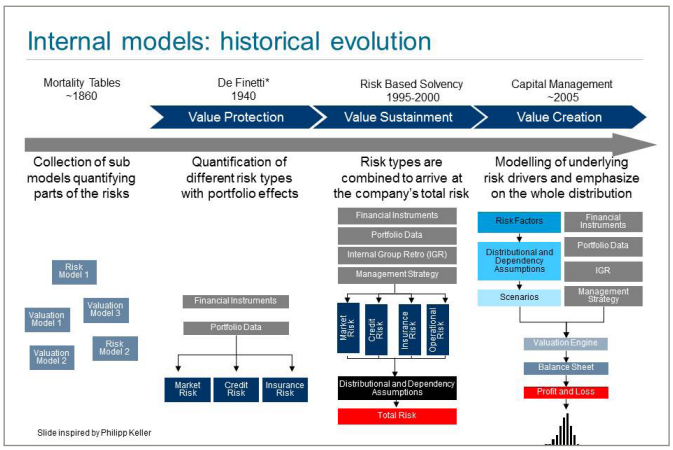
We will now consider one of the core components of this change in perspective caused by the quantitative assessment of insurance risks, namely risk modelling. Today, European regulations, whether Solvency 2 or SST, encourage companies to develop their own models to estimate their risks, or offer them the alternative of using the standard EIOPA formula or standard Finma model. Whatever their choice, companies will need to perform a quantitative assessment of their risks. Some, like reinsurers, who are often avant-garde in this respect, have not waited for the new regulations to perform quantitative modelling of their business portfolio. Swiss Re, for example, has been developing an in-house model since 1993, while SCOR has had its own model since 2003.

The in-house model is used to quantify all the risks to which the company is exposed: underwriting risks (life and non-life), market risks, credit risks and operational risks. The risk of the company's economic balance sheet is estimated by modelling the variable, X(t), defined in equation (4) at a one-year horizon. This variable is considered to be a stochastic variable, usually modelled by means of Monte Carlo simulations based on knowledge of the probability distributions of underlying risks and their dependencies. Since it is a one-year projection, the in-house models include economic planning data in addition to accounting and actuarial data. The integration of the company's various data is one of the collateral benefits of these models. They provide an overview of all the processes involved: economic planning, accounting and actuarial.

Over the years, these instruments have become increasingly sophisticated and complex, but their development is a natural part of the evolution of modelling in insurance which is no doubt one of the first industries to systematically quantify its risks in order to establish a viable business model. We have already mentioned Euler's article written in 1765, which proposes a way to calculate life annuities. The widespread use of mortality tables goes back to the 1860s. Actuarial calculations

in property insurance did not appear until later, at the beginning of the 20th century. Modelling thus began by taking an interest in the risks themselves. In a natural evolution, the actuaries studied the aggregation of these risks in a portfolio. It was an Italian actuary, de Finetti, who first developed the portfolio optimisation theorem in the nineteen-forties (de Finetti, 1940). The theorem was to make Markowitz's fortune in the 50s and 60s when he applied it to the field of financial investments in conjunction with his idea of an efficient frontier (Markowitz, 1952). This first generation of models, whose main aim was to calculate policy premiums, gradually led to the emergence of models integrating all the risks involved to evaluate the capital needed to conduct the company's business. The evolution occurred at the same time as that of banks and the first efforts of the Basle committee to instigate

Figure 3



Development of modelling in the insurance industry

risk-based banking regulations. The beginning of the 21st century was marked by Dynamic Financial Analysis models (DFA) (Blum and Dacorogna, 2004) aimed at determining the company's risk by modelling the balance sheet and estimating the risk measure (VaR or TVaR) related to a change in the company's accounting value.

