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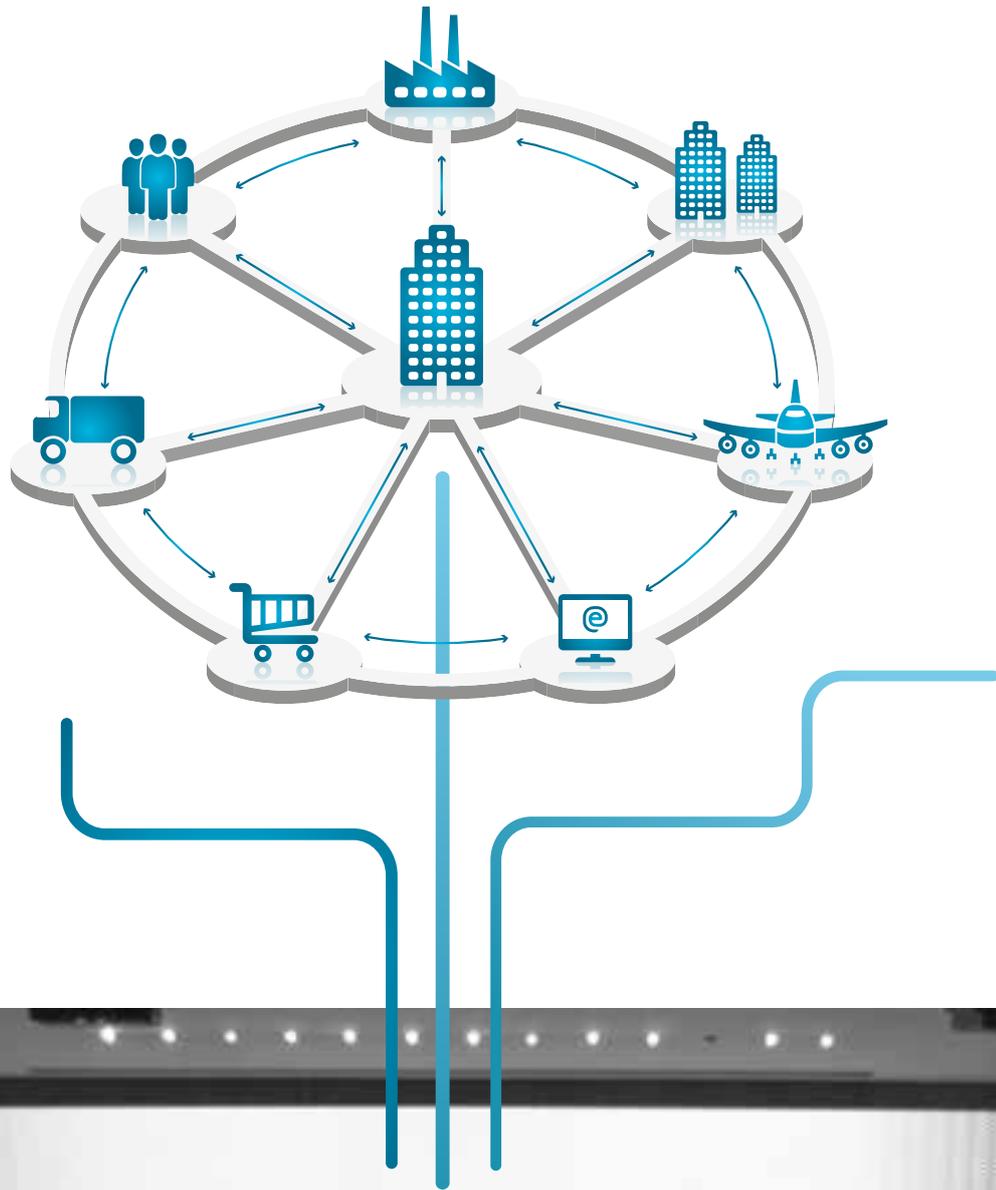
April 2015

Gaining a strategic edge through capital management

Key issues faced by the P&C (re)insurance industry

SCOR Global P&C

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through capital management
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SUMMARY

1

CAPITAL MODEL AS A STRATEGIC DECISION MAKING TOOL

DENIS KESSLER
Chairman & Chief Executive Officer
SCOR SE

Under the pressure of regulators and capital stakeholders, capital management has now become one of the main preoccupations of (re)insurance leaders. Managing the capital of a (re)insurance company is all about optimizing capital under multiple constraints and seemingly conflicting objectives, such as solvency, growth and profitability (see Figure 1).

For example, a (re)insurance company can grow organically or by acquiring other companies and portfolios. These strategies can create new risks to the company, since new business may not be of the same quality as existing business, and since the company may venture into unknown markets. Also, growth is capital-intensive for regulatory reasons. Very strong growth is therefore likely to decrease solvency. If the (re)insurance company is seeking a very high level of profitability as well, there will necessarily be a trade-off because increasing the solvency position decreases the return on equity for shareholders.

At SCOR, we have decided to focus on only two targets: the expected level of profitability and the expected level of solvency. Growth is not a target in itself. In other words, we aim to reach both our solvency and profitability level targets and then determine the growth we can achieve within this given framework.

Figure 1: **Capital stands at the confluence of seemingly conflicting objectives**

Defining and managing the risk appetite

As part of its capital management, a (re)insurer's risk appetite defines the risks it will and will not take (see Figure 2).

Figure 2: **Definition of a (re)insurer's risk appetite – profitability according to risk appetite**

Profitability according to risk scenarii depends on risk appetite

1. A higher risk appetite leads to a higher profitability gap between favourable and adverse scenarios

2. The blue curve corresponds to a higher risk appetite than the green one

Source: SCOR internal model
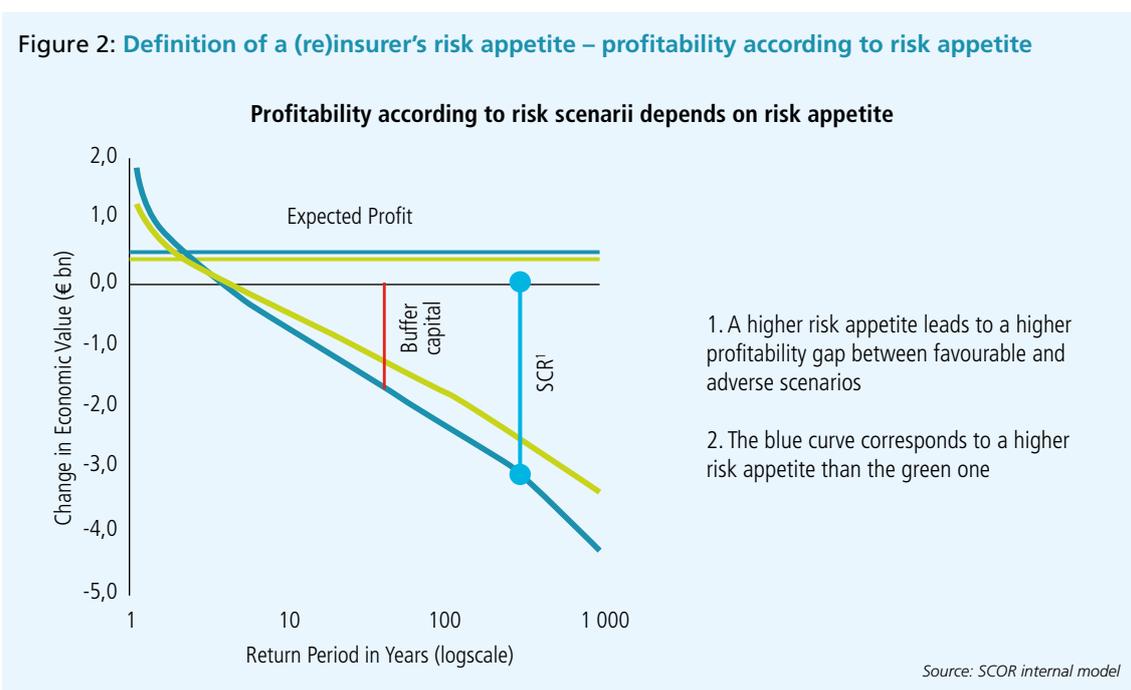
Risk appetite is very personal and differs from one (re)insurer to the other. Each company has a degree of risk aversion, regardless of whether it is a risk taker, a risk avoider or risk neutral. Whether the risk appetite is low or high, it is extremely important that the management properly understands the consequences of its company's risk appetite.

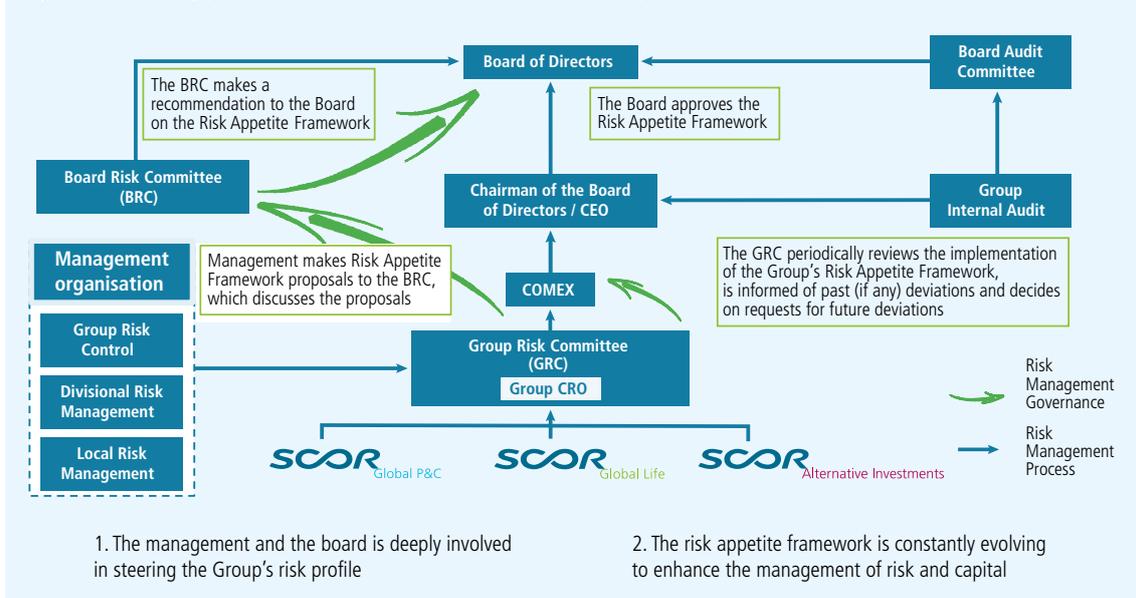The board of directors, as a representative of the shareholders, is responsible for determining the risk appetite of a company, which is explained to the shareholders, the rating agencies and all stakeholders. The bigger the risk taken, the higher the expected profit. It is for the board of directors to decide how much capital the company is prepared to lose under a given probability.

_____

(1) SCR: Solvency Capital Requirement.

Risk management at the heart of decision-making – The example of SCOR

Once the risk appetite has been defined by the board, it has to be embedded in the company's decision-making process. At SCOR for instance we have chosen a mid-level risk appetite, which is revised every three years. The following figure (see Figure 3) shows the decision-making process around the risk appetite framework at SCOR.

Figure 3: Risk appetite framework and decision-making at SCOR

1. The management and the board is deeply involved in steering the Group's risk profile

2. The risk appetite framework is constantly evolving to enhance the management of risk and capital

SCOR's risk appetite framework is an integral part of its strategic plan (see Figure 4).

Figure 4: SCOR's Risk Appetite Framework as part of its current strategic plan, "Optimal Dynamics"

	"Optimal Dynamics"		
Risk appetite	• A mid-level risk profile (after hedging) with a focus on the belly of the risk distribution, avoiding exposure to extreme tail events, but aligned with the increased size, diversification and capital base of the Group • Volatility is controlled through diversification and Capital Shield Strategy		
Risk preferences	• Business focus on selected reinsurance risks • Most mainstream insurance risks covered in Life and P&C, with a recalibration reflected in an increase in longevity risk and a slight increase in Nat Cat risk • Low appetite for interest rate risk (at least in the short term) and no appetite for operational risk, clients' asset risk, financial Directors and Officers liability insurance, Guaranteed Minimum Death Benefit new business		
Risk tolerances	**Solvency target**	**Capitalization level** SCR, Buffer capital and flexible solvency target driving a process of gradual escalation and management responses	
	System of limits	**Risk drivers (probabilistic)** Post-tax net 1:200 annual aggregate loss for each risk driver ≤ 20% Available Capital	
		Extreme scenarios (probabilistic) Post-tax net 1:200 annual per-event loss for each risk ≤ 35% Buffer Capital	
	Limits per risk in the underwriting and investment guidelines		
Footprint scenarios	Impact assessment of **past events (deterministic)**		

At SCOR, the risk appetite framework encompasses three complementary concepts: risk appetite, risk preferences and risk tolerances.

The risk appetite defines the quantity of risk that SCOR wishes to accept to achieve at a desired level of profitability. This determines where SCOR wishes to position itself on the risk-return spectrum, between extremely risk averse (i.e. low risk-low return) and extremely risk prone (i.e. high risk-high return). In terms of risk appetite, SCOR has decided to focus on the "belly" of the risk distribution rather than on the "tail", meaning it avoids exposure to extreme events. As mentioned before, SCOR currently uses a target solvency ratio range and a target expected profitability to provide a complete definition of its risk appetite. Volatility is controlled through diversification and the capital shield strategy. SCOR aims to maximize profitability within its risk appetite, and has had the lowest volatility in the industry since 2005.

The risk preferences are qualitative descriptions of the risks the Group is willing to accept. SCOR selects the reinsurance risks it insures and covers mainstream insurance risks in Life and P&C. SCOR has no appetite for interest rate risk. This is illustrated by the fact that SCOR does not provide guarantees for capital or returns and has no variable annuities. SCOR has no wish to cover any kind of market risks on the assets associated with the liabilities of its clients. Moreover, SCOR has no appetite for operational risk.

Once the risk appetite has been defined and translated into risk preferences, the **risk tolerances** define the limits set in order to ensure that the Group's risk profile remains aligned with its risk appetite framework. The Group uses various risk measures to define these limits, which can take several forms depending on the technical constraints or the level of information available, and may be based on either model outputs or expert opinions.

SCOR's tools to define limits

SCOR has created the **"risk driver" system** which ensures that the Group's annual aggregate exposure to each major risk is well managed. The objective is to avoid overconcentration of risk and hence maximise diversification benefits. The amount of retained annual exposure per main risk driver (net of tax and with a probability of 1-in-200 years) is limited to 20% of the Group's available capital.

SCOR also uses the **"extreme scenario" system**, which is designed to avoid the Group's overexposure to one single event. The amount of retained exposure to each defined extreme scenario (net of tax with a probability of 1-in-200 years) is limited to 35% of the buffer capital, where the buffer capital is defined as a certain point on the economic value curve (see figure 2). As a consequence, SCOR uses limits per risk in its underwriting and investment guidelines.

Figure 5 shows the estimated impact of these extreme scenarios, demonstrating that such losses would remain within the limit that SCOR has set, i.e. 35% of the buffer capital.

Figure 5: **Extreme event scenario losses**

Estimated post-tax 1-in-200 year annual one-event exposures in € m

Scenario	2013	2014
Major fraud in largest Credit & Surety exposure	130	210
US earthquake	210	330
US Caribbean wind	380	540
EU wind	280	350
Japan earthquake	170	150
Terrorist attack	390	390

2013 limit 35% buffer ~ € 570 m

2014 limit 35% buffer ~ € 580 m

All exposures are represented post-tax (15% haircut)

In addition, SCOR has created the **"footprint scenarios"**, which provide a further complementary deterministic risk assessment. The "footprint approach" consists in carrying out an impact assessment on the Group under a deterministic scenario. For Nat Cat risk,

SCOR has selected key historical events to assess their impact on an as-if basis on its current portfolio / in-force covers, providing reassurance that the Group's solvency is today resilient to such events.

SCOR's Internal Model

At SCOR, exposures are monitored thanks to the Group's internal model (see Figure 6).

Figure 6: **The structure of SCOR's internal model**
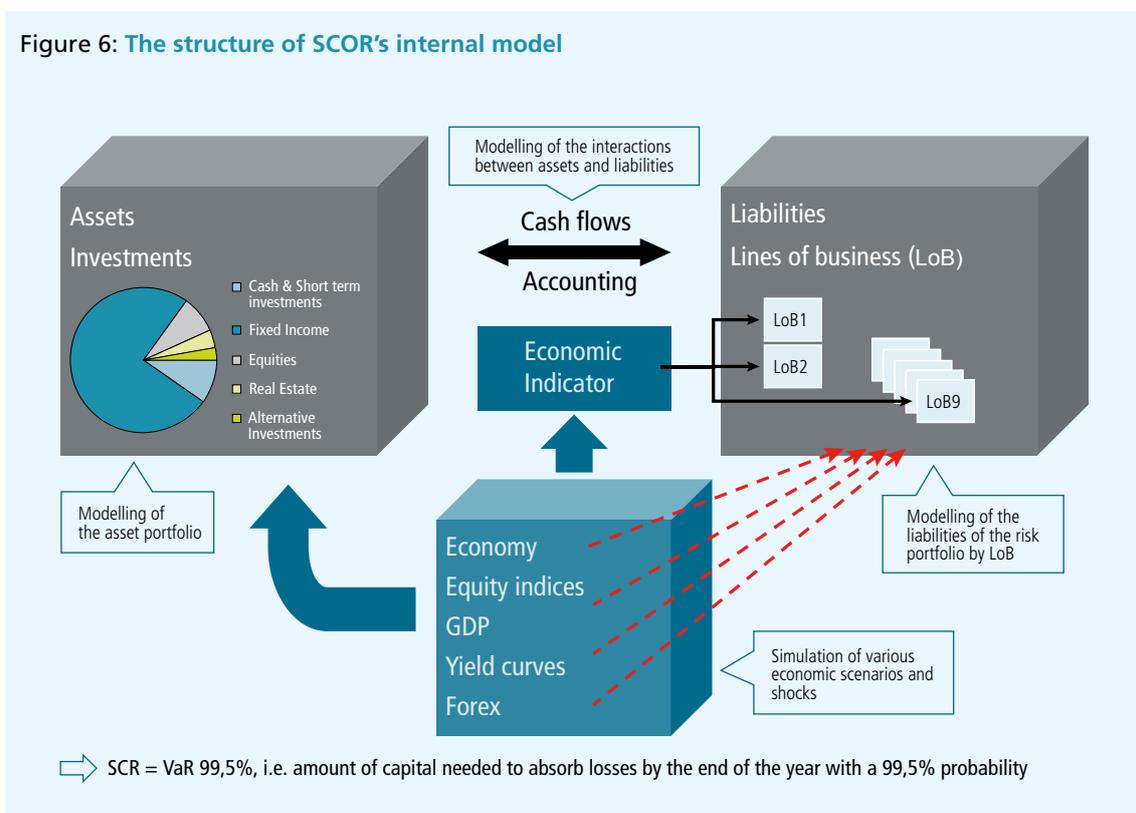
SCOR uses its internal model for its underwriting plan, to verify its consistency with the risk drivers and risk limits. The internal model is used for assessment management, ensuring that the correlations between liabilities and assets are taken into account. SCOR uses the internal model as an operational tool to help the management monitor compliance with all the limits that have been set.

The internal model demonstrates that it is very important to choose a level of risk and subsequently maximize the diversification both between and within business lines.

SCOR believes that diversification is an excellent way to balance its capital base. Today our group premiums are allocated to Life for 54% and Non-Life for 46% and we estimate that this saves around 27% of our capital needs.

Day-to-day capital management based on the internal model _____

The optimal level of capital is the level at which the targeted level of profitability can be reached, while satisfying risk appetite. Having too much capital is suboptimal since it decreases the return on equity. Having too little capital is also suboptimal because it prevents the company from protecting the interests of shareholders and carrying out its underwriting policy according to its risk appetite. It is therefore all about finding the point where the optimal capital amount is situated.

This is why SCOR has developed a **solvency scale** (see Figure 7) driving a process of gradual escalation and management responses, which associates board and management actions with different levels of solvency position based on SCOR's internal model. In the optimal range, the management's role is to simply fine tune the asset management and the underwriting policy of the company, ensuring that it stays on track. In the suboptimal zone, the underwriting and investment strategy must be redirected to return to the optimal zone. SCOR checks this level periodically to make sure that it is on track. The real issue is not how to get onto the optimal track, but how to return to it when derailing.

Once the optimal capital requirement has been targeted, capital structure can also be optimized, with for a (re)insurer, a mixture of shareholder's equity, subordinated debt and contingent capital as capital sources.


Figure 7: **SCOR's solvency scale: management and board actions associated with each level of capital position based on SCOR's internal model**
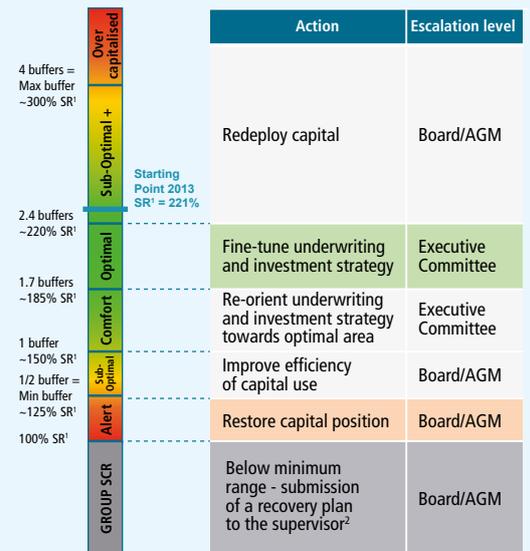
1) Asper Group Internal Model, ratio of Available Capital over SCR
2) When Solvency II comes into force - Article 138 of the Solvency II Directive

Source: IR Day September 2014

To conclude, it is essential to bear in mind that capital has to be managed constantly. For this, (re)insurers must set up a process based on the risk appetite definition, the definition of risk tolerances, a day to day calculation of the capital requirement and solvency position, together with the board and management actions associated with different levels of solvency position. We finally believe that being able to use capital model as a strategic decision making tool provides (re)insurers a key competitive advantage, and position them best in a winning long-term strategy.
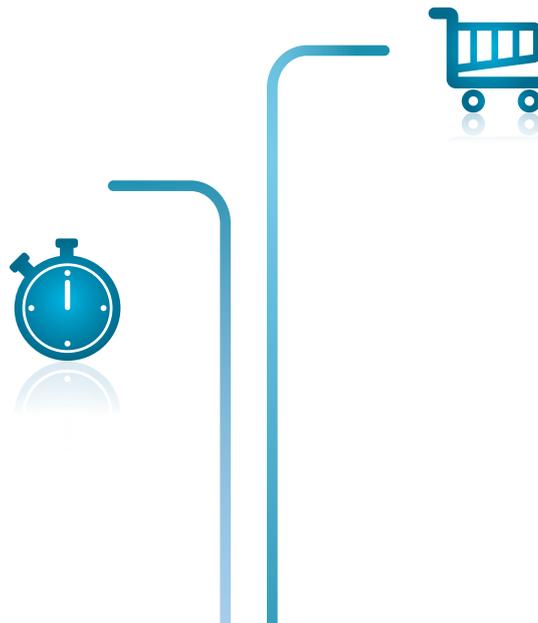
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THE REINSURANCE STRATEGY
OF THE FUTURE

CHRISTIAN DINESEN
Director
Dinesen Associates Ltd

I started in the insurance industry as a reinsurance broker in 1984, and it has never been boring. In 1986 I joined Texaco, a major oil and gas company, and became the European risk manager. It was a very interesting time, where transparency was non-existent. I had the chance to see improvement in the business.

In 2008 investments banks replicated the London Market Excess of Loss Spiral with something called the Collateralized Debt Obligation (CDO). This is where something is securitized, it's leveraged and you are basically four levels away from the risk, just like with a retrocession. If you get too far away from the risk, you lose sight of what is going on. That didn't stop anyone from doing it in the past, and one investment bank lost USD 30 billion in one quarter in the process.

History

Have the claims been paid? Has there been litigation? Have traditional prices fluctuated? Yes, but traditional reinsurance has actually worked extremely well for many years. Only one reinsurance company failed because of the World Trade Center. The other rated reinsurers did come through this catastrophe, which was not exactly the case with banks.

Evolution

The buyers of (re)insurance are more aware of their retention capabilities. They are aware that centralized buying is helpful and that the establishment of captives can be a helpful mechanism, allowing for the combination of long-term, strategic and short-term opportunistic risk transfer. Once the captive has been established, it's generally not abandoned. Similarly, ILS is probably here to stay after being cycle driven by the cost of traditional reinsurance between the late 1980's and until 2006.

Alternatives – Reinsurance and ILS

- Reinsurance, including ILS, is targeted risk transfer covering insurance risk.

- It does not cover investment, operational or reputational risk.

- It is paid up front with loss of investment income on premiums.

- Impairing reinsurance results in higher future premiums and/or retentions.

- It is important to remember that reinsurers exist only to insure insurers, they understand insurance and insurers and are looking for profitable insurance business.

- Insurers' management is not incentivized by the reinsurance result.

For 10 years I covered insurance bonds issued by SCOR and many other European insurers and 90% of the fluctuation of the spreads of these bonds was due to the asset side of the (re)insurers. The liability side, which is where reinsurance works, never really moved the spreads because they worked.

Reinsurers are insurers. They are insuring insurance companies and they actually do know what it is about, which is very important. You have, as a buyer of reinsurance, somebody who understands what this business is. This is not the case for capital market investors. Capital market investors know about the valuation of the shares of the bonds, but they are not really insurance or reinsurance people.

Alternatives – Debt capital

Debt can be loss absorbing for all risks and, almost always, ranks below policyholders in case of default. The consequences of impairing debt range from reduced financial flexibility to rating actions, regulatory action and corporate default. If you impair a reinsurance policy during a soft market, nothing happens, but in a tough market a higher premium has to be paid.

If coupons are not paid or a bond is not written down, you will get out of business. Companies who have had their bonds impaired and who did not pay their coupon are just a distant memory now. There is one large insurer that did not pay a coupon and is still around only because it has very supportive policy-holders. You can compare reinsurance with some debt capital, but if you impair it, the consequences are radically different.

Debt investors are not banks and they do not have to buy insurance debt. There are many places to invest money and insurance bonds are just one choice. I do not know of one specialist insurance bond fund in Europe. There are a lot of funds that have insurance bonds in them, mainly financial funds with banks and insurance, but none of them are required to have insurance bonds.

The debt capital market has a limited understanding of insurance. Our life is dependent on people who do not really need to invest and who do not know much about it. It is important to be aware of this when deciding.

Equity covers everything. It doesn't just cover the insurance risk. In fact, it's very rare that it covers the insurance risk because that's where the reinsurance programme works. The reinsurance programme protects the equity, but the equity protects everything.