Figure 3 shows the above evolution by depicting four generations of models. Today, insurers have more ambitious aims for the fourth generation of models. They want them to help generate more value in their business by optimising the asset-liability portfolio, examining the benefits of diversification of the different types of business, optimising reinsurance coverage to reduce the cost of capital and planning the development of the company's business more quantitatively. All these applications go much further than simply assessing the solvency requirements. They require knowledge of the entire probability distribution of any changes in the company's economic value. We have illustrated this by indicating distribution as the end product of the fourth generation of models in Figure 3. It must therefore be possible to use these models to answer the question of "What is the probability of achieving the set target?" And not just «What is the risk at a frequency of once every 200 years»! It is paradoxical that the extremes were considered first, even though by definition the data required to estimate their value is insufficient, while the centre of the distribution where the data is by definition more abundant, was neglected. The most modern insurers therefore use the entire range of data available, which has been reinforced by the advent of «big data»[5] and the possibilities it offers for defining coverage more accurately to optimize the calculation of premiums.

With the implementation of the new regulations, the process for producing the model, in addition to providing data access, is playing an increasingly important role within the organisation. Both the pertinence of the data used and the results produced by the model must be guaranteed. As in the case of balance sheets, much stricter control processes are gradually being implemented. In particular, according to the new regulations, the model must be validated by an independent body. Companies either use external consultants or develop independent capacities internally, alongside the modelling department. A future possibility would be to have the results audited by specialised firms. This is not yet the case, but consultants are appearing on the market who would like to play this role. However, the production of internal models must not be institutionalised to the detriment of the flexibility needed to adapt the methodologies to developments in science and programming techniques. This is one of the dangers facing insurance companies. Risk evaluation requires know-how and qualifications that go far beyond those needed for accounting. Nor will the results of the internal model ever have the precision and accuracy of a corporate balance sheet. The model is concerned with statistical estimations and not the calculation and classification of cash-flows. Assuming that the model is perfectly adequate, these estimations will only ever be accurate to within a few percent, which represents several tens and even several hundreds of millions of euros. This situation is difficult to accept for managers who are used to the precision of accounting figures.

(5) An insurance company such as AXA Winterthur in Switzerland has no hesitation in offering discounts on its vehicle insurance policies if customers agree to put a «black box» in their vehicle to record their driving parameters. It thus collects a substantial amount of data

Table caption:

Internal Model Results for SCOR as published in 2009

Risk capital (RC) of group (net of reinsurance)	Individual RC	Diversified RC	Total portion of RC	Diversification benefit
New P&C business	1200	820	24%	32%
P&C reserves	1600	1240	36%	23%
Life business	1800	900	26%	50%
Investments	970	130	4%	87%
Counterparty and credit risks	280	40	1%	86%
Risks due to exchange rate and other positions on the economic balance sheet	330	60	2%	82%
Operational risks	210	210	6%	0%
Total	**6720**	**3400**	**100%**	**47%**

The supervisory authorities are in the same situation and regard with suspicion any variations in figures concerning the internal model. Yet these are inevitable.

One of the important products of the model is the diversification benefit, in other words, the amount of capital saved by aggregating the risks on the portfolio. The diversification benefit is calculated as follows (Bürgi et al., 2008):

$$D_n = 1 - \frac{\rho(\sum_{i=1}^{n} Y_i)}{\sum_{i=1}^{n} \rho(Y_i)} \qquad (4)$$

where the random variable, Yi, represents a particular portfolio risk and ρ represents, as in equation (3), the risk measure chosen (VaR or TVaR). It should be noted in passing that, although it is of considerable interest, this quantity is not universally defined and depends on the number of risks considered in the calculation. This is why we have defined it with an index, n, in equation (4). In Table 1, we give an example of the diversification benefit as reported by SCOR during its Investor Day in July 2009 (SCOR 2009). Even if they are a little dated, these figures are a good illustration of the advantage to be gained by examining the diversification benefit obtained by a company when the calculation of its capital is based on all the risks involved. It can be seen, for example, that in the case of a reinsurer, investments only represent a small portion of the risk in comparison with the portfolio, although their individual capital corresponds to more than half the individual capital of the company's life insurance business. In the end run, when its main business lines are considered, the company achieves a diversification benefit of 47%, which is considerable. The figures published by other reinsurers are similar. The diversification benefit is essential for this type of business to operate smoothly (Boller and Dacorogna, 2004). Reinsurers therefore take particular care when modelling their portfolios.

To complete this brief incursion into the world of internal models, we would like to mention that at least three types of quantitative model exist for insurance risks:

1. Stochastic-type models based on probability distributions and more or less sophisticated modelling of risk interdependence. Generally speaking, the internal models of companies belong to this category.

2. Deterministic-type models, or factor models. The capital is calculated by multiplying the volume of business by a specific factor (often called the capital intensity). These models are typically used by rating agencies to estimate the capital requirements of the companies they are rating.

3. Scenario-based models. Several scenarios are applied to the economic balance sheet to examine the value of the company in relation to different states of the world. These models, also called stress tests, were applied by the FED to American banks in March 2009. The positive results restored market confidence in the financial system.

Most companies use a combination of these approaches. While deterministic models are preferred because they are simple to use and give almost instantaneous answers to the questions posed, they are not very flexible. Factors that have been determined in certain situations may be less influential in other circumstances or if there is a substantial change in the insurer's portfolio. The other two types are basically the same. Stochastic models are used to explore a large number of scenarios with considerable efficiency. However, the scenarios they generate are rarely identified or comprehensible to their users. Scenarios applied to the economic balance sheet are more intuitive because they are based either on historical values or strategic visions of a possible state of the world in the future. In practice, the latter are often used to verify the plausibility of the results obtained with stochastic models. That is how they are used by Finma which asks its insurers to provide the results of six scenarios in addition to those of the internal model. For more details on the subject of internal models and their developments, the reader should refer to the article by [Dacorogna, 2009].

The quantitative estimation of the company's risks is playing an increasingly central role. We have seen that it enters more and more into the organisation's other processes. It increases the perception of risk in the company as a whole. At the same time, it guides strategic choices and facilitates meaningful discussions on major issues. It does not mean blindly following the results given by models, but any decision to depart from the model's outcomes must be based on solid arguments. This is why insurers are using them more and more and we are witnessing the move towards increasingly industrialised systems that are becoming an integral part of companies.

5. Enterprise Risk Management

We will complete this overview of the fundamental changes in the insurance world due to the implementation of new solvency rules with the still very topical question of enterprise risk management, often designated by its acronym, ERM. For many years, risk management was considered to be the specific duty of the Chief Financial Officers (CRO) and their small teams. They were responsible for ensuring that the organisation was not too exposed and that the designated limits were respected. With everyone working in silos, CROs had to make sure that the sum of the parts did not exceed the capacity of the whole. Most of the time, they reported to the Chief Financial Officer (CFO). This is still the case in many companies. However, new awareness that risk is the very object of insurance has completely changed the perspective. Managing risks means managing insurance business in the long term. It is thus one of the direct tasks of both the Chief Executive Officer (CEO) and the Chief Underwriting Officer (CUO). In the most progressive companies, the (CRO) is directly accountable to the CEO. Within the structure of the board of directors, alongside the strategic, audit and wages committees, there is now a risk committee to which the CEO and the CRO must report. These organisational changes are a reflection of the new awareness that risk management is essential to good business.

Enterprise Risk Management is based on the recognition that there is a risk associated with each performance and the two must be proportionate. The higher the risk, the greater the performance must be and vice versa. Since the company's capital is limited, it must be used in such a way that it will generate maximum profit while guaranteeing the company's financial stability. A point of equilibrium must be found between solvency, profitability and business development. Managing risk thus also means managing the company's performance. The CRO is no longer seen as a spoilsport but as a business facilitator, the person who encourages ongoing development that is commensurate with the company's capacities and market characteristics. What a change of perspective!