If you impair equity, there are consequences. Equity and credit analysts don't understand insurance the way reinsurers do. A lot of insurance analysts do have some benchmark and they do need to own some insurance, but not in large quantities.

Alternatives – Interactions

REINSURANCE BUYING, AND PARTICULARLY RETENTIONS, SHOULD BE RELATED TO CAPITAL

People don't look at their capital and think reinsurance is affordable, so they are ready to invest it. They ask how much they need to buy, depending on how much capital they have. Then of course when the market is soft, they will say they don't really need to buy it, but if it's being given away for free, they will take it.

REINSURANCE BUYING CAN REDUCE CAPITAL REQUIREMENTS

CEOs of some reinsurers don't think Solvency II has improved their business. Is that completely true? I know many insurance companies who will not

survive in a Solvency II requirement without buying more reinsurance. What a fantastic opportunity for the reinsurance market.

MODELLING THIS IS POSSIBLE FOR AN INDIVIDUAL COMPANY BUT DIFFICULT GENERICALLY

Is it just a question of the cost of capital and can't you simply compare the cost of capital for buying reinsurance versus equity, versus debt, etc.? The answer is no. The reason is that there's a very different approach to the risks that these cover. Reinsurance and ILS cover insurance risk; debts and equity capital cover all risks. Comparing the cost of capital for these is very complicated.

Alternatives – Market risk

When working in an investment bank, you understand that things can go really wrong when a group of people decide they're bigger than the market and they can control it. Either they get locked up by the regulator or the market steamrolls them. There's been a rate on line volatility in the reinsurance market and those of you who buy it over a long period of time know that, that's what's going to happen. But both reinsurance and the capital markets are volatile. Do not believe that you're going to be able to play it right with both. I like the alternative strategy. I like the idea that you can now use different things, but they both have market risks and they can both go wrong at the same time.

An illustration of how little investors understand about insurance: a reasonably sophisticated investor told me that they had been proposed some CAT bonds that were paying 4.5%, and he thought getting paid 4.5% for credit risk that is totally non-correlated sounded really good but it was not credit risk; it was volatility risk.

To demonstrate how correlated these things can be, you can have an earthquake like the one in Kobe, where they have a "just-in-time" economy. They don't

have raw materials and they have to import everything very quickly, which is very expensive. Consequently the stock market gets upset, and it falls a bit. At the same time, you have somebody sitting in a 100 year-old investment bank in Singapore and betting on the Nikkei index. That investment bank doesn't exist anymore. How can you tell me that these things are not correlated? This is a complete correlation between an earthquake, a stock index and the financials market. It's not causation, it is correlation. People need to be much more questioning of this idea that things are not correlated. Correlation is the single most difficult concept I have ever worked with.

It is important to note that capital markets have more alternatives than reinsurers do have. Reinsurers don't have to insure and reinsure everyone, but they have to reinsure someone or they have no business. The capital markets do not have to buy your bonds and buy your equity and buy your ILS. If you look at the ILS market, there are two things about it that I really worry about. One is the capital market. At these low interest rates, when it's very difficult to get 3% on anything at all, then CAT bonds look really nice. But

when we have 5% interest rates, will they still be attractive? They most probably won't.

Secondly, after 30 years in the reinsurance business, we have never had a big loss. The World Trade Center, though a terrible tragedy that changed many things in the world, "only" cost USD 40 billion. Large investment banks could lose that in a quarter. When we will have a USD 400 billion loss, which I think is what the biggest potential European storm is modelled for, let's see what the ILS market and what the reinsurance market will look like. The real difference is that the reinsurance market has taken a few hits before. The idea that we have never had a big loss is quite intriguing.

Decision process – Balancing security with cost effectiveness _____

Let's say you have bought a reinsurance programme and that you now know much more about your capital. Then you decide to get some alternatives, and buy some ILS. Then a big loss occurs like the one mentioned above and you have to go into your boss and explain…

It's very hard to get fired for buying traditional reinsurance. It is a good alternative to buy some ILS, but it is important to understand it and understand the incentives of the people who invest in ILS who provide cover. Alternatives are good, but just remember that when it gets properly challenged by something it has not faced before, you will be the one who has to explain it to your boss.

Traditional reinsurance will continue to play a major role for a very long time to come. If you want cost effectiveness, if you want this to be as well priced as possible, you need to be aware and possibly consider some alternatives like the ones that have been mentioned.

We have not seen a serious challenge to ILS. Also, I know that the capital market does not understand you as well as the reinsurers do. I don't think most people who buy ILS understand the incentives of ILS investors well enough.

If you're going to have a strategic approach, an important word is balance. You need balance between greater risk retention, smaller risk retention and capital, and a balance between tradition and innovation. If you can do all those things, you will have a really good strategy. It does require the four drivers: risk retention versus reinsurance buying, or traditional versus alternatives.

Remember market risk. If you think pricing volatility can be bad in reinsurance, try and have a look at some of the capital markets. They could really teach you something about volatility. Reinsurance is stable compared to the capital market.

There's still scope to improve how people look at the short term versus the long term. The current environment where everything is cheap is very tempting, but we all know that there could be a future when interest rates and inflation will be different. Don't try to take advantage of everything this year, just remember that there will be another year and remember who you will be working with at that time.

3

AN INSURER'S PERSPECTIVE ON REINSURANCE BUYING:
RECENT TRENDS IN THE REINSURANCE MARKET IMPACTING THE PURCHASE IN THE P&C INSURANCE INDUSTRY

STUART FORBES MCMURDO
Head of Reinsurance
Santam Limited

Santam is based in Cape Town and has been in business since May 1918. The Group's premium volume at the end of December last year was around USD 2 billion, with a gross underwriting margin at the half year of 7.5%. Return on capital stood at just under 30% with a market share of approximately 23%. We have a reinsurance spend of just over USD 250 million, so reinsurance is an important part of our world.

In South Africa we see business from as far afield as South Korea and China through our inwards reinsurance operation, while through our Group we are invested in India, Malaysia and across Africa. Santam has an extensive branch network across South Africa and into Namibia, so we have a very strong emerging markets bias in what we see. We have been around for 96 years which has allowed us to develop a well-diversified business with a unique footprint of South Africa with 700,000 policy holders. Santam was proud to be ranked the top insurance company in Africa in 2012 by PricewaterhouseCoopers (PwC), with the most technically qualified employees in the market.

At Santam we talk a lot about what is changing and what is affecting our business. We have identified ten meta-trends that are shaping our future. Among those ten, we believe there are three that are driving change in the reinsurance industry. All these trends touch the insurance industry and, by default, they touch the reinsurance industry. For us in the reinsurance

purchasing world, we believe that the three big impacting factors are the power and knowledge shift, the digital world and low barriers to entry.

POWER AND KNOWLEDGE

Across the board we have capital markets moving into the arena of reinsurance, creating a shift around the reinsurance world as we know it. This shift has been enabled through vast amounts of information and technology that are available to these alternative markets. It makes these markets feel informed, rightly or wrongly, facilitating the deployment of this capital into the reinsurance world.

DIGITAL WORLD

Also a significant element of change in the reinsurance space, information is moving quickly from place to place. We are able to place risk all around the world and are no longer limited by geography or time zone. An email can be sent off to somebody on the other side of the world and deals are often done within a day. We have over 65 reinsurers on our panel ranging from China to the U.S. and the time zone is no longer an issue. Speed and ease of access is the new norm for the reinsurance marketplace. If you are slow, you are out and if you are quick, you are in business.

LOWER BARRIERS TO ENTRY

Large investment funds seek out yield in this world of quantitative easing that we live in. It seems somebody has decided that the Holy Grail of profits is reinsurance, though these vehicles haven't really been tested by any major losses. Entry is being facilitated by the very companies it most threatens, the large reinsurers.

WHY WE USE REINSURANCE AT SANTAM

We cluster our reinsurance essentially into three categories. The first priority is to reduce the volatility of underwriting profits, protect our balance sheet and facilitate and protect adequate solvency.

We want to stabilize earnings, protect our capital and be able to use this capital efficiently, at the same time making sure that our solvency is adequate and remains intact. To be able to do business, we need to be able to spread the concentration of risk around, which is what we use the reinsurance market for, eliminating Cat exposures and large single risks.

We have a defined risk appetite which we use for both single risks and Cat perils, but in order to be a meaningful player in the market and to be competitive you have to leverage off of trusted reinsurance capacity. We are able to access reinsurer pricing that we believe is cheaper than the cost of us carrying the risk. Finally, and perhaps most importantly, does the intangible element of the value added through our relationships give us access to the broad global market knowledge of our reinsurers?

There are three key points that highlight Santam's relationship with its reinsurers.

- **Training:** Many of the major reinsurers offer valuable training. We send our staff regularly to different reinsurance companies and brokers so that they can profit from the training programmes on offer.

- **Expertise:** SCOR is our chosen lead on our engineering portfolio because it has the specialist expertise. What drives that position is not price, not capacity, but the ability to go to SCOR, ask questions and get comprehensive answers around complex risks.

- **Market knowledge:** Obviously, there is always a risk that if you are based in a certain geographic location, your view of the world can be quite narrow and quite limited. For this reason we leverage regularly off of the more global knowledge of our reinsurance partners, both companies and brokers, to make sure that we are considering all of the key issues in the market place.

Our view of reinsurance is based on our internal model, surrounded by the application of capital management, risk appetite, reinsurance strategy and asset allocation. We have had this internal model for over 12 years now, and it informs what we call financial risk management in our business.

The key component of the financial risk management in our business is capital management. We work to determine the correct levels of capital that we need so that we can manage this properly and enhance the return on equity to our shareholders.

At the heart of it all is the risk appetite. We define very clearly what our risk appetites are for different classes of business and different types of risk exposures, whether events or single risks. This then informs the reinsurance strategy. This strategy tells us how we will buy and what we will buy. It is deeply connected to the internal model at the heart of this management process.

The asset allocation determines how much equity we will hold relative to our solvency and ensures that we don't end up holding too much, putting our solvency in jeopardy, but at the same time that we don't hold too little, which would prevent us from achieving the ROE hurdles.

When it comes to the optimization of the spend, at Santam it is important that we buy the right levels of reinsurance and we watch leakage quite closely. The spend is really divided into three components.

- **Capital model:** modelling determines the optimal level of reinsurance protection relative to the financial risk management parameters of the business.

- **Market conditions:** soft and hard market conditions will inform reinsurance buying outside the parameters of the capital modelling guidance.

- **Missed risks:** continual consideration of input from the business on risks missed by modelling and day-to-day risk assumptions. We have a highly diversified portfolio of business that ranges from complex liability, engineering and industrial risks to the more basic, private and small commercial insurance. Within these more complex lines of business, there is a continual verification process with those business owners around what they think sits in the business which we might be missing in the models.

If I unpack the components of the market, it's made up of the soft market, the core purchase and hard market. Cheap pricing, broad covers and exposed structures are all available in the soft market, potentially leading to an increase in the reinsurance purchase.

The core purchase is informed by our risk appetite, which in turn is informed by our internal model, so this core purchase doesn't change. Some companies might move the core purchase up and down, but our core purchase is constant. We don't change this purchase because we believe that the core purchase is what is needed to protect the business and contribute to its sustainability into the future.

In the hard market cycles pricing above the modelled levels, restricted cover and limited insurance structures may lead to a restriction of reinsurance purchases.
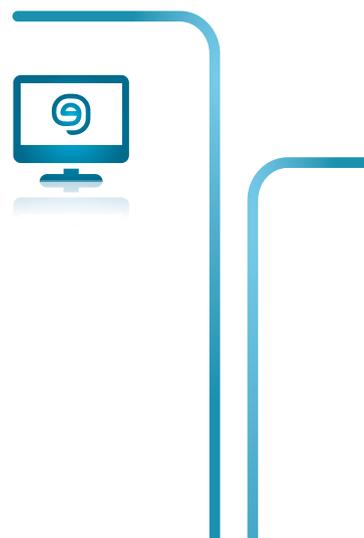
What is the role of the broker in the reinsurance programme? At Santam we use brokers on every piece of business we place, we have a very well developed buying approach that is supported by a technically competent team and because of our deeply embedded financial modelling, we understand where the risks are in the business and know where the programme should trigger. So why do we have a broker in the mix?

Brokers allow us access to both actuarial and Cat analytics data. This constitutes an acid test for the work that we are doing and a review to make sure that we are not missing anything in the assumptions that we have.

At the same time, we view brokerage companies as the places where a lot of the administration is absorbed. We create one claim notification or one premium payment that gets replicated 65 times. Santam can either employ 10 people to do this administration 65 times over, or we can outsource it to the reinsurance broking market.

We leverage their geographic footprint. The brokers give our local business the ability to reach into global markets quickly and in an informed fashion. We push very hard for the brokers to identify market trends and buying patterns that are different to what we might be thinking about or what we've assumed to be right for the last 5 to 10 years.

Most importantly, the brokers that we transact with really bring to us an informed second opinion about what we are doing. We often have rigorous debates with our brokers before our programmes go into the market, which ensures that by the time our programme is in the market, the information is robust and our expectations are reasonable.

AN INSURER'S PERSPECTIVE ON REINSURANCE BUYING: RECENT TRENDS IN THE REINSURANCE MARKET IMPACTING THE PURCHASE IN THE P&C INSURANCE INDUSTRY

3

RISK MITIGATION WITHIN THE PURCHASE

Risk mitigation within the purchase has become more and more important due to changes in regulation. You have to think very carefully about what you have in your reinsurance programme. This is dealing with the credit risk as opposed to the reinsurance programme itself. We track this closely and use three metrics to do so:

- **Credit quality:** we look at the credit quality of our partners.

- **Maximum cessions:** we set maximum cessions and we will not cede more than a certain predefined percentage to any one reinsurance company.

- **Overall default measurement:** we track an overall default measurement across our entire reinsurance portfolio.

With the ever growing new markets, alternative structures and the emergence of large reinsurers wanting dominant cessions, these three metrics play an important role in securing a balance within the ceded portfolio.

THE IMPACT OF ERM

Enterprise Risk Management (ERM) is pushing insurance companies towards the use of quantitative measures to evaluate reinsurance counterparty default risk.

One of the dynamics is large reinsurers wanting dominant cessions out of certain programmes. Africa, and so in turn South Africa, has become very popular for this over the last two years. Through our risk mitigation metrics we have been able to determine that that's not how we want to do business. This protects both Santam and our existing reinsurance panel through robust business principles.

Our regulator is committed to the implementation of solvency (SAM), and part of this is the measurement of the overall default of the reinsurance programme. A lot of this is informed around the ratings of companies from the likes of S&P and A.M. Best, but it is fair to say that the world since 2008 has changed. It is not as simple as it used to be, when an A- rating was your ticket to the game. We have new capacity entering the market that we have never heard of before that comes in with an A rating, and we have old capacity that we have been partnered with for 20 years that all of a sudden suffers a downgrade due to the downgrade of their sovereign. As a buyer we are forced to think more carefully around what the rating means to the programme that we have in place. We try to take into account who the reinsurer is and the company's history with our organization.

MARKET DYNAMICS

The reinsurance market appears to be under pressure from four key sources:
- Insurance-linked securities
- Shifting of traditional reinsurance capacity
- Rationalization of the reinsurance spend by large global insurance companies
- Emergence of large reinsurers targeting specific insurance companies in specific countries wanting major participation in all ceded premium

The market as we see it is soft, with very little sign of any change in the future. We see a situation where we are able to buy things that in theory we shouldn't be able to buy. We see competitors getting cover where we think they shouldn't be able to get cover because we know they have burnt the reinsurance markets, but yet these covers are still there.

ALTERNATIVE REINSURANCE CAPACITY

Our view of this from a South African point of view is that despite all the market indicators, the capital continues to flood into this market. A.M. Best recently revised the global reinsurance industry rating to negative from stable, stating that the outlook for the reinsurance industry does not look good.

Alternative capital continues to be the main source of new capacity to the reinsurance sector. This capacity takes the form of:
- Cat bonds
- Sidecars
- Hedge fund reinsurance companies

Interestingly, this new capital mainly goes into the USA and Europe. We don't see this in South Africa and we don't see a lot of it in the emerging markets because it goes where the modelling is believed to be robust and trusted, as opposed to the emerging markets where modelling is less developed and tested. But the fact is that, it is impacting the markets Santam is in.
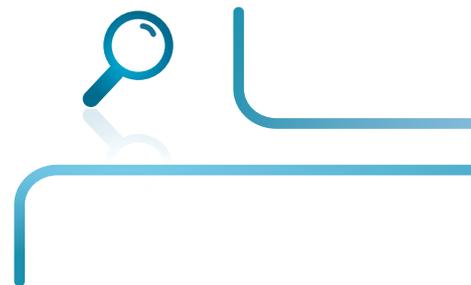
SHIFTING TRADITIONAL REINSURANCE CAPACITY

This ILS capital is mainly focused in the USA, but it is shifting traditional reinsurance capacity. Because of this, traditional Cat capacity is shifting to emerging markets. We see increasing capacity coming into Africa, India, South East Asia and China. For example, we have seen programmes in China that have suffered sizeable losses but that get renewed with better terms than they had the year before. This is a result of that shifting capacity that is now looking for a new home. This alternative capital through this shifting of traditional capital is chasing down prices in the emerging markets. What we have recognized is that ILS, whilst not directly in our market space, is something that is definitely influencing the markets that we operate in.

REINSURANCE RATIONALIZATION BY LARGE INSURANCE COMPANIES

There is an increasing sophistication in the insurance companies around the world. This development also impacts the reinsurance buying process, with reinsurance optimization and leakage being a key focus. Santam continually tests and checks whether we have optimized our spend and what any potential leakage there might be. We are no different to anybody else. The only difference is that some of the large companies are now centralizing their buying and taking large volumes of premium out of the marketplace.

What does this lead to? Like the impact of the ILS market, reinsurance capacity is shifting and looking for new markets. Once again, emerging markets in Africa, India and Southeast Asia are very popular, which increases their capacity and we see traditional capacity shifting into these markets.
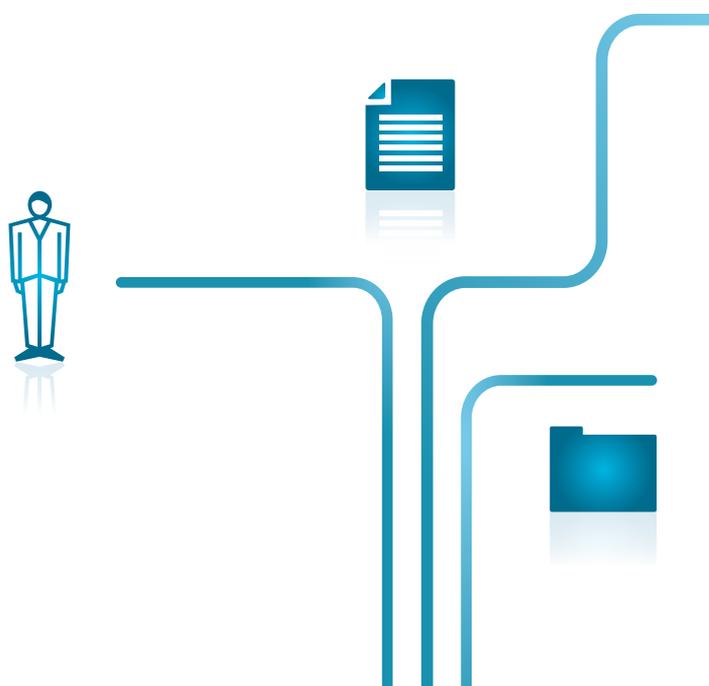
LARGE REINSURERS WANTING MAJOR PARTICIPATIONS

The last key issue moving the reinsurance market at the moment is the fact that large reinsurers want major participations on all ceded premium. We have seen large companies coming into the market wanting significant levels of cession out of the Santam portfolio. This is relatively new to South Africa. While the existing panels obviously want to retain their positions, these large cessions come in at attractive terms and ultimately the reinsurance panel gets squeezed, putting pressure on the existing reinsurance companies. Again, here we see the same common theme: the emerging markets are now the new focus, making Africa, India, Southeast Asia and China very popular, resulting in major participations that chase down prices for the existing reinsurers.

The current reality is that these four key components ultimately begin with the alternative reinsurance capital that is sitting in markets far away from where we operate at Santam, but it impacts a shifting of traditional capacity. At the same time, we have rationalization by large companies, predominantly in Europe, coupled with the emergence of a desire for major participations on companies like ours and others in the emerging markets, all pushing down on the price.

THE VALUE OF RELATIONSHIPS

The intangible value of relationships plays a major role in the sustainability of the traditional reinsurance market. These relationships are not quickly replicated by new entrants and in the convergence capital arena these relationships are often non-existent. With SCOR we have built our relationship over many years and it won't easily be thrown to one side. When SCOR asks what we want at Santam, we expect a clear understanding of our

AN INSURER'S PERSPECTIVE ON REINSURANCE BUYING: RECENT TRENDS IN THE REINSURANCE MARKET IMPACTING THE PURCHASE IN THE P&C INSURANCE INDUSTRY

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business. Our business is shifting and changing, we are moving outside of South Africa, and we want to work with reinsurance companies who understand this and are willing to support the changing face of our business. This is key to the value proposition offered by a reinsurer.

On the flip side of that, what is important is that we, as cedants, need to have open communication and need to be transparent about our exposure and what we are doing. At Santam we work very hard on the quality of what we can share with our reinsurance partners, allowing them to develop an understanding and a high level of comfort about why they are partnered with us on.

We currently seem to be in something that might be a super soft cycle rather than just a soft cycle. Commentators say there is no end in sight, but the

reality is that during these cycles it's these relationships that underpin the long term sustainability of the business that we build with reinsurers.

An interesting concept which illustrates the cyclical nature of our industry was developed a number of years ago but is still as relevant today as it was back then. The Underwriting clock was developed by Paul Ingrey in the early 1980s. This was developed some 30 years ago, long before anyone knew about Windows, Excel or iPads. He said that it was a useful tool to visually remind us about how stupid we are. Just because we have all this technology at our fingertips today doesn't mean that we are any smarter in our decision making than the market was back then. In fact our decision making seems to be exactly the same as what was evident back in the 1980s.

THE UNDERWRITING CLOCK

1:00	Reinsurance capacity is rampant and it will support anything that moves. Few questions are asked and prices start to drop. The clock starts to tick.	**7:00**	Rating agencies express concern about the reinsurance market. Reinsurers start cancelling participations.
2:00	Companies start inventing new programmes and new marketing ideas. The cover that we can get from the reinsurance market broadens and the pricing continues to drop.	**8:00**	CRUNCH! There is a capacity crisis. Cover given starts to tighten. Suddenly the reinsurers are winding in what's available.
3:00	Prices fall dramatically and profit levels start to level off.	**9:00**	Prices are up sharply, but the results are still poor. Combined ratios begin to improve.
4:00	Profits slide. Investment income becomes insufficient. Pricing is unrealistic, but the covers are wide open and the cash flow for reinsurance now starts to push towards the negative position.	**10:00**	Capacity becomes expensive. Pricing continues to rise. Cash flow starts exceeding the underwriting losses and things start looking good for the reinsurance market.
5:00	Market results are now very bad and the capacity starts to be withdrawn from some of the key markets.	**11:00**	All the companies are flourishing. Losses are recovered and the combined ratios are all at a profit.
6:00	Halfway through the cycle, the pricing cannot go any lower, but nothing improves. The reinsurers now start going back to the basics of underwriting.	**12:00**	Euphoria. Prices stop rising… and the cycle starts all over again.

It is particularly interesting to note that this underwriting clock was developed long before we had heard about ILS, convergence capital or the rationalization of reinsurance. Despite this, I don't believe that the current situation is all doom and gloom. Before the World Trade Center, we were also in a soft cycle and people said it would never turn. Something is going to happen, something is going to break; the question is simply what and when?

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TAKING DIVERSIFICATION TO THE NEXT LEVEL: KEY CONSIDERATIONS FOR COMPOSITE LIFE AND P&C (RE)INSURERS

FRIEDER KNÜPLING
Chief Risk Officer
SCOR SE

Every (re)insurance company should aim to optimise diversification benefit across its entire portfolio. This requires a deep understanding of the most important drivers of diversification, their nature and the way in which they can influence the company's risk profile.

Using SCOR as an example, we illustrate key concepts and tools which can be employed for such an analysis[1]. Moreover, special attention is dedicated to composite (re)insurers and to what needs to be considered when combining Life and P&C business.

Property & Casualty (P&C) and Life characteristics

P&C can be materially segmented into risks that have a short duration, such as Nat Cat, and those that are longer, such as Liability. Consequently, Natural Catastrophes and other short-tailed business lines are much more important contributors to premium risk, while Liability and other long-tailed contracts are more important contributor to reserving risk in a one-year time horizon. By comparison Life insurers typically want a ratter long duration which can span across several decades.

Economic factors can influence business risks in different ways. A general distinction is that obviously long-tails risks are affected more by factors like changing interest rates and other long-term economic risk factors, so this also plays an important role.

Moreover, the P&C and Life businesses are different in terms of the nature of their renewals. Most Life business has the same term as the underlying policies, i.e. many years or even decades. Conversely, P&C business renewals are not contractually guaranteed. Therefore the perimeter considered is typically limited to the current underwriting year's portfolio, but not to subsequent renewals.

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(1) The scenario and corresponding charts are for illustration purpose and are not meant to represent SCOR's actual risk profile.
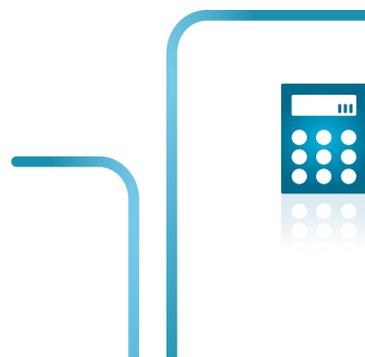
Drivers for diversification

The most important key drivers for the optimisation of the diversification within different types of business are size, volatility and dependence. Large risks are difficult to diversify, very volatile risks are difficult to diversify, and risks which have a strong dependency lead to low diversification benefits. The typical measures a reinsurance company can use to improve diversification are to reduce the size of its key risks, reduce or limit the volatility of the risks which have a large size and large volatility, and optimise dependence. The traditional way of doing the latter is to look for uncorrelated risks and extend business to risk which has a low dependency.

Obviously, these should be risks which the company understands well and which can then be properly managed.

Using SCOR as a case study, Figure 1 shows our risk composition over the past two years. The predominant risks for SCOR are P&C and Life underwriting, which are almost of the same size. Economic risk factors can have some influence on SCOR's risk profiles. The increase in interest rates last year reduced the weight of our Life risk slightly, but there is still a relatively balanced mix between the two. Other risks such as assets make a relatively small contribution to SCOR's risk profile.