Enterprise Risk Management therefore implies the fostering and widespread application of a risk culture throughout the organisation. It concerns everyone in the company. Each person must be conscious of their role and be familiar with the risk management guidelines approved by management, which have the following aim:

- A clear definition of the types of risks that the company wants to have in its portfolio, that is, its risk appetite
- The precise delimitation of its risk tolerance as it can be deduced from the requirements of the various stakeholders (shareholders, customers/regulators, rating agencies and corporate management)
- A clear vision of the risk profile deduced from the two aims set out above
- The establishment of precise limits for each individual risk as deduced from the three elements above, namely risk appetite, risk tolerance and risk profile.

In order to establish this type of culture, the different components must be explained in a series of guidelines available not only to each person in the company but also to all the stakeholders concerned. They are the ground rules, so to speak, established by the company and promoted both inside and outside the organisation.

An efficient and deeply rooted governance structure is obviously required. We saw earlier that changes are taking place that will make risk management a company's core consideration. The role of the Board of Directors, as the shareholders' representative, will be to guarantee that a clear risk appetite and associated profile are established. It is the board that determines the risk tolerance, in conjunction with the General Management, and ensures that this information is understood properly throughout the entire organisation. This not only means greater transparency in hierarchical relations in this respect, but also regular feedback from the lower ranks to the management and board of directors.

To explain this approach more clearly, we are going to illustrate it with a concrete example drawn from our own practice. Establishing an investment strategy in insurance is a complex process that involves several sectors of the organisation. The board of directors and the executive committee define the limits not to be exceeded in terms of capital. For example, they decide that investments must not account for more than 20% of the capital allocated to the company's risk. Once the limit has been determined, the executive committee decides what effective portion of the capital is to be allocated to investments, for instance, 10%. The investment committee must then determine the effective allocation of the capital to the different asset categories according to the assets/liabilities management strategy used to determine both the duration of the bond portfolio to hedge reserve fluctuations due to interest rates and the proportion of the different types of risky assets that will optimise the performance of the investment portfolio without exceeding the allocated limits. On this basis, the managers, who are responsible for carrying out the transactions on the market, will receive a risk budget that they then have to optimise. It can be seen in this example that the ERM approach concerns every level of the company and that communication in both directions is essential to the execution and effective control of the strategy.

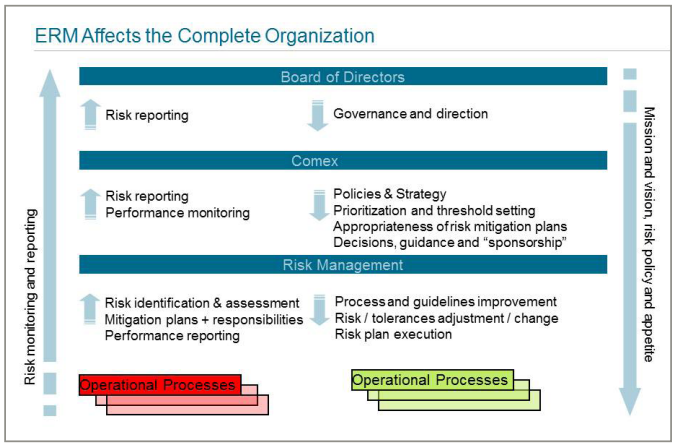
This necessary transparency is illustrated in Figure 4 showing the different responsibilities required for good risk management and the correction of faulty operational processes (in red). It can be seen that the risk culture must be widespread within the organisation and have feedback systems at every level. This is the basis on which enterprise risk management can be built according to the following three pillars:

1. Quantitative assessment of the risks based on a model of the company's portfolio

2. Monitoring and management of emerging risks

3. Development of risk control and signalling processes

Figure 4



Diagrammatic representation of risk management transparency policy

The first pillar was discussed at length in the previous section.

The second pillar is an essential component of risk management to prevent the company being taken by surprise by the emergence of a devastating risk such as the discovery of the consequences of using asbestos or the change in French legislation concerning the reimbursement of automobile accidents which went from a system of awarding damages to the payment of annuities. Continual monitoring must be organised within the different departments to identify and evaluate potential risks and propose ways of hedging their consequences. For the first mission, both internal sources and all possible external sources will be used. An example of using external resources is that of a company in the US that digitalises all the scientific articles published each year on chemistry and biology (more than 50,000!) to determine the number of times certain substances are mentioned, which is seen as an indication that side effects of the substances are being discovered. The

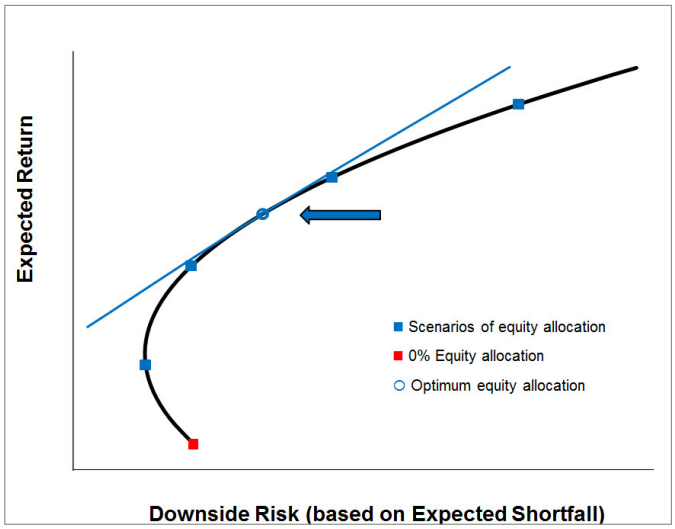
consequences of such risks are evaluated by involving all the parties concerned in the organisation, including the finance department to examine the financial impact and study hedging possibilities in financial markets. Various measures can be taken if a risk is identified: the search for a hedging strategy with reinsurers or on financial markets, imposing of new limits on underwriting, changing of insurance contracts and, as a last resort, securing access to liquidity through contingent capital contracts, for example. To conclude this brief reminder of the measures to be taken to prepare for emerging risks, we should point out that it is important to draw lessons from those which have already appeared by setting up specific procedures to manage them.

The third pillar of enterprise risk management is, of course, the control and information processes which must be present at every level. This means identifying, prioritising and controlling any possible sources of risk. We have already spoken of the importance of precise, written guidelines which must be known throughout the organisation. In addition, these rules must also include clear procedures concerning the risks incurred if they are not respected. None of the above would make sense without the existence of regular processes to measure the application of limits. Here, the internal model is a precious tool because it pools all the portfolio data available, but it is not enough. Tools to control accumulated exposure to risk are indispensable complements. All the major reinsurance companies, for example, have developed IT platforms to monitor their exposure to natural catastrophes. They are used to compare the business volume to the limits defined and produce reports that will be used in the CRO's quarterly risk dashboard presented to the company's risk committee and board of directors. The risk dashboard, which is a short document consisting of several pages of text and images designed to rapidly visualise the problems involved, is an indispensable communication tool at management level. The aim is to regularly produce a rapidly accessible inventory. The effort required to produce this summary report involves reflection on crucial points by all the company's different structures.

The European regulations, with Solvency 2 and, soon, the American regulations, have highlighted the efficiency of ORSA (Own Risk and Solvency Assessment) to complement quantitative risk assessment. Reports are developed alongside the regular and economic balance sheets which will provide an assessment, so to speak, of the company's risks and identify its strengths and weaknesses in this respect. ORSA is becoming an increasingly important component of the corporate reporting system and fits in perfectly with the third pillar of enterprise risk management.

The risk culture and the three pillars are the substrate that makes strategic risk management possible. As we have already pointed out, this type of management focusses on balancing risk and performance and is aimed at optimising the portfolio accordingly. An example of this type of management can be seen in Figure 5.