Figure 1: **Relative contribution to Solvency Capital Requirement (SCR) by risk category**
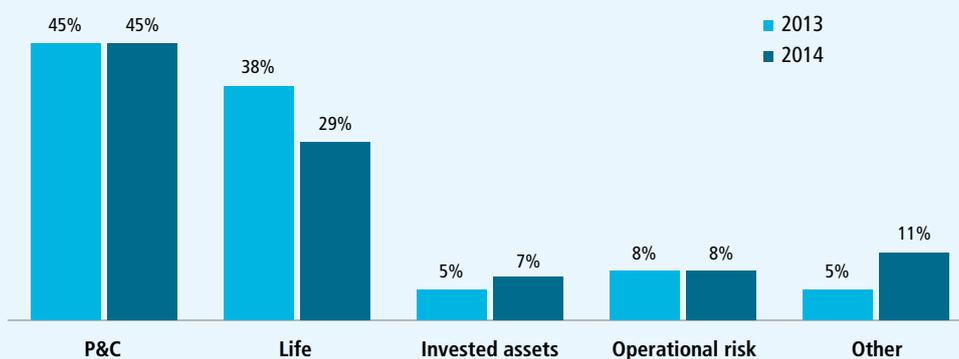
Economic risk plays a fairly small role in a reinsurance company that does traditional Life reinsurance business. SCOR's Life risks are primarily biometric. We assume mortality and disability claims risks, but SCOR does not have much risk appetite for interest rate risk and interest rate guarantees. Most traditional primary insurance companies would have a completely different risk profile. They could easily have 80% of market risks, and a very small remaining share of biometric risks. We accumulate those biometric risks and develop a quite unique risk portfolio and profile by aggregating them with P&C risk.

Figure 2 and Figure 3 show an overview of our business mix on the P&C and the Life sides, respectively. P&C business is relatively well diversified on a geographic basis and this has been further improved in recent years, as can be seen from the graph. Property risks naturally play a big role in terms of line of business share, making them the biggest component.
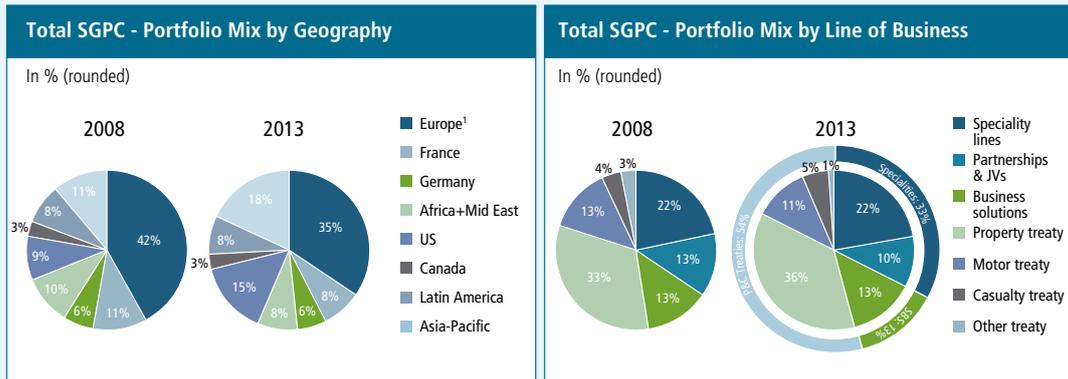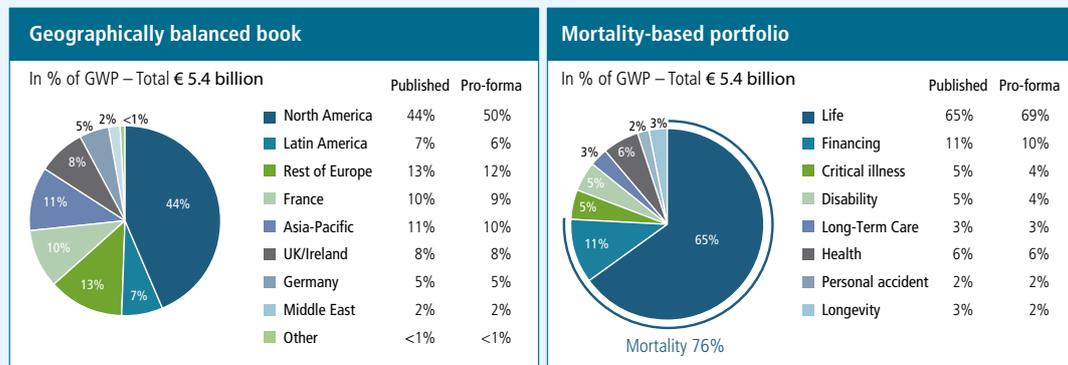
Figure 2: SCOR's P&C business mix

Total SGPC - Portfolio Mix by Geography

In % (rounded)

2008	2013	
42%	35%	■ Europe[1]
11%	18%	■ France
8%	8%	■ Germany
3%	3%	■ Africa+Mid East
9%	15%	■ US
10%	8%	■ Canada
6%	6%	■ Latin America
11%		■ Asia-Pacific

Total SGPC - Portfolio Mix by Line of Business

In % (rounded)

2008	2013	
22%	22%	■ Speciality lines
4%	5%	■ Partnerships & JVs
3%	1%	■ Business solutions
13%	11%	■ Property treaty
13%	10%	■ Motor treaty
33%	13%	■ Casualty treaty
	36%	■ Other treaty

Specialties: 33%
P&C Treaties: 34%
% EL: 33%

1) Excludes France & Germany

Figure 3: SCOR's Life business mix for 2013

Geographically balanced book

In % of GWP – Total € 5.4 billion

	Published	Pro-forma
■ North America	44%	50%
■ Latin America	7%	6%
■ Rest of Europe	13%	12%
■ France	10%	9%
■ Asia-Pacific	11%	10%
■ UK/Ireland	8%	8%
■ Germany	5%	5%
■ Middle East	2%	2%
■ Other	<1%	<1%

Mortality-based portfolio

In % of GWP – Total € 5.4 billion

	Published	Pro-forma
■ Life	65%	69%
■ Financing	11%	10%
■ Critical illness	5%	4%
■ Disability	5%	4%
■ Long-Term Care	3%	3%
■ Health	6%	6%
■ Personal accident	2%	2%
■ Longevity	3%	2%

Mortality 76%

Life is slightly different, in the sense that SCOR's portfolio focuses on mortality risks. Two-thirds of our business is mortality based, but critical illness risks, disability, longevity risks and other related risks are also reinsured. Geographically, about half of the business comes from the USA, which broadly mirrors the worldwide distribution.
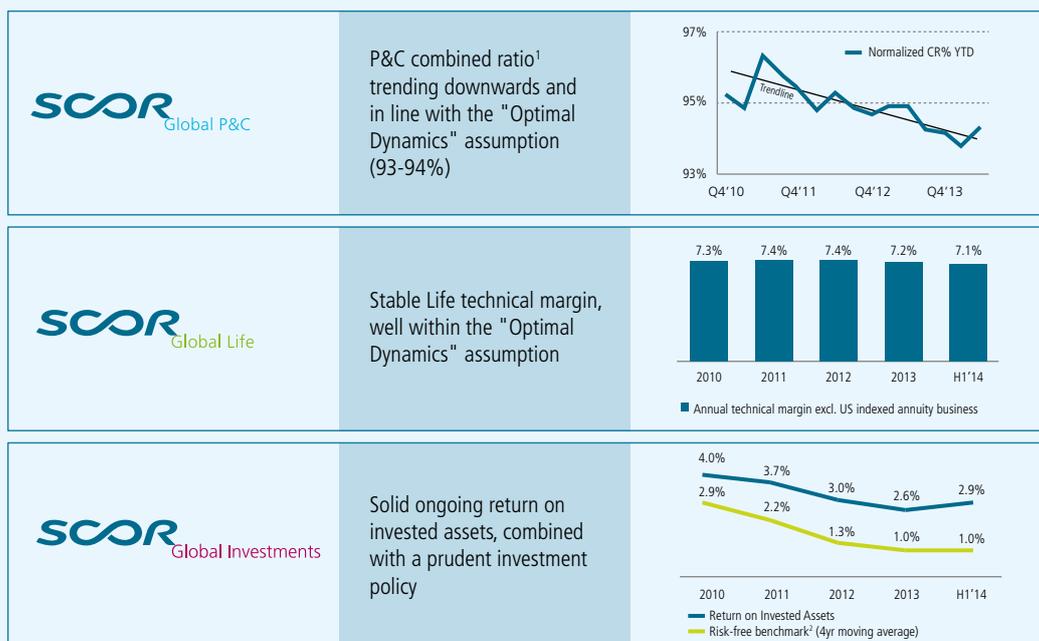
Main risk factors

What are the main risk factors determining the risk profile for Life and P&C? In P&C, risks arise due to the actual claims experience being different from the best estimate. Underwriting and reserving risks are influenced by numerous factors, e.g. windstorms, earthquakes, floods, claims inflation, etc.

On the Life side, the main risk drive is also mainly claims variation for a biometric portfolio like SCOR's. However it can have different time horizons given that the underlying business usually has a long-term nature. We model short-term volatility and short-term shock risks, such as catastrophes, accidents and pandemic events, and similarly long-term mortality and others claims risks. These include level risks, i.e. the risk of mis-estimation of the mortality level, and adverse trends, such as the risk of diabetes, obesity or unknown diseases spreading rapidly in our portfolio and leading to a permanent, long-term deviation in mortality. These have similar characteristics to long-term reserve risks on the P&C side.

How has that translated into profitability and what is the return side of such risks? Figure 4 offers a summary of the main technical profit indicators that SCOR tracks and publishes on a regular basis.

Figure 4: Historical performances

P&C combined ratio[1] trending downwards and in line with the "Optimal Dynamics" assumption (93-94%)

Stable Life technical margin, well within the "Optimal Dynamics" assumption

Solid ongoing return on invested assets, combined with a prudent investment policy

1) The net combined ratio is obtained by calculating the difference between the Cat budget and the actual cost of catastophes (in %) and by normalizing reserve release
2) The 4-year risk-free benchmark has been derived by calculating the average generic government bond yields for the respective years and weighting these as follows: actual breakdown of the portfolio by currency at the end of each quarter

The combined ratio has followed a good trend-line, with some volatility around it. The technical margin, shown in the graph, is usually very stable, especially on a large and well diversified Life business portfolio.

P&C has a relatively high profitability, but somewhat more volatility than the Life business, which has very stable margins over time.

Risk measures capital allocation and diversification

SCOR measures capital using the Solvency II metric, i.e. the 1-in-200 year percentile of the whole loss distribution. With this metric SCOR has defined a solvency scale which describes how management sets objectives in terms of optimal capital levels and which includes escalation measures in case a deviation from the optimal capital level is observed.

Allocating capital is not straightforward if one looks only at an individual percentile of the overall change in economic value distribution. The 1-in-200 year capital is one single point in the distribution and it does not always lead to a very stable capital allocation. Thus, for the purposes of capital allocation, SCOR considers the average losses on the 1% worst cases of the modelled economic loss distribution, which is a more stable and somewhat more reliable metric.

Diversification is a measure of how the combination of risks requires less than the sum of the individual

risks. To take an example, on a standalone basis, our P&C and Life business would require a little more than EUR 2 billion of capital measured using the SCR, good and bad scenarios can partly offset each other in a combined business. The capital requirement is 27% lower than the sum of the individual capital requirements for P&C and Life. Is that small or big in terms of diversification? A simple benchmark can be obtained by modelling the risks just using normal distribution. With two risks which have equal size, the volatility of an independent combination of those risks is the square root of the volatilities of the underlying distribution.

Thus, the volatility of the combined business would be about the square root of 2, and would lead to a diversification benefit of $(1-\frac{\sqrt{2}}{2})$, i.e. of almost 30%. So 27% is close to that level, which is almost optimal. Combining risks of equal size and equal distributions which are completely optimises diversification.

Diversification between different business maturities

Figure 5 illustrates, via a simplified example, a tool often used by SCOR to visualise its risk profile distribution. This is simply the distribution of the one-year change in the economic value presented in a not so common manner. Profits and losses are shown on the Y-axis, profits being at the top and losses at the bottom. On the X-axis, we show the return period of a specific result scenario, using a logarithmic scale to emphasise the tail of the distribution. Essentially, this is just a specific way of showing a distribution function.

Figure 6 provides a visualisation of what happens when aggregating different maturities of one type of business. On the left hand side one sees the risk profiles or loss distributions of the Life in-force business, which is business that has been written up until a year ago, along with new business in the last underwriting year, and planned new business, which is the business expected to be written in the next 12 months.

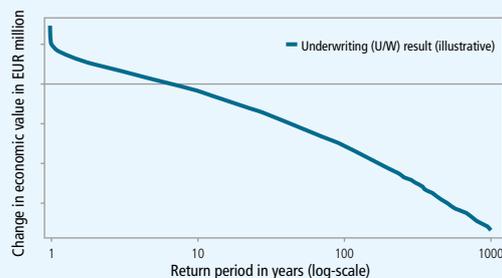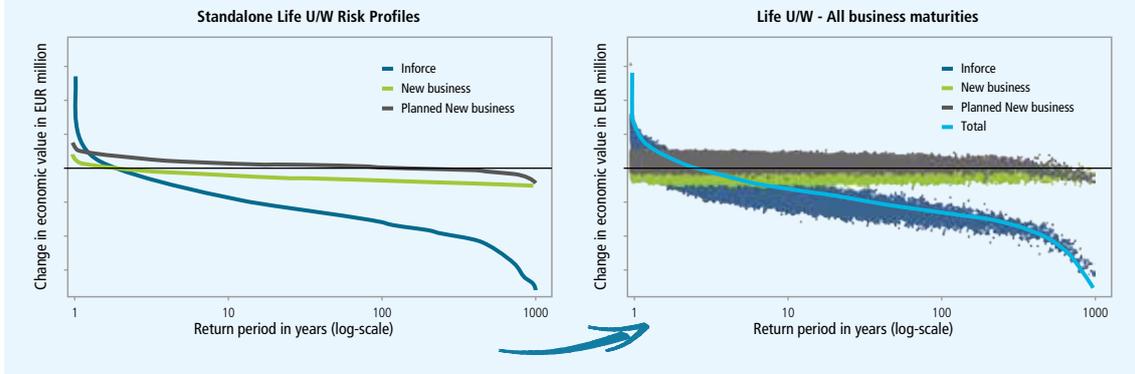Figure 5: **An example of a risk profile chart**

Figure 6: **Life risk profiles by business maturity**

The three curves have a similar shape, but the in-force business is much larger in size compared to any single generation of new business. Given its size it produces higher profit, but it also generates the bulk of the risk, so it is responsible for most of the capital requirement. Otherwise, the shapes of the curves are relatively similar. When writing Life business, one is adding new generations of business every year which have a very long duration. So on a mature portfolio like SCOR's at any point in time, 85% to 90% of the business is old business written at least a year ago and only a small fraction of the business is recent.

This also drives the way in wich these risks combine. The solid curve on the right hand side of the graph is simply the combined distribution of those three sub-risks. For each point on that combined curve we have added vertically the contribution to those risks stemming from the three generations on the left side of the graph. For any given point on the solid curve there are blue, green and grey points showing the contribution of the underlying three generations of business to the combined loss on the solid curve.

It can be observed that the further one goes to the right, the more the graph becomes dominated by in-force business, and so large losses on the existing business are mainly responsible for the aggregate large losses. Occasionally one can have large losses from the new generations of business, but their volume is small, adding small profits or losses to the tail of the distribution.

Figure 7 shows the interaction among the different business maturities on the P&C side.

Figure 7: **P&C risk profiles by business maturity**
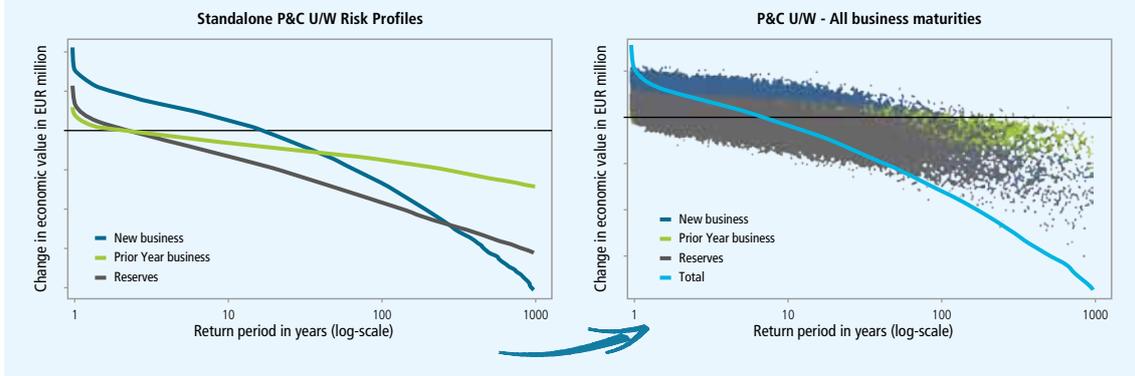
We have the same generations of business on the left side of the graph, but we see quite different shapes in those curves and there are specific reasons for this. One is that the weight of Cat business is obviously quite different for different business maturities. For old generations of business, the prior-year or reserves, Cat business plays practically no role. Typically short-term risks are very important for new business and then they fade out. For the older generations of business, what really matters are long-term and reserve risks.

The three curves have more comparable sizes compared to the Life curves. Every year a much more substantial portion of the total risk is renewed, so one can manage the risk profile much more quickly on the P&C side.

Figure 8 is a visual representation of how dependency plots should look for different types of combinations of business.

Figure 8: Correlation density plots

Worst-case scenarios (largest losses)

Best-case scenarios
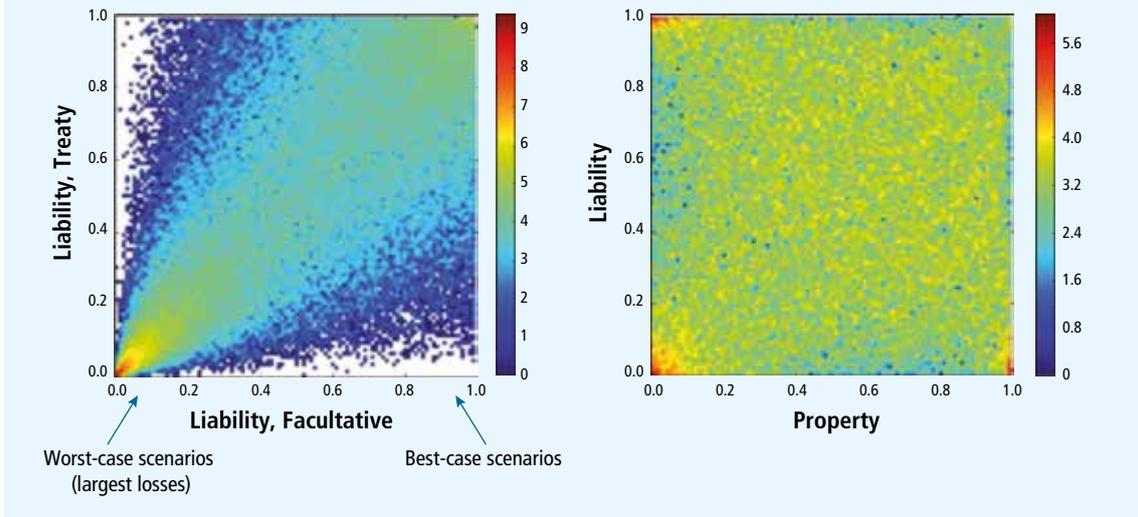
For businesses which are more similar and have more intrinsic dependencies (i.e. they share common risk drivers), one can expect to see a higher weight of combined scenarios. An accumulation of large losses is coming from both combinations of the business, whereas when looking at the combination of fairly

independent lines of business, one can expect to see a well spread-out plot with no clearly visible weight in any part of the combination of those risks.

Figure 9 compares the diversification gain between different types of dependency assumptions.

Figure 9: Diversification varies with modelling assumptions
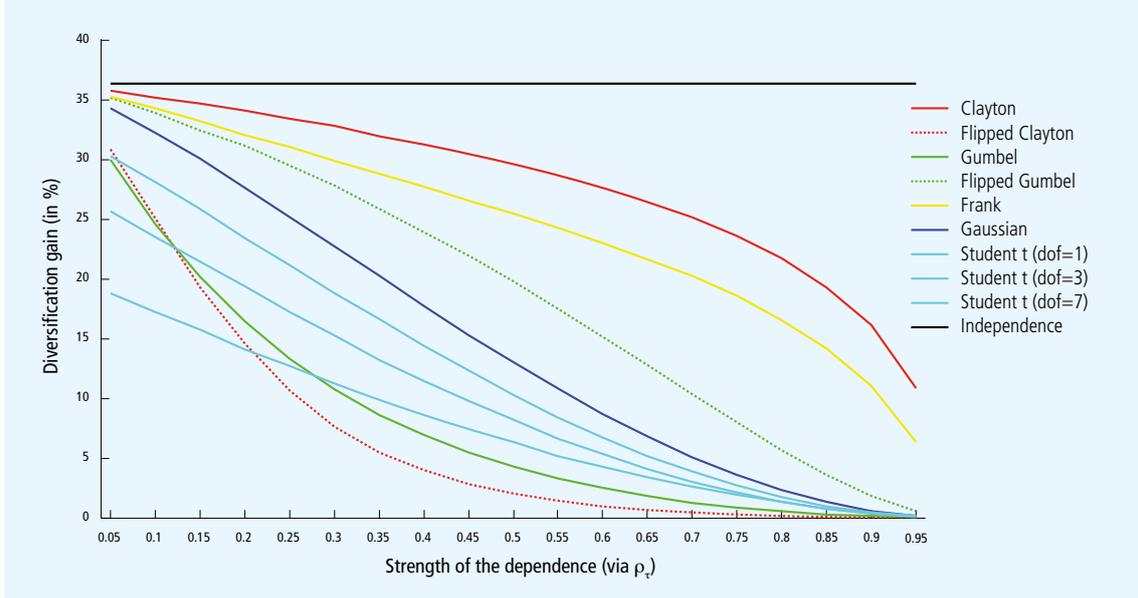
It compares the diversification gain which can be obtained by aggregating two risks (both modelled as Log-Normal) with the same rank correlation, but combined with different copulas.

The diversification gain is measured as 100% minus the ratio between the capital requirement of the combined portfolio over the sum of the capital requirement of the standalone risks.

One can observe that different ways of modelling dependency (different copula families) for one or the same rank correlation can lead to very different diversification gains.

The flipped Clayton copula shows the most conservative results in terms of diversification gain among the alternatives presented in such a comparison.

One step further: when P&C meets Life

What does a (re)insurance company needs to consider when combining Life and P&C business? First of all, SCOR strongly believes that the Life and P&C businesses are largely independent, as they are driven by mostly independent risk drivers. There are certain areas which can lead to accumulation of risk or losses on both sides, but. Large man-made or natural catastrophes, for example, can lead to an accumulation of P&C (property) claims, but in modern western societies, given the available infrastructure and the emergency services, they very rarely lead to really measurable claim-peaks on the Life side.

Biometric risks can even be negatively correlated to P&C risk, especially for casualty lines with reserves that include annuities. These are more exposed to longevity risks than mortality risks.

Macroeconomic risks could potentially lead to some dependency in an indirect way because they can influence both Life and P&C liabilities in a similar way. For example, a significant decrease in interest rates would imply a reduced benefit from the discount of the liabilities, potentially impacting both Life and P&C. However, this is a relatively small risk driver on a one-year time horizon. Similarly, the risk of extreme inflation on a one-year time horizon is relatively small and partially mitigated by improved discount rates. Therefore, even if this may be a common driver, the risk is limited for both Life and P&C.

Figure 10 shows on the same graph the standalone risk profiles of both Life and P&C risks, separately.

Figure 10: **Life and P&C standalone risk profiles**
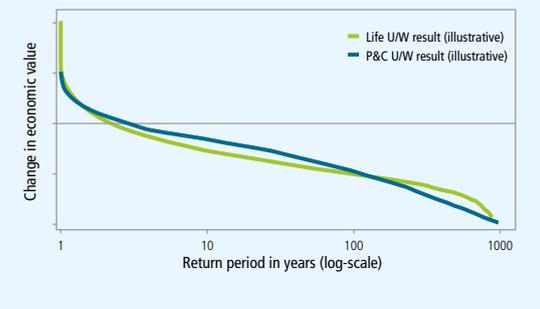
The two risk profiles are quite different in shapes for the reasons described above. When looking at different return periods for the overall risk distribution, one gets different combinations of risk and different types of diversification benefit. One way to illustrate this is to plot the combined risk distribution, and for each combined loss point to add the contribution of the respective P&C risk, see Figure 11.

Figure 11: **P&C U/W scenarios contributing to combined Life and P&C U/W**
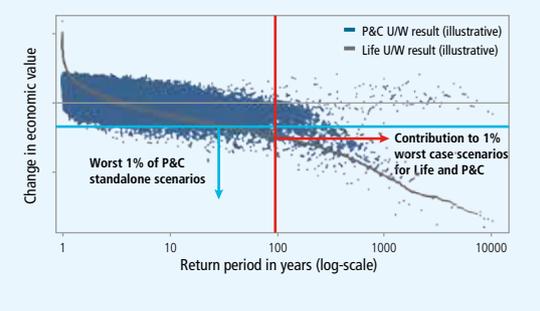
The solid line is the combined Life and P&C underwriting risk profile, and for each combined loss the corresponding P&C contribution is shown as a point on the same vertical line. The worst P&C loss scenarios are at the bottom of the graph.

If one compares the dots forming the tail of the P&C standalone risk (1% of all dots, counting from the bottom) and the P&C losses contributing to the combined tail (1% of all dots, counting from the right), it can be observed that the contribution of the P&C risk to the 1% combined worst cases is generally much more benign than the worst 1% P&C standalone risk.

Moreover, it is interesting to focus on the far tail of the combined distribution and to highlight the different contributions of the Life and P&C scenarios in that specific region. This is illustrated in Figure 12. It is apparent that different types of risks are driving different areas of the combined tail distribution.

Figure 12: **Life and P&C U/W scenarios contributing to 1% tail of combined Life and P&C U/W**
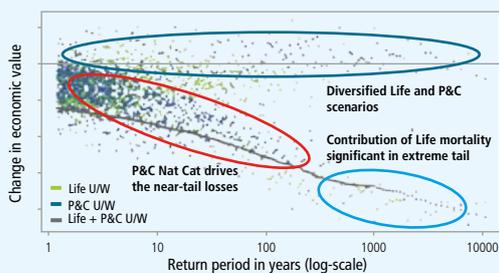
This offers a visual explanation of how different risks can combine in different ways at different return periods. We have highlighted a cloud of P&C dots near the combined risk distribution in the return periods between 100 and 1,000 years. These are mainly Nat Cat risks which ar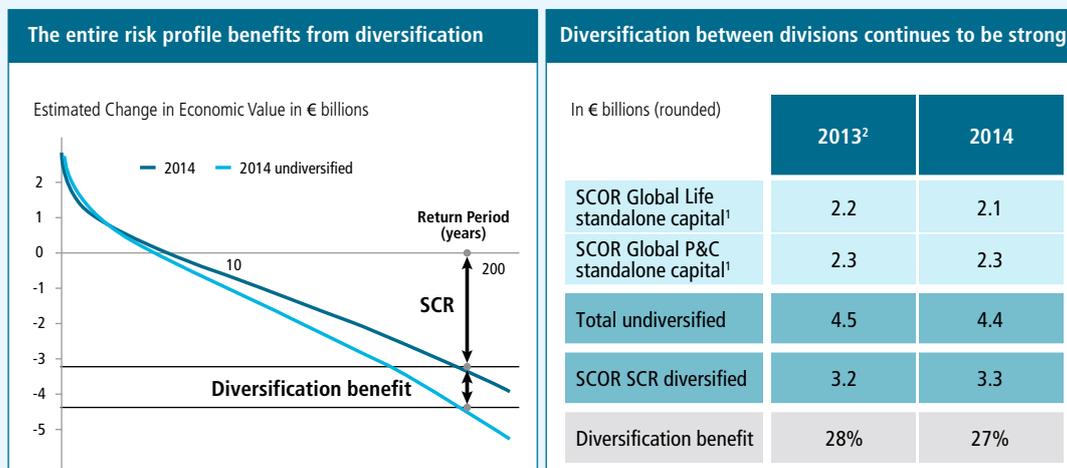e very dominant in this part of the distribution. The further we move into the far tail of the combined distribution, the more Life dots can be seen near to it. These are very extreme pandemic events which dominate the far tail of the combined risk distribution, and they drive very large losses. Thus, different paths of the tail distribution are dominated by quite different risk drivers, which is important for understanding the diversification benefits, e.g. at the 1-in-200 year return period (corresponding to the SCR).

The key result is that, when combining Life and P&C business, the worst P&C scenarios are replaced by much less onerous combined scenarios, and this is what brings diversification to P&C business. The same is of course valid for Life business. Sometimes more benign Life scenarios are combined with more severe P&C scenarios, and the combination of them drives diversification.

On a more aggregate level, the light blue curve at the bottom-right of Figure 13 is the loss distribution which one would have if one just add on the risk from the Life and the P&C divisions without any consideration of diversification among the two divisions. In other words, this would represent the risk profile if the risks stemming from the P&C and Life divisions were combined, assuming they were fully dependent, and thus assuming no diversification benefits.

In comparison, we have plotted the actual risk profile of the combined business, including the diversification benefit, which is certainly different from zero, and thus it allows for a reduction of the overall SCR. The table on the right-hand side of Figure 13 provides on quantification of the divisional standalone capitals, as well as of SCOR's diversification benefits.

Figure 13: **SCOR's strong diversification benefits**

The entire risk profile benefits from diversification	Diversification between divisions continues to be strong		

In € billions (rounded)	2013[2]	2014
SCOR Global Life standalone capital[1]	2.2	2.1
SCOR Global P&C standalone capital[1]	2.3	2.3
Total undiversified	4.5	4.4
SCOR SCR diversified	3.2	3.3
Diversification benefit	28%	27%

1) Standalone reflects the capital needs of the division before diversification with the other division
2) 2013 figures correspond to the 2013 IR Day results, including estimates of the impact of the acquisition of Generali US

Finally, the combination of Life and P&C business can be illustrated using the analogy of combining equities and bonds in classical portfolio theory, see Figure 14.

Figure 14: SCOR's highly diversified twin-engine model optimizes risk/return
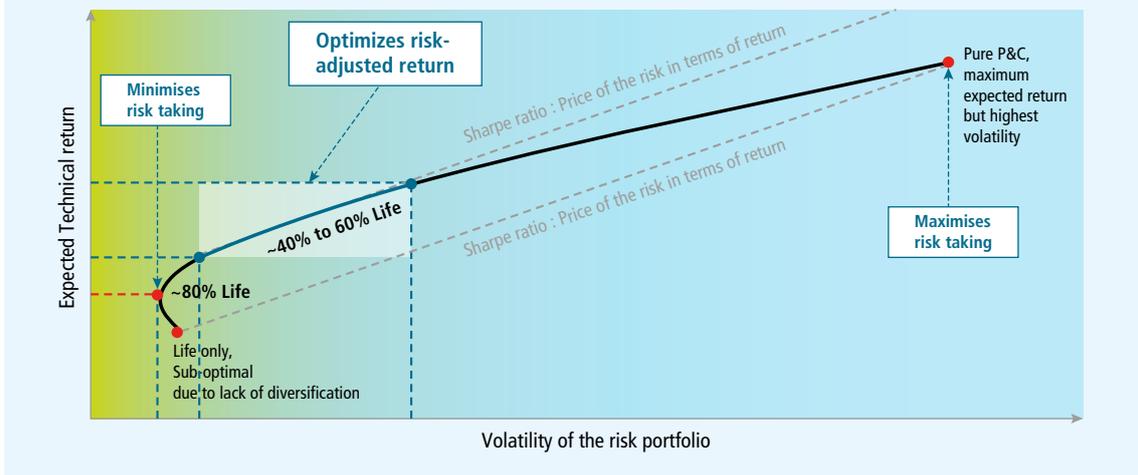
The curve shows different return and volatility combinations for different mixes of asset portfolios/ insurance risks. SCOR has performed some analysis to investigate where the optimum would be, using typical risk profiles of Life and P&C business. An optimal combination with regard to the risk-adjusted return is in the range of about 40% to 60% of either of the two risks.

Finally, Figure 15 shows a comparison of the risk-return metrics across the reinsurance industry, which shows that SCOR has the best Sharpe ratio among its peers. This is largely due to the very unique combination of Life and P&C business described above, which enables SCOR to optimise diversification benefits across its entire portfolio.

Figure 15: SCOR's risk reward profile
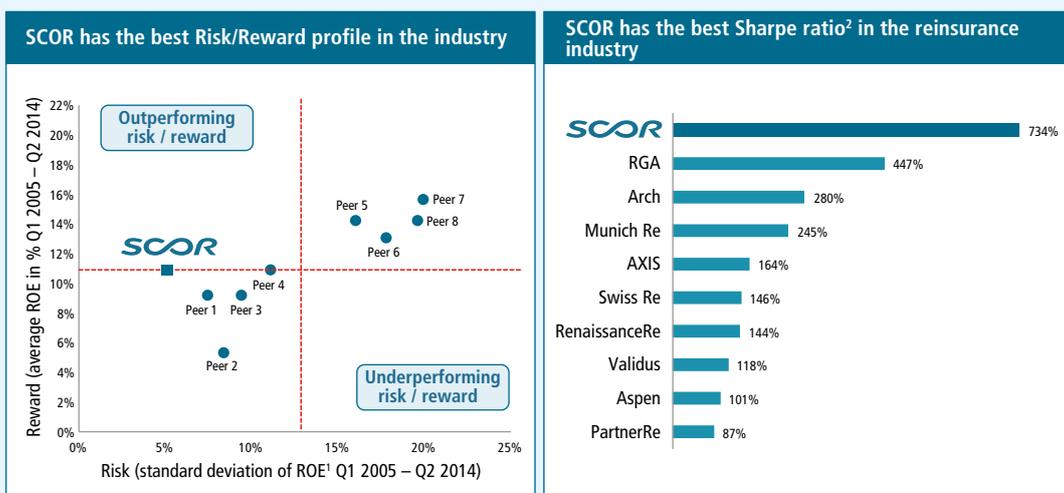
1) Annualized quarterly ROE
2) The Sharpe ratio measures the profitability per one unit of capital: the higher the Sharpe ratio, the better the performance and the greater the profits for taking on additional risk

Source: Moody's 2014 Individual Scorecards

5

KEY PRINCIPLES OF P&C REINSURANCE OPTIMIZATION IN THE CONTEXT OF RISK MANAGEMENT AND SOLVENCY REGULATION

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SCOR SE

We will begin by outlining the different motivations an insurance company may have for purchasing reinsurance. Then we will introduce the capital management view, as a driver for structuring a reinsurance program. From this perspective we will introduce specific economic valuation criteria.

Insurance companies may have different reasons for buying reinsurance:

• **Catastrophe protection**
- protects the reinsured against large losses
- better diversification across the portfolio after reinsurance

• **Profit protection**
- helps stabilize the reinsured's profit

• **Capacity and surplus relief**
- allows the reinsured to write larger amounts of policies and therefore to grow
- distributes dividends to shareholders

• **Risk management and capital management tool**
- transfers risks internally or to third parties
- managing capital constraints, e.g. from regulators, rating agencies

The use of reinsurance and cooperation with the reinsurer can also provide benefits from the reinsurer's global market knowledge or the additional services provided.

We will now focus on the risk management aspect.

Risk management for insurance companies

The risk profile of an insurance company can be modified in different ways. If the company carries too high a risk compared to the capital that it has available, raising additional capital is one option. Also, risks on invested assets can be reduced by changing the investment strategy, moving into less risky assets. Another option would be to change the underwriting policy, but the impact of this would be in the longer term. A quite immediate possibility for risk mitigation is to cede risks through buying reinsurance.

Figure 1: **Different possibilities for mitigating overall business risks according to the time needed for their application and effect**

Risk mitigation instruments

Short → Buy reinsurance

Change investment strategy

Raise capital

Long → Change underwriting policy
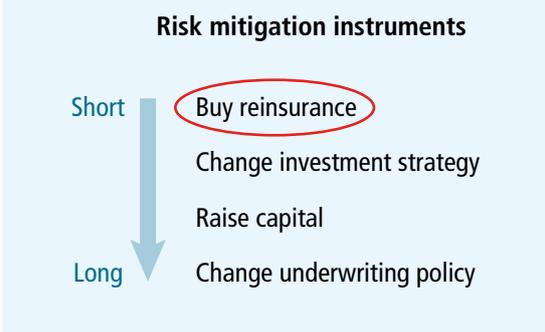
To be able to decide on an optimal reinsurance structure, optimization criteria have to be defined. The optimization criteria depend on the risk appetite and are closely linked to the motivation for buying reinsurance. For example, the price of reinsurance could be an optimization criterion. Another more relevant criterion is capital management. But capital is measured in different ways; it could be capital requirements calculated with an internal model, if there is one, or standard formula capital or rating agency capital. The most likely case is that there are different definitions of capital which are all relevant, which means that the impact of reinsurance on different types of capital has to be considered at the same time. Often there are further additional parameters which should be considered which means that you end up with a multi-dimensional optimization problem.

An economic view of reinsurance

Using reinsurance as a risk mitigation instrument means substituting some of the risk capital for the reinsurance. If some of the peak risks are ceded, the capital which needs to be held to cover the risk can be reduced. Capital has a cost, for example if a company is publically traded, the shareholders expect a certain return.

In an economic view, the cost of the capital backing the risk of a certain tranche of business has to be balanced against what it actually costs in additional margin in order to cede it to a reinsurer. It's these two aspects which need to be looked at together from an economic point of view.
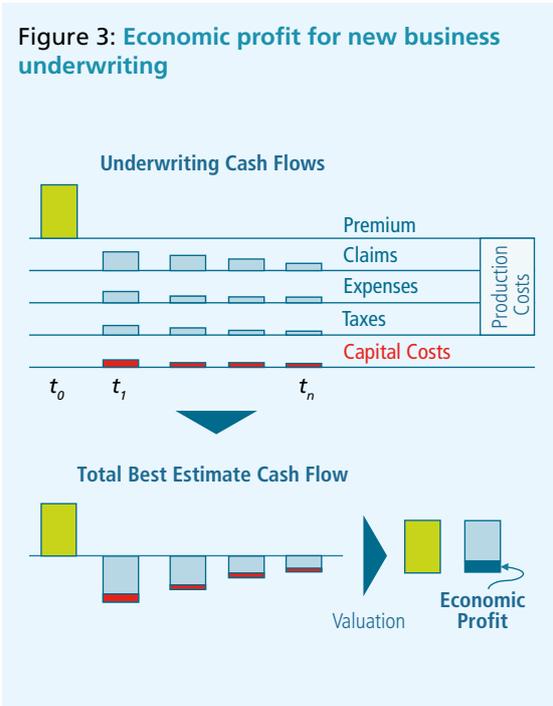
Figure 2: Economics of an insurance/reinsurance policy
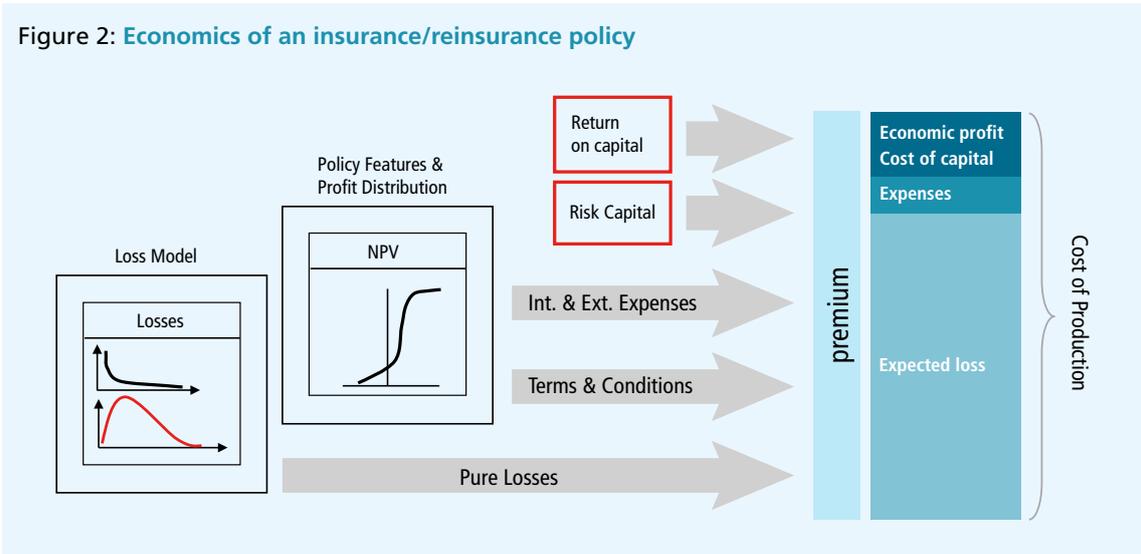
In Figure 2 a very simple example is shown of how premium has different components for a (re)insurance policy. The main component is the expected loss which is the combination of the pure losses with the policy terms and conditions (e.g. deductible, limits, exclusions). In addition, expenses related to writing the policy (e.g. broker's commission or allocated internal costs) have to be considered.

Figure 3: Economic profit for new business underwriting

Since in general a policy carries a certain risk, some risk capital is allocated to that specific risk. This is one part of the overall capital on which an investor expects a return. This return is considered to be part of the cost of production of this policy since shareholders provide the capital to write business, with the expectation that they will get a certain return. The cost of capital is normally higher than the risk-free rate because it is an investment carrying a certain risk. In addition, there is normally a component of the premium called economic profit.

In Figure 3, we show a more detailed explanation of the economic profit from the point of view of the risk taker including the concept of time. In the first row, the premium income as a one-off premium is shown, in the second row the claims development over time is shown. While, in the third row, expenses which may also arise over time depending on the type of business, are shown. Taxes which will have to be paid on profit are also shown in the graph. Economic valuation of the cash flows means discounting back to a point in time. The economic profit is then the difference between the discounted cash outflows (e.g. claims, expenses) and the premium income.

A portfolio containing many policies may have additional contributions to the profit, for example income on invested assets. In Figure 4, a simplified view of the development of the economic balance sheet is shown.

Figure 4: **Available and required capital**
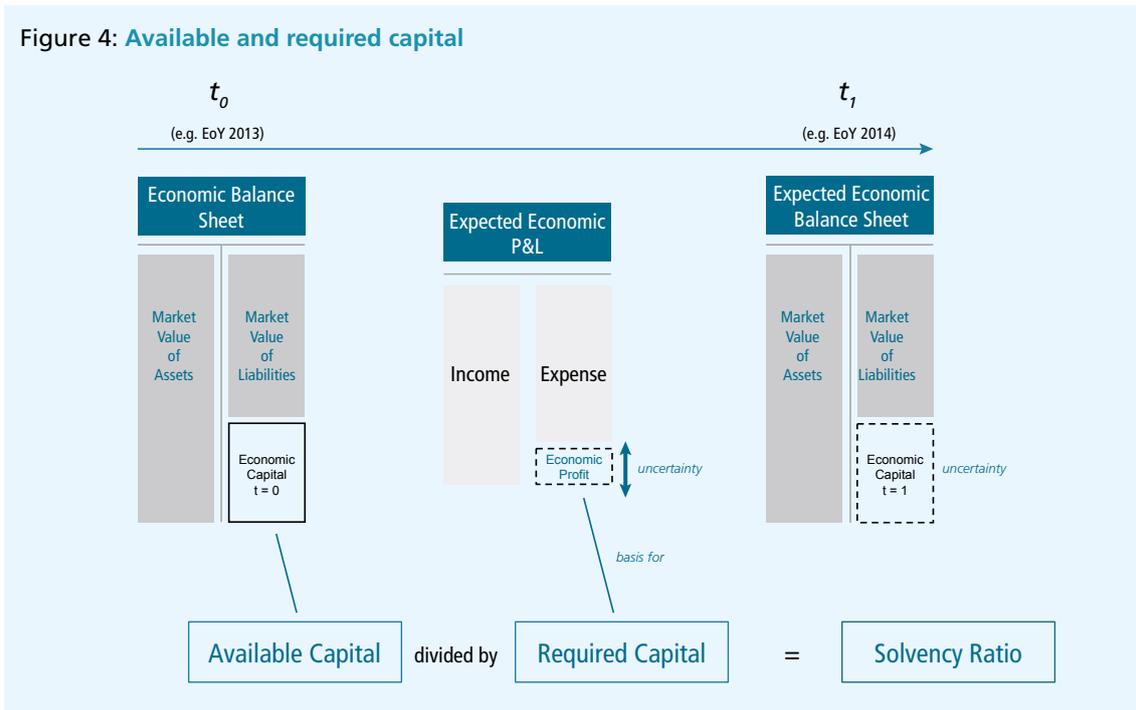
At the beginning of the year the economic balance sheet is obtained by an economic valuation of the accounting balance sheet. The economic capital is basically what is available at this point in time. Throughout the year there is a certain expectation in relation to income and expenses, on which on average, normally an economic profit is expected. But due to the uncertainty of income and expenses – for example will there be the large earthquake claim or not – there is uncertainty around the economic profit. This uncertainty is the basis for calculating the required capital, or the solvency capital requirement.

Uncertainty over the economic profit implies uncertainty on the economic capital at the end of the year. There can even be cases when this becomes negative, for example if the large earthquake claim happens and if a large reserve increase is required at the same time.

The solvency ratio is calculated by taking the available capital (economic capital on opening economic balance sheet) divided by the required capital (calculated based on the uncertain economic profit).

Where does reinsurance play a role in this? Buying reinsurance has the principal effect of reducing the required capital since in general uncertainty on the economic profit is reduced. Basically, the more reinsurance is bought, the less required capital is needed to cover the underwriting risk; investment risks and other risks are generally not materially impacted.

In an economic view of reinsurance, there is a trade-off between the reinsurance having a cost, which is compensated by the fact that less capital needs to be held, i.e. less costs relating to the risk adjusted or required capital which has to be held. These two things need to be considered together in the economic valuation of a reinsurance program.

Figure 5: **Premium *vs* Capital for reinsurance contract**
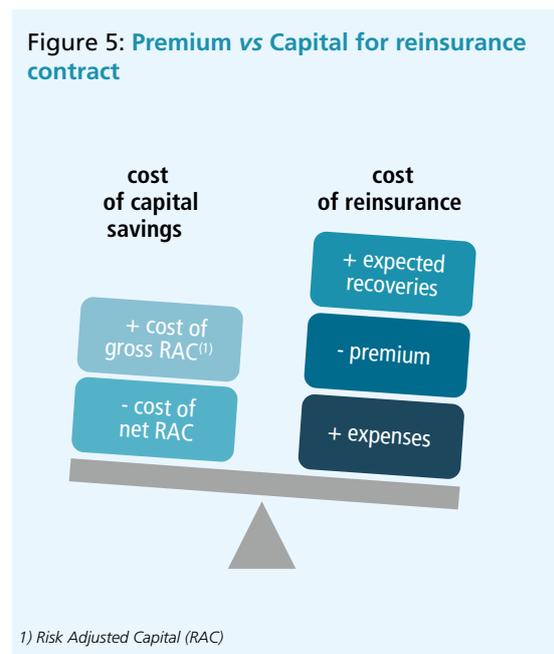
1) Risk Adjusted Capital (RAC)

Typical risk measures

For financial institutions the primary focus of capital is not to provide financing, but mainly to absorb the risks undertaken. It is thus the "commodity" used to produce the company business.

The amount of required capital is determined by the insurance company's risk appetite, in other words, the amount of capital the company is willing to risk in a certain time horizon. Besides risk appetite, at the heart of the risk/reward strategy are the proper definition of required capital and a capital allocation policy. These are prerequisites for the optimization of the portfolio's profitability, because they build the foundations on which to measure the true performance of the business. Hence they have to be incorporated at the core of business processes.

Different types of risk measures are used for the definition of required capital at specific percentiles. Solvency Capital Requirement (SCR) is defined based on the risk measure value at risk at 99.5% (or 1/200 year return period) in Solvency II, target capital in the Swiss Solvency Test is defined as Tail value at risk at 99% (or 1/100 year return period). In Figure 6, we show the definitions of the different risk measures.

Figure 6: **Illustration of risk measures**
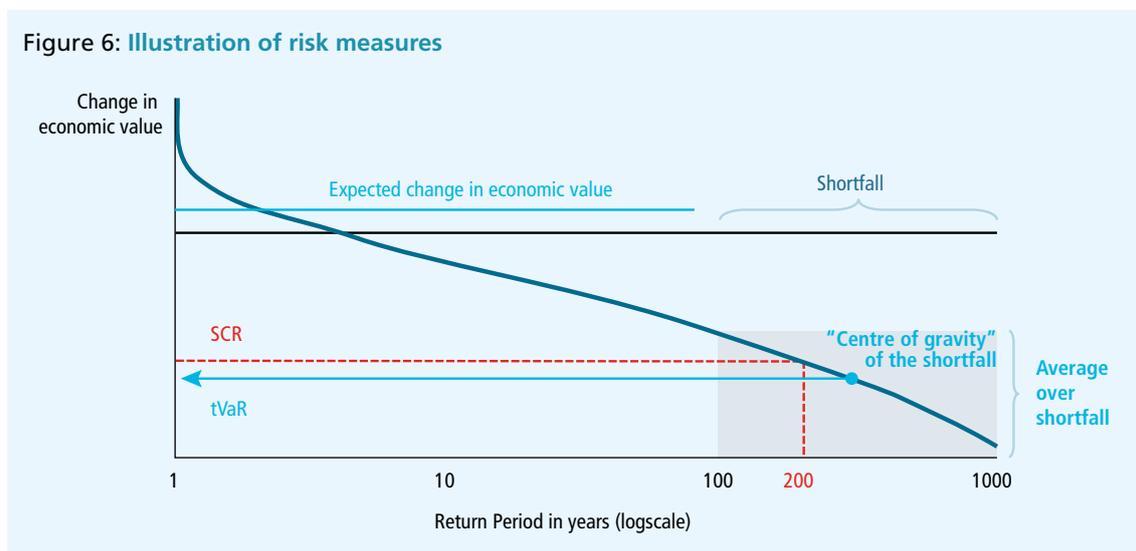
In red, the SCR (value at risk) is shown as the 1/200 year return period of the change in economic value distribution. In blue tail value at risk at the 1/100 year return period is shown; it is defined as the average over all events of the change in economic value distribution exceeding the 1/100 year event. We also show the expected profit in blue as "Expected change in economic value".

Value at risk is quite a natural view for a shareholder since their investment is lost as soon as a loss exceeds a certain level. For policyholders or regulators a more natural risk measure is tail value at risk since it is in their interest to minimize the risk of not being compensated for claims.

It's clear that for solvency regulation, there has to be an agreement regarding the choice of risk measure. It may make sense for internal purposes to use a different risk measure, as long as it can be translated it into a risk measure which the regulator requires. Value at risk is the defined risk measure of Solvency II, but for capital allocation, it's really not very easy to use. If risks are normally distributed, it can be managed. But for the typical heavy tail risks that we see in (re)insurance, using it for capital allocation is not straight forward.

Even though an informed investor will want to know what is expected to happen in extreme tail events, in general, he or she is interested not only in cases where the risk exceeds the capital but also in deviation from expected profit.

For managing the company, tail value at risk is a coherent risk measure facilitating the allocation of capital to the various risks involved. As we have seen previously, the risk measure is calculated on the uncertain economic profits or losses from new policies as well as all other profit contributors This capital requirement is then allocated to different components of risk possibly down to individual policy level. This allocation is then the basis for the calculation of the cost of capital for the individual policy. The methodology used in capital allocation will steer the portfolio in a natural way.

To illustrate the full economic view of a reinsurance program, please refer to the example shown in Figure 7. The impact on the insurers and the reinsurers required capital is shown for a reinsurance program on the new business underwritten.

Figure 7: Optimal (Re)Insurance (RI), why it makes sense economically – an example
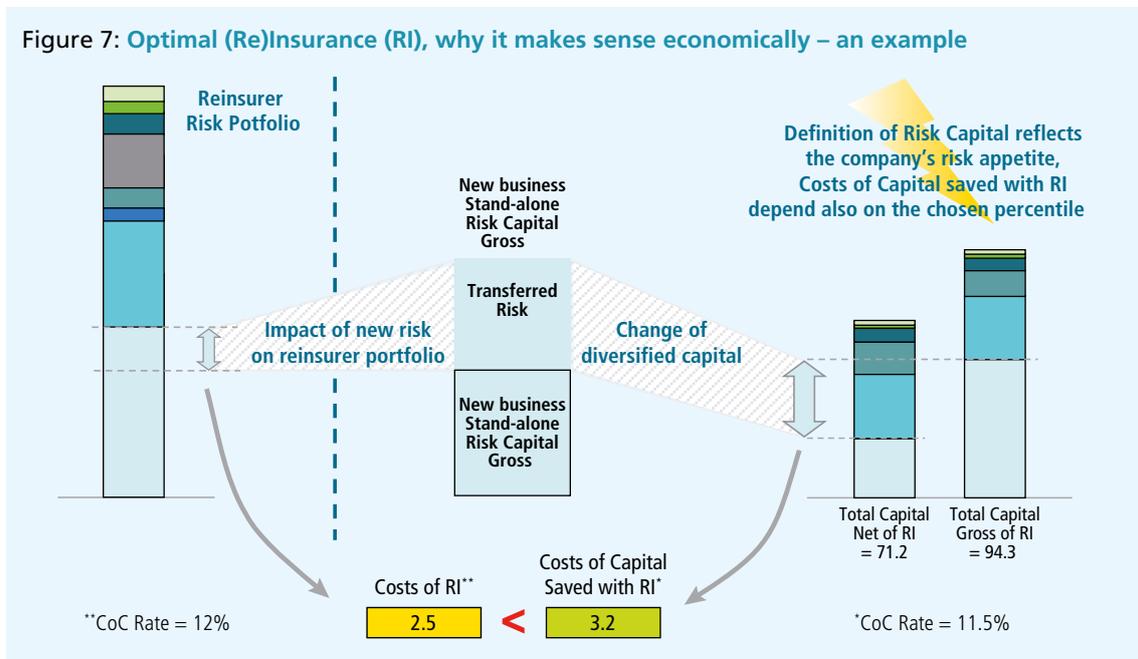
In Figure 7, we show how the same sub-portfolio looks different when kept in the insurer's portfolio or when it is ceded to a (re)insurer. On the right-hand side of Figure 7, the impact on total capital requirement of reinsurance is shown. The capital requirement of 94.5m is reduced to 71.2m considering reinsurance of a sub-portfolio of the new business underwritten (light blue box). The same transferred risk is shown on the left as part of the reinsurer's portfolio where the capital requirement is lower due to better diversification with other risks. In particular the cost of capital which the insurer saves on the transferred risk is higher than the cost of the reinsurance, which means that economically this is a viable transaction.