Figure 5



Efficient frontier of assets-liabilities portfolio as a function of the share breakdown of investments

The portfolio's efficient frontier is shown as a function of the risk measure considered (here, TVaR) and the breakdown of the company's asset portfolio. The aim is to determine the strategic allocation of assets. The frontier is based on modelling the portfolio as a whole (assets and liabilities) where the proportion of the investment in shares is made to vary from 0% to 25%. It can be seen that a portfolio that only contains bonds (first point on the curve on the left) would not be on the frontier. A minimum risk can be expected with a portfolio containing 5% shares. This will therefore be the lower limit of strategic allocation. The upper limit is determined by the maximum authorised risk capital which, here, is about 16%. The optimum point will be obtained at the point of contact between the tangent, whose slope will be equal to the company's profit target, and the efficient frontier curve, here 12%. The strategic share allocation will therefore be between 5% and 16% with an optimum allocation around 12%. The investment committee will

then have the task of fixing its tactical allocation within these margins depending on the strategic indications provided. The importance of good risk quantification can be seen here as well as the usefulness of the internal model combined with a clear process for defining the strategic allocation. This is a far cry from the discussions held by management bodies in the past on portfolio share allocation. The capital and how it is used is now the main focus and enables the different business proposals to be assessed accordingly. The very aim of Enterprise Risk Management is to make the most of the capital at the company's disposal in order to achieve the company's performance objectives.

It can therefore be seen that ERM is a logical development of insurance practice. It affects the entire organisation, it highlights the value drivers of insurance, it allows us to measure the performance of the business and it helps to make the company more transparent for all stakeholders. It is not a passing fad that the companies are forced to accept. Enterprise risk management is simply a more professional way of approaching business. It will therefore be the backbone of insurance in the future. It requires long-term commitment on the part of all the company's structures in order to achieve excellence. In the words of Aristotle: «We are what we repeatedly do. Excellence, therefore, is not an act but a habit.» This maxim expresses a wisdom that applies to ERM one hundred percent.

6. Conclusion

We have come to the end of this review of the changes experienced by insurance companies with the implementation of Solvency 2. The arrival of the new directive spurred on a process that had already started well beforehand, under the pressure of financial markets and liberalization of the capital and insurance markets. Social protection and security requirements encourage insurance companies to think about the best ways of offering consumers high-quality services at the lowest price. They have to adapt their practices accordingly. The 2008/2009 financial crisis showed the importance of relating performance to risk. The resilience of insurance companies during this period is also evidence of more consistent risk management on the part of institutions that have always been faced with extreme risks.

In insurance, we are moving from cash-flow management to risk and capital management. This implies long-term commitment and, as we have seen, a fundamental reorganisation of the company's structures. The quantitative approach is becoming increasingly important. Actuaries are coming out of the wings onto the stage. They are now in the front line and must answer the company's basic strategic questions. Internal models and complex IT systems to process large amounts of data are becoming core activities. Following the example of banks, the industrialisation of quantitative activities is on the agenda everywhere. In addition to the production of ordinary balance sheets, economic balance sheets and risk assessments will now be regularly produced and published with ORSA and the third pillar of Solvency 2. This practice should encourage transparency and market discipline.

There are numerous limits and controversies concerning the application of these new standards. We have mentioned some of them in these pages. Many are related to the application of economic valuation to insurance contracts. Economic valuation was initially designed for short-term financial instruments. The methodology must be adapted to the specific conditions of insurance contracts which, by definition, are long-term commitments, particularly in life insurance. What risks should be attributed to time? And, as a result, how much capital should be allocated? This question remains largely unexplored and should find a satisfactory theoretical answer in the future. This should solve many of the problems still posed today. However, since the advantages of economic valuation largely outweigh its drawbacks, it is clear that this approach will override the others and there will be no going back. Enterprise Risk Management will soon be part of insurers' DNA. The path is long and thorny but there is no question about the direction in which it is going.

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