To illustrate this effect, assume that a national monoline insurer cedes risk to an international reinsurance company which is well diversified, both geographically and through different types of business. In the reinsurers' portfolio, diversification is different and capital allocated to that transferred risk is very different. Even if the cost of capital rate of the reinsurance may be higher, the underlying capital which is allocated to that piece of business may be smaller.

Conclusions

• Various aspects must be taken into consideration when setting a reinsurance program. The economic impact, and in particular the impact on capital as shown in this presentation only represent one aspect.

• An adequately used internal model may provide indications of the economic impact of a reinsurance program and help to optimize the economic cost, by considering business constraints and risk preferences. Partial stochastic models allow evaluation of capital impact for different reinsurance options in a more appropriate way.

• The capital required by a given risk depends on the whole portfolio. This applies for example to a portfolio from a regional insurer which is ceded to a global reinsurer, giving rise to another level of diversification.

• A fully diversified capital view is essential to take into account the cost of capital relief.

• Factor models or models based on aggregate distributions (like rating agencies' models and standard formula) do not properly reflect the impact of non-proportional reinsurance.

6

TRENDING TOWARDS THE P&C OPTIMAL LIABILITIES PORTFOLIO:
HOW TO ALLOCATE CAPITAL AND MEASURE RETURNS ON A DYNAMIC, MARGINAL BASIS

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The optimization of a (re)insurance company's portfolio is critical to its long-term success and survival. One can look at optimization as managing the balance between maximizing profits and minimizing the use of resources required to generate business; in (re)insurance one key resource is the capital supporting the risk that the company is assuming/covering from its clients/cedants. While recognizing that there are other considerations and dynamics (e.g. long-term versus short-term, the impact of cycles and the importance of managing through these cycles; and resources besides financial capital such as brand, intellectual, and human capital), the focus here is on two standard dimensions: profitability and capital requirements. Like ROE, RORAC (Return On Risk Adjusted Capital) is a measure that captures these two dimensions.

Risk-Based Capital and Diversification

But Risk Adjusted Capital must be viewed from the perspective of the whole organization, and not simply a single contract or single portfolio. For a single contract or portfolio, the focus then is the capital allocated after consideration of the whole company's (Group) capital; i.e. diversified capital. To emphasize the importance of diversification and some additional properties, which we will discuss later, we call this process Risk Allocated Capital, as the amount required is based on both the underlying risk embedded in the contract, and the projected effect of adding the contract on the Group's Risk Capital. Diversification is the essence of (re)insurance. In this article, we define a measure, the diversification index, as the ratio of diversified to undiversified capital. Figure 1 shows the diversification indices of a large P&C portfolio, sorted by volume (the dimensions have been removed for confidentiality reasons), but the graph shows the great degree of variability in the diversification index.

Figure 1: **Diversification index per account sorted by volume**
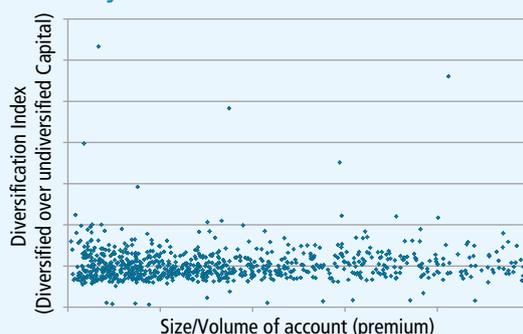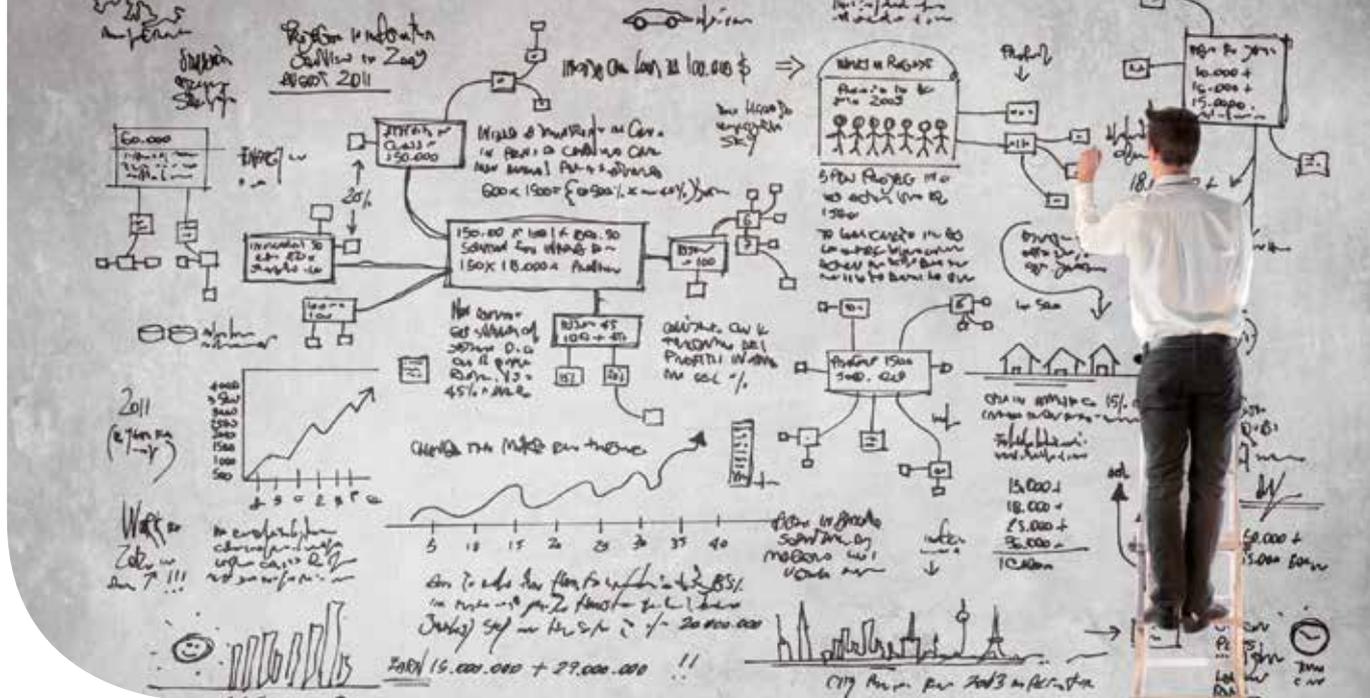
Desirable Properties of Capital Allocation Framework

In addition to the technical considerations associated with the calculation of risk capital and the underlying risk measures, there is a fundamental complication insofar as, on a single contract basis, the decision-making occurs during the renewal season, when some calibration of the portfolio compositions (shares, layers, etc.) may be necessary depending on the current market conditions. The challenge is to have a system that can address the company's targets and limitations during the planning phase (at portfolio level), and maintain consistency during the renewal system. At SCOR, the risk measure at portfolio level is xTVaR (Tail Value At Risk, with the x indicating that the risk is measured by subtracting the mean from TVaR to measure the deviation from expected). At a single contract level, SCOR uses the "diversification function", which is closely related to the xTVaR concept, to allocate capital. Both are discussed below.

Suppose we have a portfolio of risks $X = X_1 + ... + X_n$ (LoBs or Line of Business, asset classes, etc.) and we apply a risk measure p to the total profit $p(X)$. A capital allocation scheme gives the contribution $p(X_i | X)$ of the risk i to the total risk $p(X)$. A capital allocation approach should fulfill the following principles:

- **Full allocation principle:** the different contributions $p(X_i | X)$ should add up to the total risk $p(X)$

- **RORAC compatibility:** suppose that the RORAC of risk is larger than the RORAC of the overall portfolio. Increasing the weight of risk i should improve the overall performance of the portfolio. The capital allocation scheme can then be used for performance measurement

- **Fairness:** the contribution of a single risk $p(X_i | X)$ should never exceed the standalone risk $p(X_i)$ of this business unit

- **Riskless allocation:** adding a risk-free asset X_{n+1}, such as cash, to the portfolio should not change the capital allocated to the risk-carrying business units $X_1, ..., X_n$

- **Additionnal points:**

- At the margin, increasing the volume of risk X_i should lead to an increase in overall risk capital in line with the capital intensity of risk X_i (Capital Intensity is defined as capital over premium).

- The more a contract/portfolio contributes to the overall risk, the more capital should be allocated to it.

- Sum of the capital calculated (even when not allocated top-down during pricing) for each of the X_i risks sums up to the overall risk capital.

SCOR Approach (TVaR)

Expected Shortfall (TVaRα) – is the average of all scenarios that are above the "α" percentile. α, for example, is typically equal to 99% (one in a hundred year event) or 99.5% (one in two hundred). Capital allocation is calculated by the marginal contribution to the TVaR (Euler principal), preserving RORAC comptability.

This allocation scheme in Figure 2, called **contribution to shortfall**, is used in SCOR's internal model. Suppose $\alpha = 99\%$, considering the 1% worst scenarios for the whole company. The allocated capital for risk is obtained by averaging the contributions of X_i to these extreme scenarios.

$$tVaR_\alpha(Xi \mid X) = E\left[X_i \mid X \geq VaR_\alpha(X)\right]$$

Figure 2: **Example of risk measures using the TVaR method**
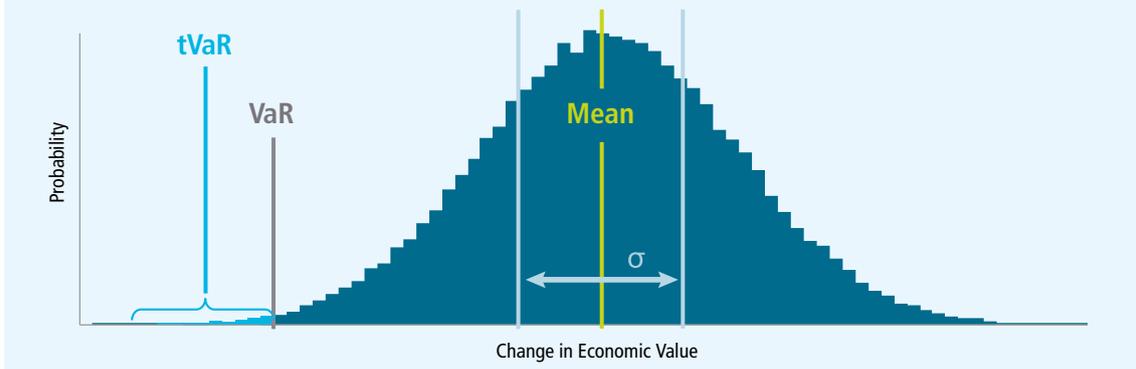
Advantages/Properties of XTVaR

Allocation of Capital, based on contribution to shortfall or xTVaR, **satisfies all the properties desired** for a capital allocation scheme, since the expected shortfall is a coherent risk measure. There are many technical papers addressing this topic, and our focus is on the practical aspects of this scheme, showing the desired

properties of: **Full allocation**, **RORAC compatibility**, **Fairness**, and **Riskless allocation**. We show some of the other desirable properties that are more related to portfolio optimization, illustrated with graphics based on modelled portfolios, and using the contribution to xTVaR as the capital allocation measure.

1. DEPENDENCE AND VOLATILITY (SIZE OF)

Figure 3: **Capital Diversification Index increases with standard deviation**
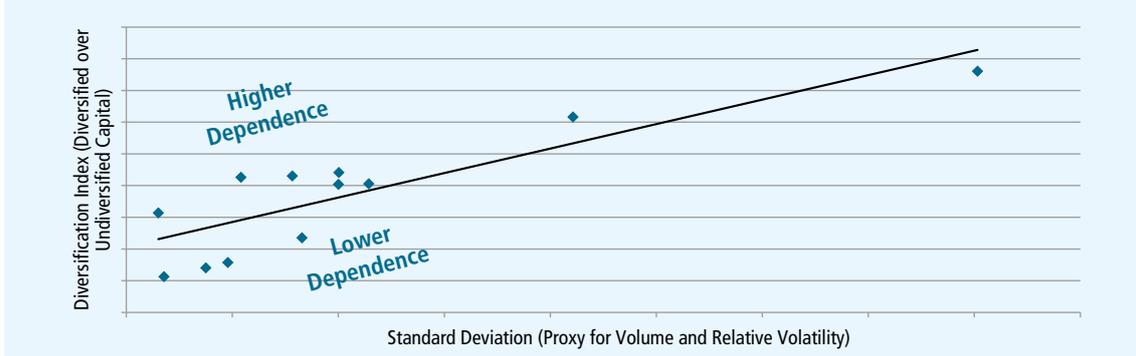
As shown in Figure 3, the Capital Diversification Index increases with standard deviation: the standard deviation of a portfolio reflects the combination of the volume of the portfolio and its volatility. As the standard deviation increases, the diversification benefits of combining this portfolio with the rest of the Group are reduced, keeping the diversified capital closer to the undiversified. For similarly sized standard deviations,

the main differentiator between a higher or lower Diversification Index is the dependence "correlation" between a particular portfolio and the overall Group. Both of these features are consistent with the desired measures, leading to portfolio optimization from a risk/benefit perspective: allocate less capital (focus more on growth) to the smaller portfolios and on the portfolios that diversify better (less co-dependence) with the rest.

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2. CONSISTENCY OF CAPITAL INTENSITY AND MARGINAL CONTRIBUTION TO GROUP CAPITAL

Figure 4: **Marginal Overall Capital (how much more capital is required for a unit increase in a portfolio) is the same as the capital intensity of that portfolio**
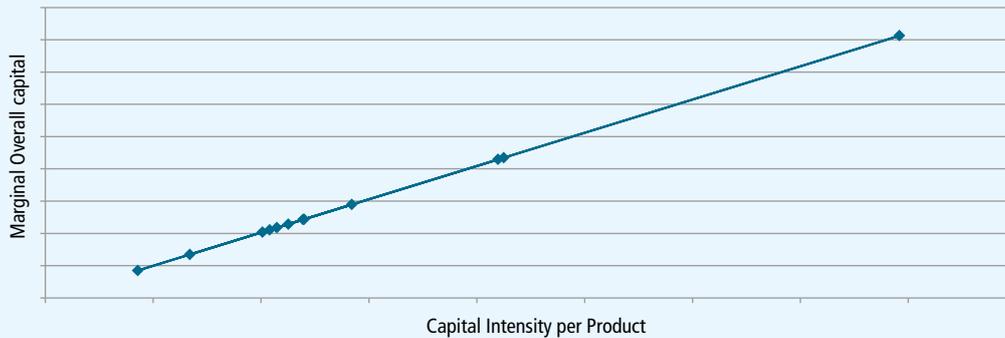
With marginal xTVaR, adding one extra unit to portfolio A leads to the same additional capital required for portfolio A and for the Group. While this is an intuitively obvious requirement, many risk measures do not have such a property. Figure 4 illustrates this feature for a combination of portfolios, where on the x-axis, the capital intensity is plotted against the marginal contribution to the Group of each of the products.

3. OPTIMALITY BASED ON RISK

Using only two portfolios (A and B) to illustrate other desired characteristics of the xTVaR measure, Figure 5 shows the volatility of the combination of the two portfolios, with relative weights between the two. Each line plot considers a different volatility of the second portfolio (B) in relation to the first (A).

In each line, the optimal combination is graphically the lowest point. Except in the case of perfect correlation, the lowest point (optimal portfolio) is always some combination of the two, with the optimality trending towards the portfolio with lower volatility.

Figure 5: **Portfolio optimization between two portfolios, varying relative volatility**
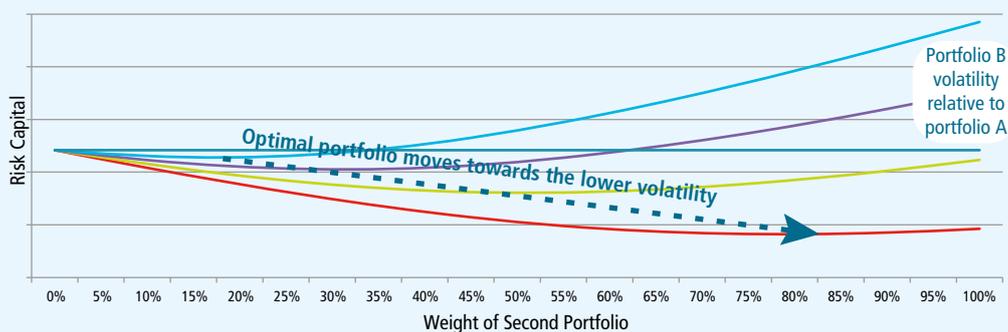
4. OPTIMALITY BASED ON RISK AND RELATION TO CAPITAL INTENSITY

Figure 6: Risk-diversified capital

Figure 7: Diversified capital intensities
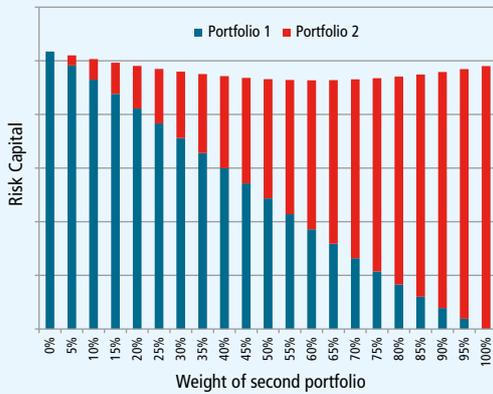
Minimizing risk capital for the same premium volume with no consideration of differences in terms of each portfolio's profitability (or assuming the same profitability), the minimum point (optimal distribution) is reached when the two capital intensities are equal. In Figure 6, the lowest required capital corresponds to a 40% weight of Portfolio 1; Portfolio 1 has higher volatility, shifting the weight of the optimal Portfolio towards Portfolio 2. In Figure 7, note the very low capital intensities (risk diversified capital per unit volume) at low portfolio weights. At optimal weighting, the capital intensities of each of the portfolios and the overall portfolio are equal.

5. OPTIMALITY BASED ON RISK AND PROFIT

Figure 8: RORAC Optimization, with portfolio 1 having relatively higher profitability

Figure 9: Optimal RORAC and Optimal Capital do not correspond once profitability per unit is different
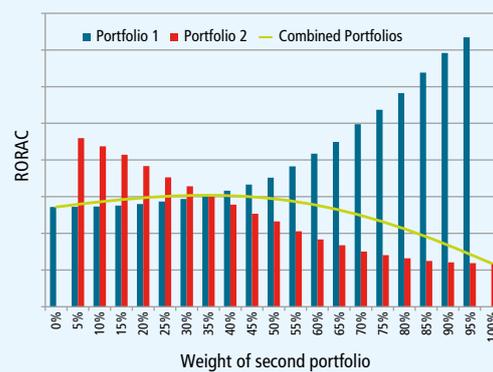
While in the previous graphics we ignored differences in profitability (or implicitly assumed the same profitability), Figure 8 shows the optimal portfolio after consideration of profit, where we assume that the first portfolio is more profitable. In Portfolio 1 the profit per unit of volume is the same. But, as shown in blue, the RORAC increases because its capital intensity decreases as we add to the weight of Portfolio 2, increasing the diversification effect of Portfolio 1. The same phenomenon (but in the opposite direction) occurs for Portfolio 2, with optimal (maximum RORAC) reached when the two RORACs are equal. Figure 9 shows the optimal portfolio looking simply at capital, and the optimal capital from a RORAC basis.

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Capital allocation and RORAC during renewal at single risk level __

With the TVaR approach, the "diversification function" is deduced by portfolio. A key characteristic is the fact that it reproduces the diversified risk capital allocated to this portfolio.

During the renewal, the portfolio cannot be frequently remodelled to measure the marginal xTVaR of a contract within the framework of the Group model.

A robust approach, which does not require remodelling of whole portfolio, is devised in line with the above concepts (including xTVaR), via the use of the risk diversification functions. These functions are derived when the whole portfolio is modelled, and have the following characteristics:

- If applied to any of the risks or portfolios in the underlying original model, they reproduce the same exact xTVaR marginal capital.
- If applied to each of the risks (contracts) within a portfolio, the diversified risk capital of each of these risks adds up to the capital of that portfolio.
- Higher risk contribution leads to higher diversified risk capital.

This means that all the features/characteristics of the TVaR allocation principles can be kept during pricing, without having to re-simulate the whole portfolio. During the renewals, this system facilitates decisions based on RORAC and Capital Intensity, on a treaty-by-treaty basis, bearing in mind that the system is compatible with the overall Group capital, as illustrated by the example in Figure 10 below.

Figure 10: **Pricing layers of a non-proportional contract**
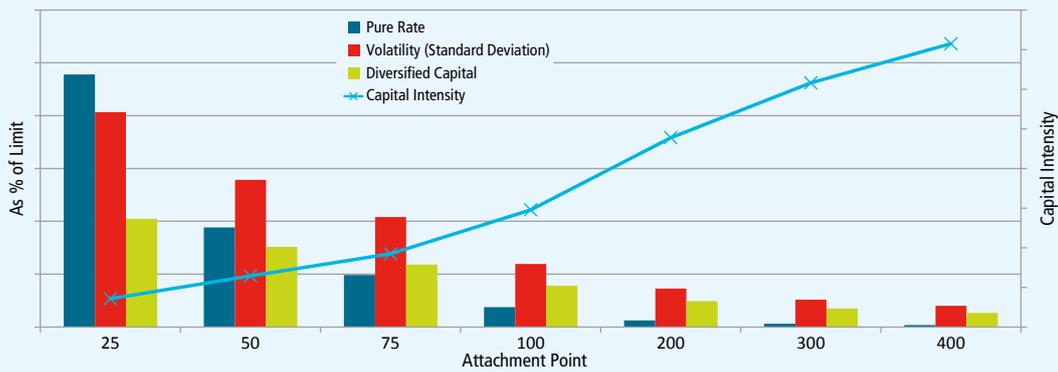
The pricing system develops the Risk Allocated Capital based on the account's risk profile and the treaty terms and conditions. Figure 11 shows the capital allocated to treaty layers of a single account. While, in Figure 12, the pure premium (expected loss) reduces as we move up the layers, the volatility and Risk Allocated Capital also reduce but at a slower rate. Especially for high layers with low expected frequency, the capital as a percent of the limit is more meaningful than capital intensity.

Figure 11: **Capital allocated to treaty layers of a single account**

Figure 12: **Loss and Cost of Capital as % of Target Premium**
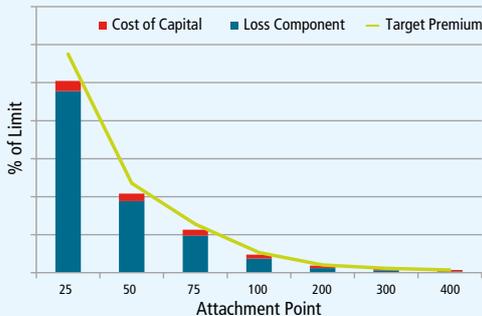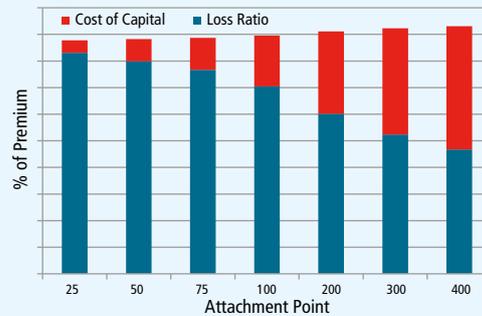
It is only the cost of Risk Allocated Capital (and not the amount) that gets factored in the pricing. With the higher layers, the premium, expected loss, and cost of capital decrease. Proportionally, when comparing the cost of the capital component to the loss component, the cost of capital as a % of target price increases.

NAT CAT DIVERSIFICATION BENEFITS

PAUL NUNN
Head of CAT Modelling
SCOR Global P&C

Introduction

Diversification is an essential and powerful feature of the Global Reinsurance business model, and this is particularly the case with natural catastrophe risk transfer. In this article we illustrate the numerical benefits with the help of a simple model, before looking at the challenges we face in trying to quantify catastrophe risk in the real world.

Simple abstract CAT model

Imagine a die that has five blank sides with no value and one side with the number six. You have many chances where nothing happens and then when an event does happen, you have a large, bad outcome.

Think of this die representing the risk profile for a single region peril, like a Florida hurricane, for example. If we do a simulation with this very simple model and roll the die 100,000 times, we get the following summary metrics:

Expected Loss = 1
Standard Deviation = 2.23
1:6 Return Period = 6

On average we would have an outcome of one, and the worst case outcome is clearly six. It happens with a relative frequency of one in six, which is a VaR measure. There will be variation around that expected loss, which is represented in the standard deviation.

If we add another die which identical to the first one, this would represent the *diversifying* nature of adding a new, independent, region peril to the portfolio. There are many different potential pairs of region perils that have no real linkage, e.g. Cyprus earthquake is completely independent to UK flood.

With two dice, we have more risk and naturally the *Expected Loss* goes up to 2. The Standard Deviation also increases, but not proportionately, so there is relatively less volatility when a different risk is added.
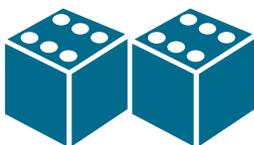
Expected Loss = 2
Standard Deviation = 3.16
1:6 Return Period = 6 !
1:36 Return Period = 12

A somewhat unexpected result in this 2-dice case is that the one-in-six return period outcome is actually the same as in the 1-die case. The diversifying effect of combining independent region perils of equal size is very strong here. An important difference is there is now the possibility of having a significantly bigger loss. We now have a worst case of twelve when both of those sixes come up at the same time.

If we had rigged dice, such that the sixes always came up together, that would suggest that our region perils are perfectly correlated. When an event happens in one region peril, it gives rise to a comparable loss in another region peril. This is essentially the same as having one die with the number twelve instead of six on it.

Conceptually, the key is to understand where we have true independence between catastrophe region perils and where there is some level of correlation. There are many examples of different insurance markets that can be affected by common events. Europe is a very obvious example where windstorms and floods can hit many countries at the same time. Similarly, in North America west coast earthquakes can simultaneously affect US and Canada.

So in the real world we have cedants in different markets of different sizes, with different levels of exposure looking for risk transfer. We are dealing with a lot of different sized dice with complex dependencies between some of the dice.

Catastrophe modelling

Historical claims information really doesn't get us very far in terms of quantifying the tail of loss distributions for natural hazards. There are far worse potential outcomes than we have loss experience data for. Catastrophe modelling started in the 80's, incorporating science and engineering knowledge to provides us with a framework to assess the likelihood of different possible loss outcomes.

CAT models represent *hazard* by creating a rich catalogue of events that plausibly might happen. For a given region peril, there can be tens of thousands of different catalogue events representing 100,000 simulated annual outcomes (or rolls of the dice). These catalogues of synthetic events that could happen form the backbone of all CAT models.

The key to how CAT models help understand diversification within a region-peril lies in the footprint of each synthetic event. The footprints help to geospatially constrain the losses calculated by testing for whether insured assets are inside or outside the damage zone of each hypothetical event. If an insured location is inside the event footprint the CAT model calculates the damage and resulting loss outcome, and keeps track of the sum of the losses across entire portfolios of insured assets. Locations correlate (and diversify) differently when tested for different sized and shaped event footprints and CAT models enable us to more completely represent this complexity in terms of the interaction between hazard and exposures.

Another challenges is that natural hazards do not respect national boundaries. While it may be convenient to manage risk on a market-by-market basis, we have to be very careful to consider the correlations between neighboring countries. As catastrophe models have matured (and compute power has increased), they have been extended to more holistically reflect hazards that can affect multiple countries, allowing us to capture those geographic nuances and complexities more accurately. Caribbean-US-Mexico hurricane clash potential, and extending European Windstorm models eastwards are good examples.

While these are core tools, widely used by our industry, we have remarkably few suppliers of CAT models. In the spirit of talking about diversification, I think we would benefit as an industry from having greater diversity and

choices in terms of models. For some countries there is only one model available. For other countries there are no available models because there is no real prospect of getting extra commercial returns on the additional research outlay for the vendors.

There is hope. An initiative called *Oasis* is currently underway at the moment. It's industry driven, with a community of around 30 large insurers, reinsurers and some of the large reinsurance brokers. It's a not-for-profit initiative and the idea is to open up the pipeline of available models by creating a shared, *open* framework that allows other organizations and institutions to reveal their intellectual property to us in a way that we can use as an industry. There are a number of new region-peril models that are being developed to run within an *Oasis* environment.

CAT diversification exemplified

Figure 1 shows a capital modelling case study focusing on catastrophe lines of business. The light blue bars show the standalone capital required to support seven different region-perils on a Gross of Risk Transfer basis.

The sum of these light blue lines adds up to 100%, which represents the total one-year capital if each of the seven CAT-lines was capitalized separately.

Figure 1: **Diversification Benefits; writing different CAT-lines (Gross figures)**
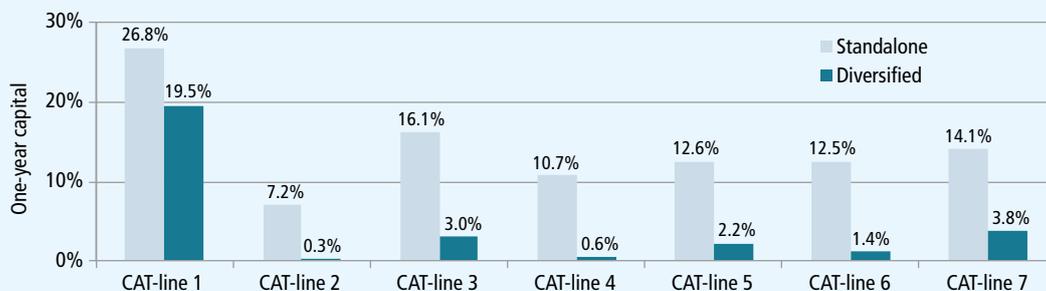
There is a significant benefit in terms of how much capital is required to support the combination of different CAT lines in a single company, and in our case study this Diversified capital amounts to just 30.8% of the Sum of Standalone Gross capital – not much more than CAT-line 1 requires on its own.

Notice the variation in relative diversification across those seven lines, you can see that CAT-line 1 benefits

least, and still dominates the risk profile and capital needs of the combined portfolio.

When we actually look at the effect after risk transfer, diversification is improved even more (Figure 2). This is because by taking out some of the peak risks, we make the relative sizes of the different risks more comparable and diversification effects are even greater.

Figure 2: Net of Risk Transfer one-year capital requirements
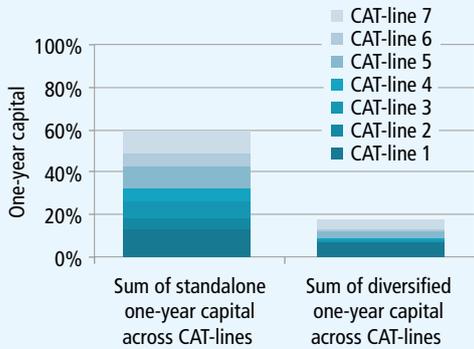
So CAT models give us the chance to quantify risk for different region-perils and our capital models help us realize the benefits of building a portfolio of geographically diverse broadly independent risks. However as alluded to earlier, we do not have CAT model coverage of the whole world. Flood has been a particularly difficult peril that is very complex and expensive to model, requiring a lot of data and computing power. At SCOR we are pretty conservative in terms of how we represent the risk to non-modelled regions in our capital modelling framework. On a standalone basis, the non-modelled pieces would require almost as much capital as the CAT modelled segments, however because they are typically smaller risks, after diversification this group of region-perils would still consume around 12% of the overall diversified capital - a material component of the capital for CAT risk in this realistic case study.

A word of warning…

From the perspective of managing natural catastrophe risk, the diversification benefits that accrue from a geographically balanced portfolio are fundamental to the global reinsurance business model. It's through diversification that we are able to accept the risks from different markets around the world. CAT models play a key role for SCOR in helping to understand diversification between perils and within perils, but gaps persist. There are limitations to some models that we need to be mindful of, and SCOR is certainly working on initiatives to close some of those gaps.

We are seeing changes in the world, such as climate change, sea level rising. In addition to changing underlying hazards, there are large scale climate patterns (like El Niño) and the subtleties of these dependency relationships are not yet explicitly incorporated into our modelling frameworks.

"Di-*worse*-ification" and "diversi-*fiction*" were two terms that were coined in 2011 after a number of people got their fingers burnt by the surprises of the Thai floods, US tornadoes, etc. It's important to understand that the risk adjusted price adequacy for CAT risk in different markets varies widely. Trusting that diversification will serve as a substitute for properly understanding and analyzing all of the risks could turn out to be a costly mistake.

8

REGULATORY PERSPECTIVE
ON SOLVENCY REFORMS

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Why a solvency reform?

In the EU, the last major solvency reform took place in the last century, about 30 years ago. The reform was called Solvency I. After the capital market crisis at the beginning of this century, a regulatory update of Solvency I was planned. This became ultimately Solvency II. The development of the project took about 10 years.

It is remarkable that the insurance sector is the only major sector in financial services that does not yet have a global accounting standard, nor a global solvency standard. This does not come as a surprise. There has been – and still is – a great deal of disagreement on how to reflect the insurance business model in an accounting standard that is acceptable world-wide. This has to do particularly with the difficulty to reflect long term business in financial statements. Similarly, the insurance sector has been very reluctant to follow the Basel reforms. The absence of a tough international regulator, such as the Basel Committee, and the absence of a major insurance crisis have no doubt been important reasons why it has been difficult to develop a global insurance solvency standard.

It is interesting to see that after the last financial crisis, which was a banking crisis, pressure is increasing on the insurance sector to modernise its regulatory regime.

Is there a problem?

It is sometimes argued that there is no need for reform because the insurance industry has resisted well during the financial crisis. This is only partly true. Not only did governments in a number of countries have to bail out a number of insurance undertakings, but more importantly one should not forget that times have changed. The old Solvency I model is no longer adapted to the present financial and economic environment. A number of major insurers and reinsurers (including SCOR) have realized that and have already taken action to introduce a regime whereby a clear linkage is established between risk and capital. This relationship which is already recognized under Basel II, is absolutely crucial if one wants to manage an insurance undertaking in a professional manner today.

Solvency I is not sufficiently risk sensitive, i.e. it does not contain any incentive for management to improve risk management. This is surprising because insurance is first and far most about a proper management of risks. Solvency I looks primarily at the underwriting risk and ignores other important risk categories, such as market risk, credit risk, liquidity risk and operational risk. It does not recognize risk mitigating techniques, such as reinsurance, nor does it recognize diversification benefits. In fact, one can say that the solvency regime that is applicable today to the insurance sector is no longer fit for purpose.

Would insurance undertakings have changed their practice without a regulatory reform? The answer to this question is definitely "no". One should not overestimate nor underestimate the importance of regulation, but one thing is certain: without a requirement to change, most insurance undertakings would still continue to do what they have been doing for decades now. With a few exceptions, the insurance industry would not by itself fundamentally change present practice. It is enough to look at the negotiations around Omnibus II

in the EU, to see how quickly the insurance industry falls back into the old practices.

The absence of a regulatory reform in insurance creates problems of regulatory arbitrage with the banking sector. This is not unimportant. One can already see today that some traditional banking activities are now being carried out by insurance undertakings because the regulatory requirements for insurers are less severe than those which have been introduced now as a result of Basel III. This is a great worry for insurance supervisors because the risks resulting from such activities do not appear under a Solvency I approach.

Finally, it is strange that in a globalised world where major insurers compete internationally, there still is a total lack of comparability between the various solvency and accounting regimes which apply throughout the world to the insurance industry. This is of course equally true within the EU: there are as many Solvency I regimes as there are Member States and the financial statements of insurers from different Member States are completely incomparable.

Main characteristics of Solvency II

Solvency II adopts the three pillar approach of Basel II: a quantitative pillar (Pillar 1), a qualitative pillar (Pillar 2) and a transparency pillar (Pillar 3). Together, these pillars form the house of Solvency II. The roof of the house is made up of group supervision.

Under Pillar 1, insurance undertakings must prepare a solvency balance sheet in which all assets and liablities are calculated on a market consistent basis. Two capital requirements are introduced: the Solvency Capital Requirement (SCR) and the Minimum Capital Requirement (MCR). These capital requirements

are linked to the risks incurred by the insurance undertakings, i.e. the better the insurance undertaking manages its risks, the lower the capital requirements can be. This is no doubt one of the major advantages of the new capital regime: it rewards good risk management.

The SCR is established as a warning signal for supervisors: if the undertaking's solvency capital falls below the level of the SCR, a dialogue is established with the supervisor to discuss possible remedies that will allow the undertaking to restore its SCR. It is therefore incorrect to state that the SCR must in all cases be above

the level established by the solvency regulation: the SCR operates more like a snake than as a straight line. This is the logical consequence of a valuation on a market consistent basis. Breaching the SCR does not mean that the undertaking is in trouble or that it is on the verge of bankruptcy as some people seem to argue. This is a difficult issue that must be properly communicated to stakeholders. The SCR can be calculated on the basis of a standard formula or on the basis of an internal model. The standard formula will no doubt be used by most insurance undertakings. It has been tested in 5 Quantitative Impact Studies (QIS). An internal model can be used if it has been approved by the supervisor. Of course, the confidence level that is adopted in order to calculate the SCR is not absolute. Solvency II adopts a confidence level of 99,5% VaR over a one year time horizon. Today, this confidence level is considered high. When Solvency II was developed, the European Commission was critized because some people considered the level too low!

The MCR represents an absolute floor, i.e. the solvency capital should never fall below the level of the MCR (which is about one third of the SCR). If the capital falls below that level, the undertaking will have to cease its activities.

Pillar 2 contains the rules on governance and supervisory action. Most insurance failures are due to a lack of good management rather than to a lack of solvency capital. Solvency II therefore attaches great importance to good governance of the insurance undertaking. Four key functions must be put in place: risk management, actuarial function, internal control (compliance) and internal audit. The people in charge of these functions, as well as the members of the board, must be fit and proper, i.e. they must be honorable and knowledgeable. As part of the risk management, each insurance undertaking will have to carry out its Own Risk and Solvency Assessment (ORSA). This assessment should serve as a tool to monitor the quality of the undertaking's risk management.

Pillar 2 also contains the measures which supervisors can take in the context of the supervisory review process. For the first time in European history, supervisory tools are harmonised, i.e. all supervisors in the EU wil have the same tools, which include on-site and off-site inspection, stress testing and the power to impose sanctions. Furthermore, through a system of peer reviews, it will be possible to monitor the application in practice of the new European rules in all Member States and to force those Member States that stay behind, to improve their quality of supervision.

Pillar 3 is the area which is the most disliked by industry: transparency. Insurers will have to change their present practice of very limited disclosure. The amount of disclosures to supervisors will increase tremendously. This cannot come as a surprise. At present, supervisors receive very little information about the way an insurer is running its business. This is no longer acceptable because it makes it impossible for supervisors to take appropriate action before a major crisis breaks out. With the new Pillar 3 dislosures, the insurance industry will at last become comparable with the banking industry, which has been subject to very detailed and regular reporting requirements for decades.

Through the Solvency and Financial Condition Report, the insurers will communicate with the outside world. Here again, the mentality will have to change. Because of the high level of sophistication of the new solvency regime, it is in the interest of insurers to properly communicate with the market.

Finally, Solvency II attaches great importance to group supervision: all groups will have to set up a college of supervisors which is chaired by a group supervisor. This is the most difficult area of supervision because it has to do with power and glory: can supervisors from different countries accept that one of them – the group supervisor – is more important? Which powers should be given to the group supervisor? Can (confidential) information flow freely between supervisors who are involved in the supervision of the same insurance group?

Group supervision receives the same attention under Solvency II as solo supervision. Each group must prepare a group solvency balance sheet, calculate a group SCR (possibly on the basis of a group internal model) and a group MCR, prepare a group ORSA and report the group situation to the group supervisor and to stakeholders.

Recapitulation of the legislative process

The new solvency regime was proposed by the European Commission on 10 July 2007. The proposal was adopted by the Council of Ministers and the European Parliament on 29 November 2009. It is now commonly referred to as the Solvency II Framework Directive. The Directive is legally binding. It is addressed to Member States, which must adapt their national legislation so as to make it comply with the principles set out in the Directive. Originally, the first date of application of Solvency II was set at 1 November 2012.

The new solvency regime applies in principle to all insurance and reinsurance undertakings. Very small undertakings are exempted.

Solvency II follows the so-called Lamfalussy approach, i.e. the legislation is spread over three levels of rules: a framework Directive containing the principles (level 1); implementing measures developed by the European Commission (level 2); guidelines developed by the supervisors in the context of the Committee of European Insurance and Occupational Pensions Supervisors (CEIOPS).

Solvency II was developed before the financial crisis broke out in 2008. It has however been affected by the financial crisis. Two important developments followed from the financial crisis. A proposal was made to amend the Solvency II Framework Directive in January 2011 and it was decided to transform the CEIOPS into an authority, the European Insurance and Occupational Pensions Authority (EIOPA), with new powers and a larger budget.

Omnibus II changes the Solvency II Framework Directive in a number of important areas (treatment of long term guarantees, proportionality, powers for EIOPA and for the Commission, transitional measures, new date of application). It was adopted after difficult negotiations on 16 April 2014. The new date of application of Solvency II is now 1 January 2016 and Member States must implement the Solvency II Framework Directive, as amended by Omnibus II, by 31 March 2015. It is important for Member States to respect this deadline as a number of approval processes (for instance, for undertaking specific parameters, own fund items and internal models) must already start on 1 April 2015 if undertakings are to benefit from these approvals from 1 January 2016. Omnibus II also changes the legislative approach: the Lamfalussy approach initially adopted was abolished in conformity with the changes following from the Lisbon Treaty which increases the powers of the European Parliament. Five important changes: a number of detailed requirements were added to the Solvency II Framework Directive, so that the European Parliament could have co-decision powers on the issues concerned; implementing measures from the Commission are now called Delegated Acts or Regulatory or Implementing Technical Standards; the Regulatory or Implementing Technical standards are prepared by EIOPA; the Delegated Acts adopted by the Commission are subject to the scrutiny (during a period of at least 3 months) of the Council and of the European Parliament; EIOPA is established as the main driver for the further development of implementing legislation on Solvency II.

EIOPA is very different from its predecessor, CEIOPS. It has received a number of powers that will fundamentally change the way in which insurance supervision is carried out in the EU.

At the regulatory level, EIOPA can develop technical standards (Regulatory Technical Standards or Implementing Technical Standards), which become legally binding after adoption by the European Commission. EIOPA can also adopt Guidelines and Recommendations. These are addressed to supervisors or to insurance undertakings. Although they are not legally binding, supervisors and insurance undertakings are expected to comply. If an insurance supervisor does not want to comply with a guideline or a recommendation, it must explain why this is the case. This explanation (for instance, the guideline or recommendation would conflict with national law) must be made public. In order to prepare supervisors and insurance undertakings for Solvency II, EIOPA published in September 2013 a number of preparatory guidelines which became applicable as of 1 January 2014. These guidelines dealt primarily with Pillar 2 and Pillar 3 issues.

EIOPA also has the power to intermediate in discussions between national supervisors. It is represented on all colleges of supervisors, can intervene when it discovers breaches of EU law, can organise peer reviews and stress tests and can take measures aiming at the development of a common European supervisory culture and at a better protection of consumers.

If one wants to know what is going on in insurance in the EU, it is no longer possible to ignore the actions taken by EIOPA.

On 17 January 2015, the Delegated Act implementing Solvency II was published. This Delegated Act, which constitutes the level 2 measure under the Lamfalussy approach, was approved by the Commission on 10 October 2014 and was endorsed by the Council and by the European Parliament on 12 January 2015. It deals, inter alia, with the following issues: valuation of assets and liabilities, including long-term guarantees, the level of capital for asset classes in which insurers may invest in, the eligibility of insurers' own fund items to cover the capital requirements, governance, equivalence assessments of third country solvency regimes, internal models, insurance groups, simplified methods and exemptions for small insurance undertakings and capital requirements for high-quality securitisations. The Delegated Act takes the form of a Commission Regulation, which is directly applicable in all Member States so that no national measures are necessary to implement the Delegated Act.

Meanwhile, EIOPA has adopted a first set of Implementing Technical Standards which have been submitted to the European Commission for endorsement as well as a first series of Guidelines (level 3 measures under the Lamfalussy approach). A second set of ITS and Guidelines have been published for comments in December 2014. The whole legislative package should be available during the course of 2015.

A major objective of Solvency II is the introduction of a uniform solvency regime for insurance undertakings in the EU. This is the reason why the Solvency II Framework Directive only contains few options for Member States. Nevertheless, undertakings fear that the new regime will still not be applied in the same way in practice because of action by national insurance supervisors or by national governments. In order to prevent "goldplating", EIOPA tries to close as many gaps as possible through recommendations and guidelines. This is the reason why the number of measures that now make up Solvency II becomes larger every day. The question is whether this is really necessary. It would no doubt be better to move in stages and to introduce more detailed rules after having had more experience with the application of the new solvency regime. This would be more in line with the original philosophy of Solvency II which was meant to be a regulation based upon principles. On the other hand, the insurance industry is often asking for more rules because they do not trust the supervisors.

EIOPA is taking a number of measures to contribute to a uniform application of the new solvency rules. It is developing a single rulebook and a supervisory handbook. It is also monitoring the implementation

of the new regime so as to see which supervisor or Member State is going above the mark (goldplating) or stays below the mark (not fully implementing the new rules). Finally, in the area of internal models, EIOPA is setting up a system of benchmarking so that national supervisors as well as undertakings know what could be acceptable practices. EIOPA has also set up a centre of excellence for internal models in order to help national supervisors in the approval process and to provide for convergence and consistency in practice.

As many European insurance groups are operating globally, it was very important for the EU to provide for a solution for the treatment of operations of EU groups in third countries and for the operations of third country groups in the EU. This is done through a system of equivalence recognition. To the extent that a third country's solvency regime can be considered equivalent with Solvency II, operations of EU groups in these countries will be treated as if they were taking place within the EU for the calculation of the group solency capital requirement. This avoids costly recalculations.

Similarly, for the purpose of group supervision, to the extent that a third country's solvency regime is considered equivalent with Solvency II, supervisors within the EU will be able to rely on the group supervision exercised by the third country supervisor over the operations of the third country insurance group within the EU. A similar regime also applies to reinsurance.

In order to facilitate the equivalence recognition process, Omnibus II introduces the possibility to grant provisional equivalence recognition to those third countries that are developing a risk based solvency regime that is similar to Solvency II. Equivalence and provisional equivalence decisions are taken by the European Commission. The first decisions will be taken in 2015. It is likely that equivalence will be granted to Switzerland, Bermuda and Japan (for reinsurance). Provisional equivalence decisions are being prepared for countries such as the US, Mexico, Australia, South-Africa, Israël and China. Equivalence and provisional equivalence decisions are based upon advice from EIOPA which consults widely before it sends its advice to the Commission.

Long-term guarantees

The financial crisis made it necessary to take a fresh look at the treatment of long term guarantees under Solvency II. The market turbulence that followed the financial crisis created a great deal of volatility in the calculation of technical provisions and own funds. This became apparent after the results of the last quantitative impact study became public at the beginning of 2011.

The low interest rate environment complicated a smooth transition from Solvency I to Solvency II as insurers in a number of Member States had contracted life policies that provided for long term guarantees that were way above the new lower market rates. Indeed, the question was raised whether traditional life contracts would still be possible under Solvency II, which advocates a market consistent valuation of technical provisions.

In looking at the problems, it became clear that a one size fits all solution was not possible because of the existence of different life policies in the EU. On the other hand, a European solution was necessary to avoid creating distortions in the internal market and to prevent a move away from a unified approach to solvency.

The final package of measures was tested by EIOPA. It includes a matching adjustment (mainly for annuity products), an extrapolation for the calculation of the risk free discount rate (mainly for very long term business), a volatility adjustment to avoid artificial volatility in the applicable discount rate (mainly for insurers that invest heavily in sovereign bonds), an extension of the recovery period for the SCR in extreme circumstances, a transitional measure for the application of the risk free discount rate (because of the low interest rate environment) and a transitional measure for the calculation of technical provisions. The package of measures can be further implemented through a Delegated Act and through Regulatory and Implementing Technical Standards. It will be monitored by EIOPA and will be reviewed after some time. The application of the measures must be reported on by undertakings in their Solvency and Financial Condition Report.

International solvency developments

Many countries around the world are presently preparing an insurance solvency reform. It can be said that there is general agreement among insurance supervisors that a modern solvency regime should provide for a linkage between capital and risk and that more emphasis should be given to proper risk management and to group supervision. However, there are still divergences of views and not all major countries in the world are at the same level of reform.

The International Association of Insurance Supervisors (IAIS) has been working at the development of an internationally agreed solvency framework already for some time. The approach is similar to that adopted in the EU because the EU regime took the international developments into account in the design of Solvency II. The main problem within the IAIS is an agreement on quantitative requirements, whereby particularly the US is making a great deal of difficulties, notably because of the strong linkage there between the solvency requirements and the accounting requirements.

After the financial cricis, the IAIS has come under increasing pressure notably from the Financial Stability Board (FSB) to develop an international solvency capital standard.

It is indeed difficult to explain why such a standard has not yet seen the light of the day in insurance, when this has been the case in banking already for quite some time.

The IAIS started the process by developing a Common Framework for the supervision of Internationally Active Insurance Groups (IAIG's). The number of IAIG's is expected to be around 50. This means that only the very large multinational groups will be covered by this regime. The Common Framework, often referred to as CommFrame, builds and expands upon the high level requirements and guidance currently set out in the Insurance Core Principles which generally apply on both a legal entity and group-wide level. Formal adoption after field testing is expected in 2018. The main problem remains the development of quantitative requirements.

Another workstream relates to the so-called Systemically Important Financial Insitutions (SIFI's). After the FSB had identified a number of globally active banks as systemically important, with the consequence that these banks are expected to be subjected to further requirements in terms of capital, crisis management and resolution and recovery, the attention of the FSB turned to insurance.

The first question was: can insurance be considered as systemic? When the IAIS was asked to answer this question, there was no doubt that its answer could only be "yes", although views on that issue differed enormously between the insurance industry and the supervisors and between supervisors themselves. After lengthy discussions, it was concluded that – in principle – traditional insurance cannot be considered as systemically relevant and that attention should therefore be placed on those activities in which insurers sometimes engage and which are akin to a banking activity (maturity transformation).

In the end, the IAIS developed a methodology for the identification of those insurers whose activity might be considered as systemically relevant. On the basis of this methodology, the FSB identified in July 2013 a number of 9 insurers as so-called G-SII's: Global Systemically Important Insurers. The list includes 5 insurers from the EU, 3 insurers from the US and 1 insurer from China.

The IAIS also developed policy measures to be applied to these G-SII's: enhanced supervision; separation of non-traditional, non-insurance business; higher loss absorbency (higher capital requirements); effective resolution. It was however impossible to impose higher capital requirements on G-SII's as long as there was no agreement on what constitute "normal" capital requirements. The FSB therefore asked the IAIS to develop a Basic Capital Requirement (BCR) by the end of 2014 for application in 2015 by G-SII's and a global Insurance Capital Standard (ICS) by the end of 2016 to be applied by IAIG's (including G-SII's) from 2019.

Meanwhile, the IAIS has published the BCR standard at the end of 2014 and is working on the development of an ICS. There is still a great deal of disagreement which relates in particular to the general approach (scenario based approach as in the EU v. factor based approach as in the US; accounting standards to be applied (IAS/IFRS or national GAAP such as US GAAP); confidence level; intervention level (MCR and or SCR).

Concluding remarks

It is usually said that there are only two certainties in life: death and taxes. I believe we can add a third certainty: there will be more regulation in insurance in the years to come. The regulation will be heavily influenced by the banking agenda.

Although it might appear strange that the regulation of banking (an area that has had many problems) is now extended to the insurance sector (an area that has had much less problems), this can in fact not come as a surprise. Insurers are usually not good at communicating the particularities of their business model. And in the absence of proper insurance regulation, regulators will look at banking regulation as a source of inspiration. The examples are manifold: risk based capital requirements, group supervision, governance, resolution and recovery, systemic risk, crisis management, living wills. To some extent, the insurance industry is suffering now from a lack of regulatory action in the past.

As a former regulator, I have often been surprised how difficult it is to explain to people outside the insurance industry what insurance is all about. Many regulators look at insurance as a form of legalised gambling. Many people do not understand that there is a linkage between an insurance premium and the risk that it is intended to cover.

The message is therefore clear: better communication about what insurance is and what distinguishes the insurance business model from other business models is absolutely crucial if the insurance sector wants to be properly regulated.

9

THE ROLE OF NON-TRADITIONAL RISK TRANSFER SOLUTIONS: BRINGING ALTERNATIVE SOLUTIONS TO P&C INSURERS

VINCENT FOUCART
Head of Alternative Solutions
SCOR Global P&C

In the current reinsurance environment, SCOR has developed a global strategy for non-traditional risk transfer solutions. We define a non-traditional risk transfer solution as any kind of non-traditional technique that provides some type of risk bearing and risk transfer solution. Such solutions are typically structured reinsurance solutions, (well established structured quota share, any reinsurance with experience accounts, multiline, multiyear, aggregate stop loss or excess of loss cover and, to a lesser extent, adverse development cover and loss portfolio transfer), Insurance Linked Securities (ILS) solutions, and corporate and captive structured solutions. This segment includes in our view all kinds of self-risk management solutions, specifically developed for corporate clients.

Meanwhile, we hear a lot about securitized products. These certainly include products relating to either Cat bonds or contingent capital, but for SCOR these are not the dominant products in this area. At SCOR, we address non-traditional and alternative solutions by taking a broad view of all the various techniques that exist on the market for aggregation and for the financing of any kind of risk transfer situation.

Capital Management has emerged as one of the key drivers for alternative (re)insurance buying

In SCOR Global P&C's client offering, alternative reinsurance is basically used in three types of major situations. The first of these is financial optimization. Profit & Loss (P&L), balance sheet, and financing optimization issues are clearly the key drivers behind the purchase of alternative solutions. The second situation is any special event type of cover (typically post Mergers & Acquisitions (M&A) or post loss-event types of solutions). The third situation is anything that relates to developing cover for hitherto uninsured or badly insured risk or emerging risk.

Capital Management has a clear preference for structured reinsurance solutions

With regard to capital management, there is a lot of buzz on the market about bonds, sidecars and alternative capital. Last year in Monte Carlo, ILS were mentioned in every sentence or every headline of the newspapers. Our view is that it is clearly a slightly wider issue but these are not really the preferred solutions when you consider the issue of capital management.

In that respect, structured reinsurance is an interesting option, offering flexibility and efficiency, while purely securitized products and Cat bonds are currently probably more driven by a pricing rationale than by any kind of elaborate capital protection or capacity diversification consideration.

Figure 1: **Product life-cycle analysis**

Nascent	Developing	Mature	Declining / Stagnating
		• ADC / LPT • Agg Stop Loss • Capped QS • Finite Risk • Multi-Year / Multi-Line • Structured Captive RI • Transaction Liability • Weather Derivatives	
	• Cat Bonds: Indemnity • Collateralised RI • Sidecars		• Cat Bonds: non-indemnity • CDS • Contingent Capital • ILWs • Multi-Trigger • Residual Value
• Cat Swaps • Cat Options / Futures • CoCo Bonds			
GWP pool: c.\$0.2bn	GWP pool: c.\$6bn	GWP pool: c.\$20bn	GWP pool: c.\$2bn
Recently established NTRT products / products experiencing embryonic growth	High growth products growing in importance and relevance in the (re)insurance market	Widely recognised and commonly offered products. Considered 'traditional'	Products whose offering is not currently compatible with market demands / in decline

Sources: Aon, Aon Benfield practitioner insight, Swiss Re Sigma

At SCOR we maintain a long-term view of product cycles (Figure 1). Looking at the past, a certain number of product innovations have been pushed by market players, but not all of them have achieved a permanent and established position on the market.

For example, the non-indemnity Cat bond was viewed as a top "fashion" product two years ago. Today it's less prominent and everybody is wondering what the Hedge Fund Re strategy could be and what it could bring to the reinsurance industry. Product innovation is always important, but long-term experience is necessary to understand permanent solutions. In our view, this is currently the case for all structured reinsurance and, to an increasing extent, all that relates to indemnity Cat bonds and collateralized reinsurance.

On the competitive market you have buyer motivation increasing the appetite for structured solutions, and increasing capacity coming from large institutional funds that sustain and support alternative collateralized capital.

At the same time, this is only a partially tested market segment and a significant liability-driven event could impact the structure of this market, as could an asset-driven event, because we are all convinced that the huge capacity that has been attracted by this segment has been driven largely by th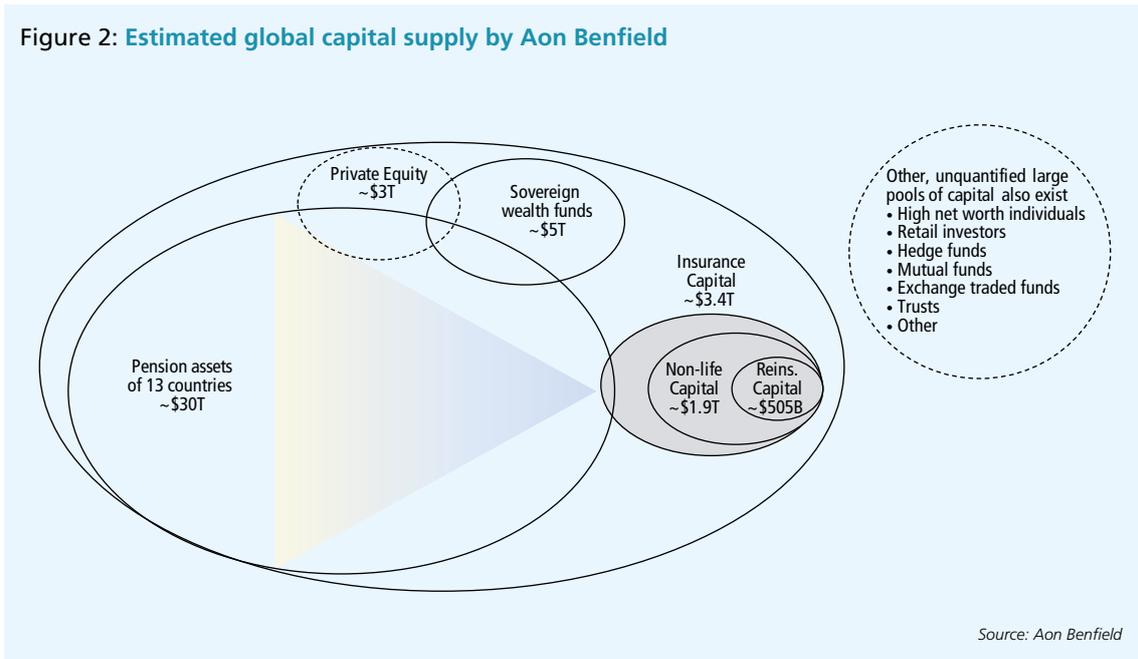e very low interest rates we are seeing on the market. And if we have experienced that traction on both the traditional retrocession and the traditional reinsurance markets, this means that the capacity of traditional reinsurance and traditional retrocession to adapt is there. Moreover, the business models of long-term players have also shown that the added value and the capacity to adapt are there.

Figure 2: **Estimated global capital supply by Aon Benfield**

Private Equity
~$3T

Sovereign
wealth funds
~$5T

Insurance
Capital
~$3.4T

Other, unquantified large
pools of capital also exist
• High net worth individuals
• Retail investors
• Hedge funds
• Mutual funds
• Exchange traded funds
• Trusts
• Other

Pension assets
of 13 countries
~$30T

Non-life
Capital
~$1.9T

Reins.
Capital
~$505B

Source: Aon Benfield

The fuel for capacity is available when you look at the worldwide asset management industry, the desperate search for absolute returns and the appetite for de-correlation. The USD 30 trillion of assets under management for the 13 most developed countries alone would be sufficient to overwhelm the reinsurance capital on the market, whatever the metrics (Figure 2). Clearly, if we continue to see this kind of appetite for insurance risk asset class, there is some room for permanent capital in this segment.

All of this has led to a certain amount of reshuffling and reshaping of the reinsurance universe. Our conviction at SCOR is that there is a bonus to be gained from long-term partnerships. A lot of opportunistic players have come onto the market, but not everybody will have the same level of competence, experience, vision and longstanding presence.

Figure 3: A gradual Shift in capacity structure
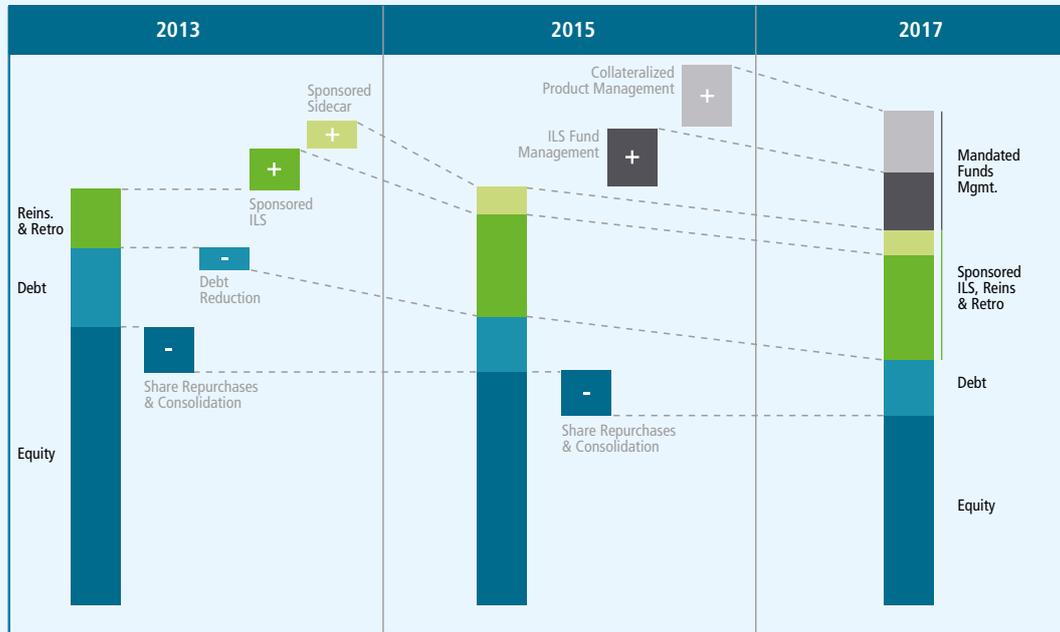
Source: AON Benfield

As shown in Figure 3, in recent years we have observed a regular evolution in the refinancing of the capacity on the market. You can see that there has been a lot of optimization of the equity base, and some regular debt issuance in order to optimize debt pressure. Currently, all the new inflow of capacity comes in the form of securitized products or any type of collateralized reinsurance support bringing capacity to the industry.

The issue underpinning all of this is the optimal diversified cost of capital that you can obtain by sourcing the various pockets that you have at your disposal on the market. What we do and what we propose to our clients is to build an optimized diversified book of business, and at the same time find the optimal capacity on the market and source it. SCOR has already developed many different instruments for financing its activities, from equity and debt lines to contingent capital, traditional retrocession, ILS and sidecar strategies.

Inc Self-Risk mgmt
■ Capital $300bn
■ GWP $275bn

Growth summary
■ Capital 73%
■ GWP 18%

+'Self' risk mgmt $215bn

+'Self' risk mgmt $245bn

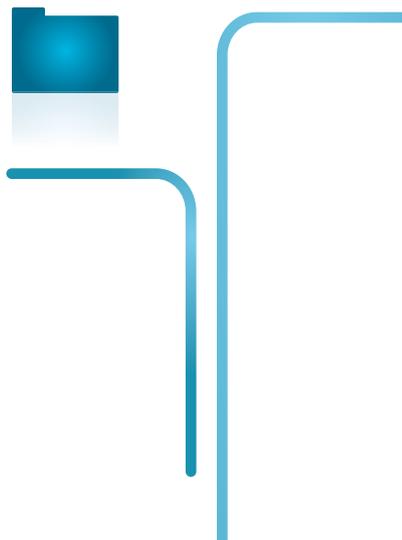| Penetration (% of overall mkt)	2000		2003		2005		2007		2009		2011		2013	
Non-Life	7%	2%	6%	2%	6%	1%	4%	1%	4%	1%	4%	1%	5%	1%
RI / Retro	46%	22%	40%	22%	41%	5%	29%	6%	27%	8%	27%	9%	33%	13%

$49bn, $24bn, $67bn, $34bn, $76bn, $9bn, $59bn, $13bn, $55bn, $16bn, $62bn, $21bn, $85bn, $29bn

Sources: Aon, Overview of the Art market (2009), Swiss Re Sigma

Looking at the last 15 years, Figure 4 shows the evolution of the capital on the market. The self-risk management solutions are clearly the most important part of this. (Re)insurance capital alone currently stands at USD 85 billion. At the same time the chart clearly shows that these types of techniques have gone from the top layer to the working layer. The average rate online relates to higher expected loss types of business.

Another interesting feature that we will continue to monitor very closely is the penetration of non-traditional risk transfer techniques into the various segments of the insurance business. Historically, the risk transfer market was first and foremost a traditional retro market. Today, more than 60% of the capacity on the retrocession market relates to non-traditional risk transfer. The question everyone is asking at the moment is to what extent these types of solutions and instruments can penetrate all lines of business and all classes of risk. Cleary, anything relating to property Cat, especially in the USA, has been transformed into securitized or hybrid products over the last 15 years. We cannot say that this is the case for the traditional (re)insurance solutions provided today, but we firmly believe that the market will test the frontiers of risk transfer by trying to access some additional lines and classes of risk.

SCOR's Alternative Solutions offering

At SCOR our alternative solutions offering relates to four categories of products:
- Structured reinsurance solutions for insurance clients
- Structured insurance solutions for corporates and captives
- Hybrid reinsurance solutions
- Securitized solutions

SCOR has been active in this market for the past 15 years, offering a wide range of products for corporate clients, captive clients and cedants, with a considerable focus on structured quota shares and structured excess of loss solutions. Alongside this, the Group has also developed a book of more elaborate and complex types of risk transfer.

Capital management centre of expertise

Our approach is to unite the SCOR teams within a centre of expertise relating to capital management solutions. We team up with the treaty and specialty teams to serve our insurance clients and we team up with the SCOR Business Solutions team to serve our corporate and captive clients. Of course, the first step is to leverage the retrocession team, which has issued close to USD 2 billion in Cat bonds over the past 15 years, demonstrating the recognized know-how and expertise of the professionals working in this market.

We have in-depth knowledge of all the market stakeholders, including the rating agencies and the regulators, which enables us to offer good quality advice regardless of the type of situation under consideration by the client.

Today, Alternative Solutions is a major specialty line of SCOR Global P&C. The bulk of this business is composed of capital management solutions amounting to ~EUR 500 million of premiums, i.e. 10% of the SCOR Global P&C portfolio. It is predominantly made up of structured quota shares, multiyear and multiline, and programs with experienced accounts. SCOR acts as advisor on numerous types of ILS issuance projects for its clients.

Capital management solutions

At SCOR, we believe that capital adequacy can be measured through the seven types of metrics, as shown on Figure 5.

Figure 5: **Alternative Solutions provides an expert team and a dedicated Capital Management Solutions offering**
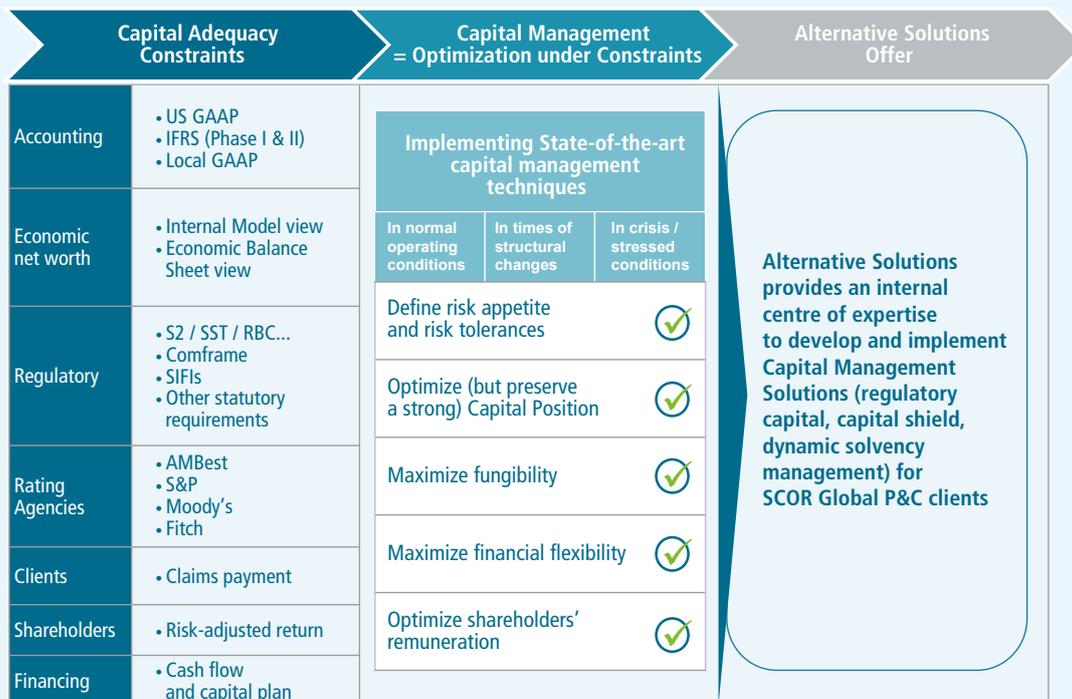
We set the risk appetite and risk tolerance framework at a strategic level – this is a very important step in any situation.

We define the optimal level of capital position, which at SCOR we refer to as dynamic solvency scale management. This is a complicated and detailed job that took more than a year of development before the launch of the new strategic plan.

When you talk about fungibility or financial flexibility, the tools that you have at your disposal to manage the capital of your company sufficiently, of course the first things you think about are financing techniques, and adequate levels of equity and debt issuance. These are often not immediately optimized, but they can be taken into consideration quite quickly.

We also pay particular attention to everything that relates to the target structure of clients' groups. Financial flexibility is immediately impacted by the structure between holding entities and operating entities, between subsidiaries and branches, between the types of top subsidiaries aiding the whole Group and of course eventually the internal reinsurance scheme put into place before going for external reinsurance. External reinsurance is our tool of last resort, but it has a lot of advantages in terms of flexibility.

Changes to the underwriting policy or the investment policy are clearly important determinants for capital management constraints, which at the end of the day aim to optimize the shareholder remuneration that you and your shareholders have defined as a mandate.

This is of course a very generic approach. All we are doing is applying a customized analysis to any type of situation. We have developed our tools so that they allow us to measure the efficiency of the reinsurance solutions we put into place, to the benefit of all types of capital adequacy metrics. Today we are able to measure the relief that a well-adapted reinsurance solution can provide to any kind of capital adequacy constraint you want to optimize.

The main purpose of capital management solutions

At the end of the day, everything comes down to the following equation: Solvency ratio = A (Available Financial Resources)/R (Solvency Capital Requirement). We consider that with the book and the diversified portfolio that we have built, there is an arbitrage possibility between the diversified capital cost that we have reached and the client cost of capital.

A reinsurance transaction becomes possible when it can help to improve the client cost of capital.

What we are trying to do is to change the expected profit for one year as little as possible, while significantly reducing capital requirements. We can create this kind of economic value distribution curve using any kind of metrics, depending on the preference of our clients.

Categories of capital management solutions

Today, we deal with three types of capital management solutions. Firstly, we have capital management solutions primarily designed to reduce solvency requirements. Secondly, we have solutions that aim to increase available capital. Thirdly, potentially, there are solutions that deal with everything relating to both increased and available, and possibly also liquidity and financing components. Each time you work on a capital management optimization calculation, you need to work on the denominator, on the numerator and potentially on everything that relates to the cash and financing component of the transaction.

This translates into reducing solvency margin requirements, generally structured quota share types of solutions. For what relates to available capital, it is more work focused on conservatism around reserving calculations, so everything that relates to work we can do on hedging and the reserve type of developments is very efficient on this type of approach.

These are the three types of solutions that we consider in any kind of situation for cedants, and each time we conduct a full analysis of the tools at our disposal, from traditional reinsurance to equity solutions, contingent capital solutions and any kind of debt financing or securitization. It is clear that structured reinsurance solutions have a lot of advantages in terms of flexibility and efficiency. They protect the P&L or the balance sheet, improve cash flow facilities, enhance the capacity to adapt and to integrate accounting and tax treatment, and at the end of the day provide not only solvency capital, but also rating capital and economic capital relief. These types of solutions present a lot of advantages and can be customized to provide a high level of efficiency.

In terms of ILS, we also monitor the way in which these types of risk transfer solutions bring some complementary capacity to existing traditional reinsurance. Cat bonds have reached a plateau in the range of USD 20 billion to USD 23 billion of capacity on the market, but collateralized reinsurance continues to expand. It has reached a certain mature size, but it is not overwhelming the old segments of traditional reinsurance. We can advise clients on any kind of structuring for these types of solutions. Today, the market is moving increasingly towards indemnity insurance, so we are working more with complex types of cover like reinstatement cover, bridge cover and any other options we can bring to our clients for this type of complex structuring, where the capital market is not ready to immediately provide the same kind of facilities as traditional reinsurance.

10

MANAGING INTERDEPENDENCIES
WITH PrObEx

DAVIDE CANESTRARO
*Quantitative Financial Risk Analyst*
SCOR SE

Introduction

For any financial company it is crucial to understand and manage the interdependencies among the risks which are part of its business. Under the latest Solvency requirements, (re)insurance companies have to account for the dependencies among the risks they assume in their internal models. In this context, SCOR has developed **PrObEx**, a new method to properly quantify and strategically manage such dependencies. **PrObEx** supports the recognition of the diversification between and within different types of business and can be applied in several contexts (P&C, Life, Market risks, etc.).

Solvency Capital Requirement (SCR) and risk aggregation

Under the Solvency II regime, (re)insurance companies need to compute the Solvency Capital Requirement (SCR) which corresponds to the 1-in-200 year event (i.e. VaR 99.5%) of the change in the economic value over a one year horizon. The economic value at a given time is given by the difference between all assets and all liabilities at that time. While the economic value at the beginning of the measurement period is typically known at the time of the valuation, the economic value at the end of the measurement period is generally unknown and it needs to be estimated through a stochastic model. In an internal model, Monte Carlo simulation techniques are typically used to estimate the economic value of the company at the end of the measurement period, corresponding to a one-year time horizon in the Solvency II framework. Such an estimate requires, in particular, an evaluation of the overall liabilities, including those related to the P&C risk portfolio. It is important to recognize that this is not a simple addition of different risks. Instead, one has to consider dependencies while adding the various risks together. The latest financial crisis has highlighted the dramatic consequences when one ignores or simply does not properly take into account the various dependencies between risks. At SCOR, we make use of so-called *copula* models in order to prudently account for dependence, especially in the tails of the risk distributions. However, when modelling the dependence among extreme
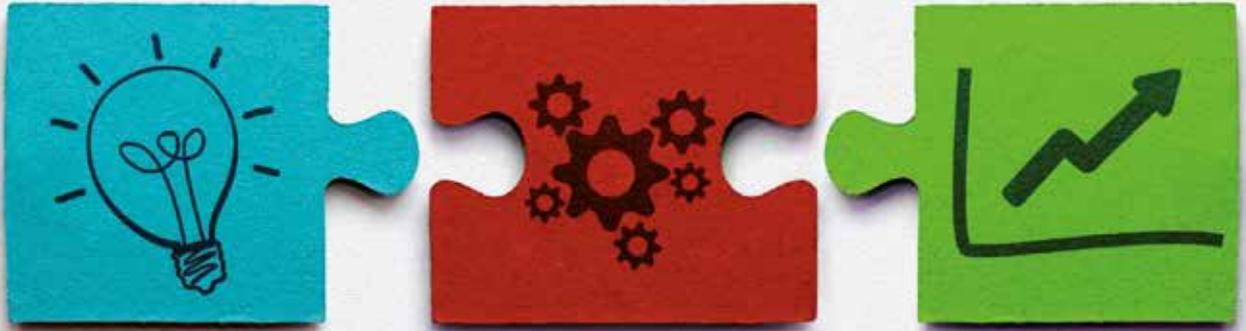
events (which are rare by definition), it is often the case that there is not enough data available to make use of standard statistical techniques to estimate the (copula) dependence parameters.

To cope with this common challenge, SCOR has developed **PrObEx**, a Bayesian model which allows us to combine several sources of information in order to derive a more robust estimate of the dependence parameters.

PrObEx

As an example, assume that a (re)insurance company has a P&C risk portfolio formed by two risks, e.g. Auto and Aviation. It is typically the case that the pricing and the reserving departments can provide an estimate of the pricing and reserving risks, respectively, for each of the Lines of Business (LoB). However, what is usually not known is how the risks will behave jointly, namely how does the overall P&C portfolio look when these two LoBs are combined.

From the actuarial literature, it is known that a family of mathematical functions called copulas can be used to define how two (or more) risks behave jointly. In this article, it is assumed that the type of copula has already been chosen, and the focus is then on the estimation of the copula's parameter. Returning to the example, **PrObEx** faces the issue of calibrating such parameter, i.e. quantifying how much dependency there is between the different LoBs.

In order to increase the robustness of the calibration, it is important to include the opinions of experts in the process. At the same time, it is crucial to design the elicitation procedure around a measure which is familiar to the daily language of the typical business expert. For this reason, SCOR has identified a dependence measure (and designed an elicitation procedure) which relates to the daily activity of risk assessment of our experts, and that can be linked to the copula parameter. In other words, SCOR's business

experts were asked to quantify a certain dependence measure, which was then used to derive, via a mathematical function, the targeted *copula* parameter.

But how does **PrObEx** work in detail?

PrObEx allows us to combine (up to) three different sources of information, i.e.:

- Prior information – e.g. information from previous years or from regulators

- Observation – statistical data, i.e. independent observations of joint realizations

- Experts' opinion – each expert provides an estimate of the dependence measure

Based on Bayesian statistics, **PrObEx** replaces an estimate based on scarce data with a more robust calibration of the dependence parameter leveraging from additional sources of information, including the experts' opinion.

Under certain assumptions, it is possible to derive the formula shown in Figure 1. The mathematical aspects are not discussed here, but they are provided in SCOR's Paper n.10 (Arbenz, P. and Canestraro, D. (2010):

PrObEx - *A new method for the calibration of copula parameters from prior information, observations and expert opinions).*

Figure 1: **PrObEx allows to combine up to three different sources of information**

$$\pi(\theta|\mathcal{O},\mathcal{E}) \propto \pi(\theta) \prod_{n=1}^{N} c(U_n, V_n|g(\theta)) \prod_{k=1}^{K} e_k(\varphi_k|\theta)$$

Prior   **Observation**   **Experts**

For our purpose, it is enough to comment that the formula in Figure 1 shows that the final calibration of the dependence parameter can be seen as the product of the three different sources of information, Prior information, Observation and Experts' opinion.

Each of them will contribute with a certain weight to the final calibration. Moreover, it is worth noting that **PrObEx** can provide not only an estimate of the dependence, but also a measure of the uncertainty around this assessment.

PRIOR INFORMATION

The prior information represents the information that is available at the time that the calibration exercise is performed. There are two main types of situation possible. In one situation, the company does not have any previous knowledge on the dependence of interest, and thus the distribution of the prior information is set to be flat, or uninformative. In the other situation, the company has some previous knowledge that can be used as a starting point for the calibration, e.g. the result of a similar analysis performed the previous year. The weight assigned to the prior information depends on the credibility attributed by the company to the source of the prior information. The more credible the source is deemed, the more weight will be assigned to

the prior information and thus the more weight this will have in the final calibration.

Figure 2 illustrates how the (density function of the) prior information looks like in the various cases. The case corresponding to the absence of previous knowledge is shown in the most left graph. The graphs from the second left to the rightmost correspond to the case where a previous estimate of the dependence is available. For all of them the dependence measure is quantified in the example as 60%, but as the level of confidence increase from left to right, so too does the weighting of this prior information when combined with the other two sources in the final calibration.

Figure 2: **Prior Information**

Confidence in the prior information

| Uninformative | Low | Intermediate | High |

$\pi(\theta)$ $\pi(\theta)$

θ θ θ θ
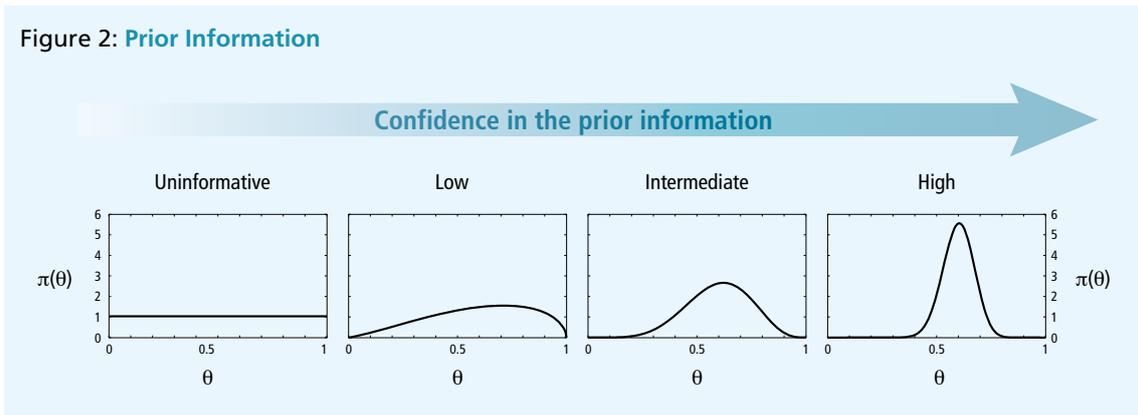
ELICITATION OF EXPERT OPINION

According to literature on expert judgment, there are at least five principles which need to be adhered to by the elicitation procedure, to ensure that the results obtained are meaningful and recognized as such. They are:

- **Reproducibility:** All data collected must be open to qualified reviewers and results must be reproducible.

- **Accountability:** Filled questionnaires are stored and each opinion can be linked to the corresponding expert.

- **Empirical control:** There should be in theory the possibility to verify the expert's opinion on the basis of measurable events.

- **Neutrality:** Experts have no incentive (e.g. change in salary or reputation) to give an answer different from their true opinion.

- **Fairness:** All experts are treated in the same way and answers can be treated differently only if justified within the mathematical approach.

When designing the elicitation procedure, it is fundamental to consider the psychological effects which are involved and play an important role in the process (a few examples are provide later in the text).

Moreover, in terms of how to move from a set of opinions elicited from the various experts to a single outcome, the literature distinguishes between two types of approaches, namely behavioral and mathematical. In the behavioral approaches, experts are asked to discuss together their different views and it is their duty to come up with a final, common opinion. The main disadvantage of this method is that it may introduce a bias in the final estimate, mainly due to the dominant personality of certain experts which may overcome more introverted personalities.

Thus, at SCOR we have chosen a mathematical approach, namely it is the **PrObEx** model itself which will take care of combining the various views, obtained independently from the various experts, into a single outcome.

MODELLING OF EXPERT OPINIONS

In order to model the expert's opinion, **PrObEx** assumes a certain type of distribution to describe the uncertainty around their quantification of the dependence measure. To fully describe such a distribution, an assessment of the expert variance is needed. Three possible approaches to calculate estimates of the variance of the experts are considered:

- **Subjective variance:** Each expert is asked to quantify her/his level of comfort for each individual opinion she/he provided.

- **Homogenous experts:** The empirical variance is computed based on the entire set of the elicited opinions and associated to each expert. In this case, all experts are assumed to be equally (un)certain about their own opinion.

- **Seed variables:** This is a slightly more complex approach, as it requires the experts to answer additional questions, whose sole purpose is to quantify her/his uncertainty. Such additional questions have to be pertinent to the original subject of the elicitation and their answers have to be known to the analyst conducting the elicitation.

AN ILLUSTRATIVE EXAMPLE

The following simplified example intends to illustrate how **PrObEx** combines different sources of information. For the purpose of the example, it is assumed that no observation data is available and that two experts are taking part to the elicitation procedure.

In a first case, see Figure 3, there is no prior information available at the time the calibration is performed, thus the corresponding distribution (the flat blue line) is set to be uninformative. Moreover, the two experts provide their respective quantification of the dependence measure, 40% and 70%, with a similar level of uncertainty. Their distributions are shown in red.

Figure 3: No prior information and two experts equally certain
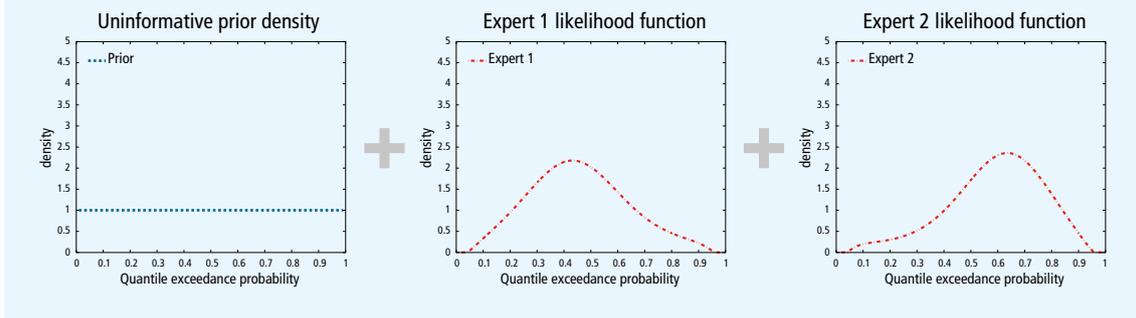
In this case, **PrObEx** would combine the available information and suggest a quantification of the dependence measure which is in between the two opinions expressed by the experts. The final (or posterior) distribution of the dependence measure resulting from **PrObEx** is represented by the black distribution in the left of Figure 6.

In a second case, see Figure 4, there is already some previous knowledge that can be used as a starting point for the calibration, e.g. the study conducted the previous year indicated a dependence of 30%. Thus the distribution of the prior information (the blue line) is not flat anymore, but it reflects this estimate as well as its uncertainty, assumed to be similar to the common one characterizing the two estimates provided by the experts (40% and 70%, respectively). Their distributions are again shown in red.

Figure 4: Prior information and two experts equally certain
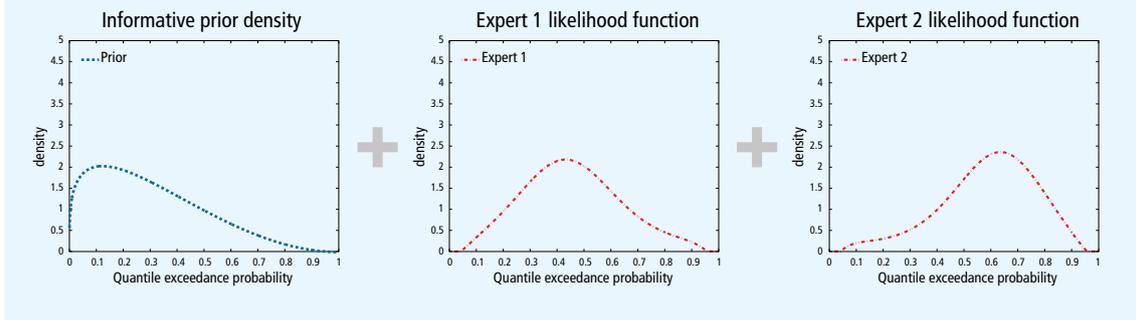
In this case, **PrObEx** would combine the two sources of information, i.e. prior and experts, and suggest a quantification of the dependence measure which is slightly more shifted towards the first than the second expert, in consideration of the also available prior information. The posterior distribution is represented by the black line in the middle of Figure 6.

Finally, we consider a third case which differs from the previous one in just one aspect. Namely, the second expert participating in the elicitation, while maintaining his previous estimate of the dependence measure (i.e. 70%), is now twice as knowledgeable as before or, equivalently, his/her uncertainty is half of the uncertainty of the other expert. This is reflected in the corresponding distributions in Figure 5, with the distribution of the first expert (the first red dotted line from the left) exhibits twice the volatility than the distribution of the second expert (the second red dotted line from the left).

Figure 5: **Prior information and two experts, one more confident than the other**
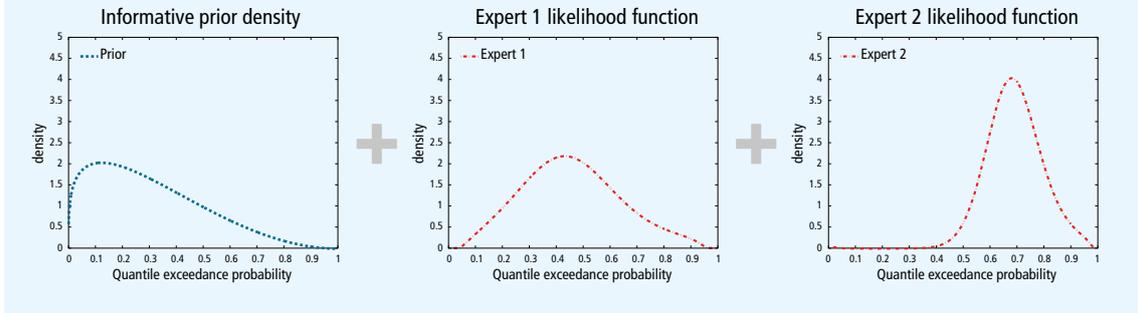
In this third case, **PrObEx** would recognize the higher quality of the information stemming from the second expert and thus suggest a posterior distribution shifted towards the more knowledgeable expert. Moreover, the overall uncertainty around the final estimation is now reduced in consideration of the reduced uncertainty associated with the quantifications provided by the experts. The posterior distribution is represented by the black line in the right of Figure 6.

Figure 6: **Final calibration via PrObEx**
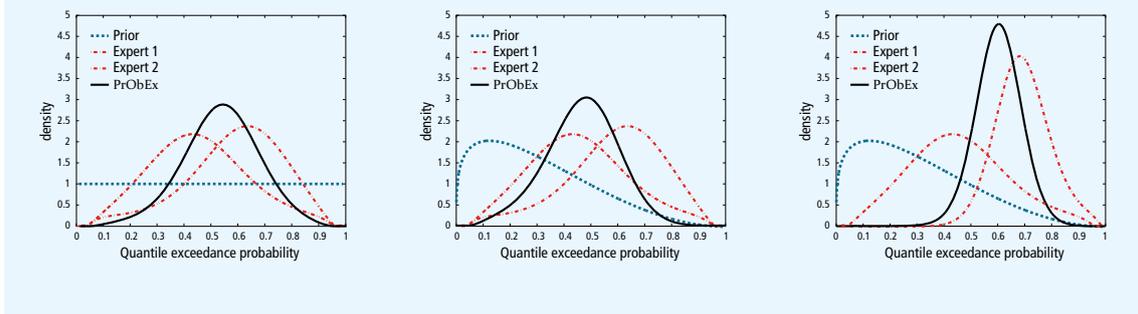
Implementation in SCOR's internal model

As part of SCOR's internal model, **PrObEx** contributes to the quantification of the SCR, thus it has an impact on key areas, such as capital allocation, underwriting and investment strategies. In line with SCOR's strategic plan "Optimal Dynamics", **PrObEx** offers support for high diversification and controlled risk appetite. To ensure robustness of final results, the process of gathering the expert's opinion has been industrialized and fully documented. Below we provide a few figures to facilitate the understanding of the relevance of the project, limiting our focus just to the first implementation of **PrObEx** at SCOR, which aimed to calibrate the dependencies within and between the various P&C LoBs. More than 33 workshops were organized and more than 100 experts, scattered in 7 different locations around the world, were involved in the project. Overall, more than 1'300 dependence assessments were elicited, covering 16 different LoBs.

THE CALIBRATION PROCESS

Figure 7 provides an overview of the calibration process. At the top, the four stages which compose each workshop are highlighted. Each workshop last on average 4 to 5 hours.

Figure 7: **The calibration process**
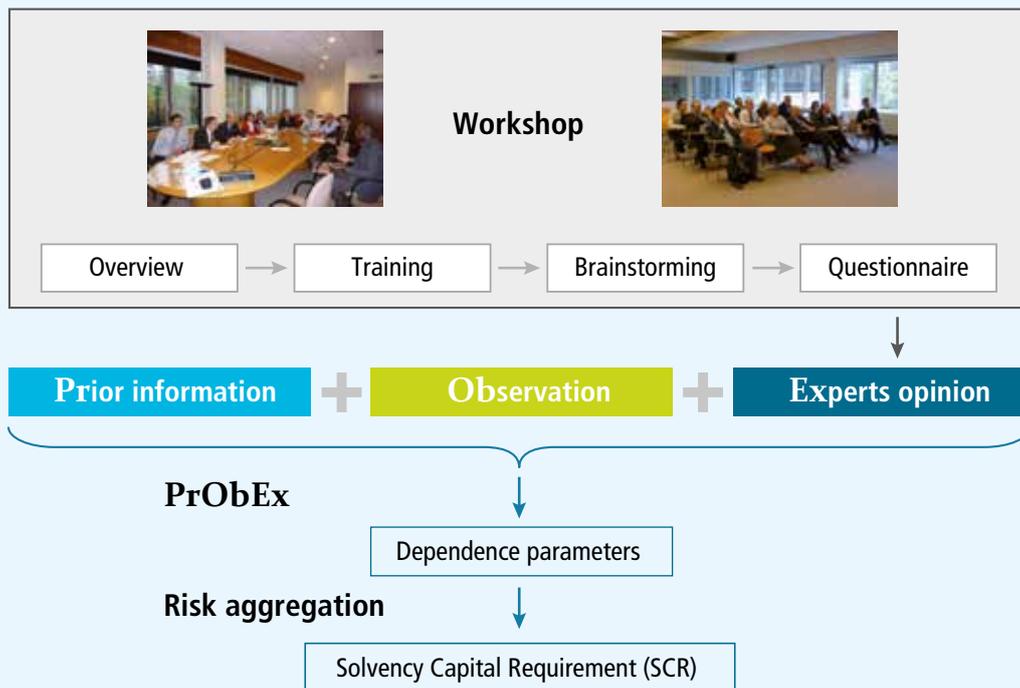
During the overview, experts are provided with the project background and expectations are set with respect to their role in **PrObEx**.

The second stage is the training session. We learned from the literature on expert judgment how crucial it is to both remind the experts about those mathematical and probabilistic aspects which are used in the questionnaire, and to discuss with them the psychological effects which play a role during the elicitation.

A brainstorm takes place during the third stage. Its purpose is to allow the experts to discuss among each other about the main risk drivers they deem relevant, e.g. for a specific line of business. Since it is valuable to have a picture of the risks as complete as possible, experts from different areas are invited to the workshops. Typically the experts invited should include representatives from the following: actuarial pricing, actuarial reserving, underwriting, risk management, claims and legal departments. Since the brainstorm allows for sharing of different perspectives, it is worth

noting that the consequent discussions are valuable not just for the calibration process. Instead, they constitute an opportunity to increase the overall knowledge and understanding of the risks within the company.

The fourth and last stage is the questionnaire. Each expert is asked to individually fulfill an electronic form, which is specifically designed, according to the literature, with the purpose to reduce the potential psychological biases and to facilitate the quantification process. Despite the common discussion of the third stage, the questionnaire is individual, thus each expert can express his/her view independently, and no common agreement has to be found.

In fact, as previously mentioned, once the experts' opinions have been collected, it is the mathematical model which takes care of combining their different views, together with the other sources of information (if available). **PrObEx** then produces the new dependence parameters, which can be used within the risk aggregation process to determine the SCR.

THE RISK AGGREGATION TREE FOR P&C SPECIALTY LINES OF BUSINESS

In order to better understand the final steps of the calibration process, Figure 8 provides a (simplified) schematic of how the risks stemming from the P&C specialty LoBs are aggregated at SCOR.

Figure 8: **The risk aggregation tree for P&C Specialty Lines of Business**
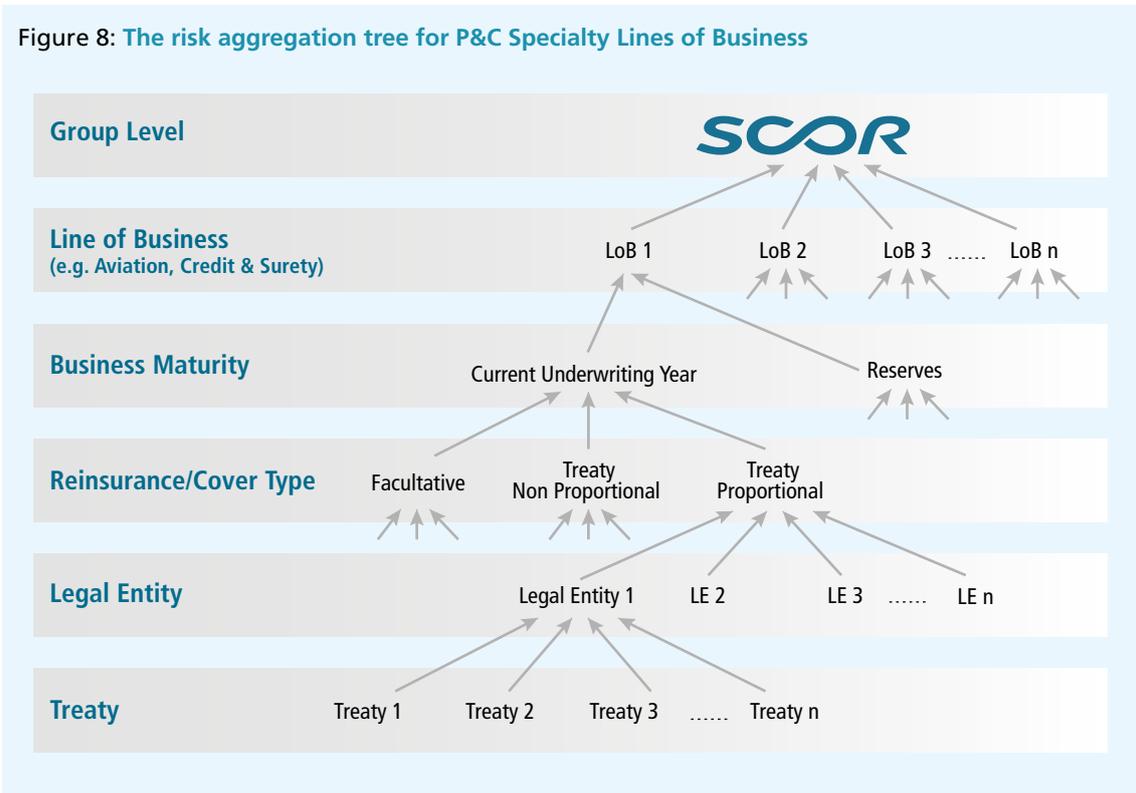
The so called aggregation tree comprises several nodes, each of them constituting an aggregation step from the individual treaty level up to the (P&C) Group portfolio. Starting from the top, we first distinguish between (specialty) LoBs, e.g. Aviation or Credit & Surety. Thus, the top node in the aggregation tree describes the dependence among the various LoBs.

We then distinguish between two main business maturities, i.e. current underwriting year (covering the premium risk) and the reserves (covering the reserve risk). Subsequently, the next split is considering the reinsurance and cover type, thus differentiating between Facultative and Treaty business, the latter being proportional or non-proportional. One more level down it is the split among the various legal entities (e.g. SCOR Switzerland AG, SCOR Reassurance, etc.). Finally, the aggregation of the individual treaties (or certificates in case of Facultative business) takes place at the bottom.

A similar structure characterizes the risk aggregation tree for the P&C standard LoBs (e.g. Auto), with a slightly different order of the aggregation steps.

DEPENDENCE MEASURE AND ELICITATION

It is worth recalling that for each node or aggregation step, as represented in Figure 9, (at least) a dependence parameter needs to be calibrated.

Figure 9: **A simple node aggregating two risks**
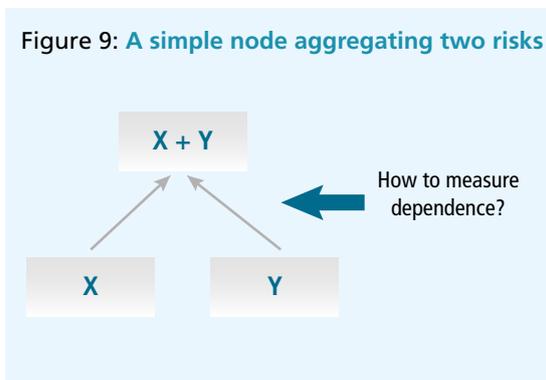
Going back to the original example, assume that a calibration is needed regarding the dependence between two portfolios, Auto and Aviation. Then, in a workshop dedicated to this calibration, the experts would be asked to answer questions such as the following:

> "Assume you that you have a crystal ball that let you see in the future. From this crystal ball, you can see that the Auto LoB is going to experience an extremely bad outcome in a one-year time horizon, an outcome that you would consider a 1-in-100 year (or even less frequent) event. Now, unfortunately, the crystal ball does not work anymore. However, you are asked to assess, based on what you have just seen and on your expertise, how likely it is that the Aviation LoB will also experience an extremely bad (i.e. a 1-in-100 year or even less frequent) outcome in a one-year time horizon."

This question is a translation in words of the dependence measure called *quantile exceedance probability*, which is represented in (simplified) mathematical terms in Figure 10.

Figure 10: Quantile exceedance probability

$$P\left[X > VaR_{0.99}(X) \,|\, Y > VaR_{0.99}(Y)\right]$$

This specific dependence measure allows us to relate the quantification of a complex object such as the dependence among risks with the daily activity performed by insurance business experts, namely the assessment of risks and their expected return period. The link to the copula parameter is then enabled via additional mathematical formulas which are not relevant for the experts in the context of the elicitation exercise.

EXPERT JUDGMENT AND HEURISTICS

As previously mentioned, the mathematical aspects do not constitute the only challenge in the elicitation exercise. It is also crucial to carefully account for the psychological aspects which can have a severe influence on the elicitation. The literature on this topic has shown that as human beings we tend to utilize certain shortcuts (so-called *heuristics*) when providing answers in condition of uncertainty. Such shortcuts are effective, in the sense that they allow us to come up with a quick answer, but unfortunately they also introduce systematic biases in the assessment. However, it has been shown that discussing with the experts about these shortcuts before the elicitation can significantly reduce the likelihood that biases are introduced.

For this reason, each SCOR expert who participated in **PrObEx** received specific training (see the above mentioned second stage of the workshop) on this topic. The following provides a couple of examples of the shortcuts discussed during the training and the lessons learned for our experts. Note that each of these examples is taken directly from previous literature, often stemming from collaboration between psychologists and statisticians (e.g. reference is made to the works in this field of A. Tversky and D. Kahneman).

In a controlled experiment, the participants were told:

> "Linda is 31 years old, single, outspoken and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in antinuclear demonstrations."

They were then asked to assess what was more likely between:

a) Linda is a bank teller; and

b) Linda is a bank teller and active in the feminist movement.

The majority of the participants considered b) more likely than a). However, from a pure statistical perspective, this is not possible, as b) is a sub-set of a). The shortcut, or false reasoning, behind this assessment is called representativeness. According to this, human beings tend to judge more likely what they consider as more representative, i.e. more similar. In this case, the question was designed to characterize Linda as more similar to the stereotype of a feminist than to the stereotype of a bank teller. However, it is possible to overcome the representativeness bias, as shown in a second controlled experiment.

During the latter, the participants were exposed to the same description of Linda but the question was phrased differently, namely:

> "There are 100 people who fit the description above. How many of them are:
>
> a) bank tellers;
>
> b) bank tellers and active in the feminist movement".

In this case, the majority of the participants allocated a larger number to b) than to a). Thus, when considering more instances of the same type (100 people and not just Linda anymore), it seems easier not to derive false conclusion. The lesson learned for SCOR's experts out of this example is to consider always a plurality of scenarios before drawing any conclusions, i.e. avoid relying on a single, maybe very special, case, but instead considering a range of similar risks/events before quantifying the dependence measure.

A second example of a shortcut is exemplified via the following question:

> "Which hazard claims more lives in a year in the United States, lightning or tornadoes?"

In controlled experiments, participants more frequently respond tornadoes rather than lightning, but in reality the opposite is actually true. The reason behind this mistake is deemed to be related to the shortcut called *availability*. According to this, human beings tend to judge as more likely what they can recall more easily. The question above, for instance, is inspired by the fact that there is a lot more media coverage of tornadoes than of lightning, making the former easier to recall. The lesson learned for SCOR's experts from this example is to remind them that just because an event can be recalled more easily than another, this does not mean that it also occurs more frequently than another event which is less easy to recall.

Conclusion

PrObEx provides a sound mathematical framework for calibrating dependencies (and copula parameters), combining (up to) three different sources of information to reduce the estimation uncertainty.

PrObEx also enables the leveraging of in-house expertise which typically exists within large financial institutions, and at the same time increasing the overall knowledge and understanding of the nature and the kinds of risks which are the subject of the analysis.

PrObEx is not limited to the P&C (re) insurance context, but it can be used in any other insurance related areas (e.g. Life or Market risk) as well as in other types of companies where a proper assessment and quantification of dependencies is a key aspect of the business.

A scientific paper on PrObEx has been published in the ASTIN Bulletin (42 (1): 271-290), see Arbenz, P. and Canestraro, D. (2012): *Estimating copula for insurance from scarce observations, expert opinion and prior information: a Bayesian approach.*

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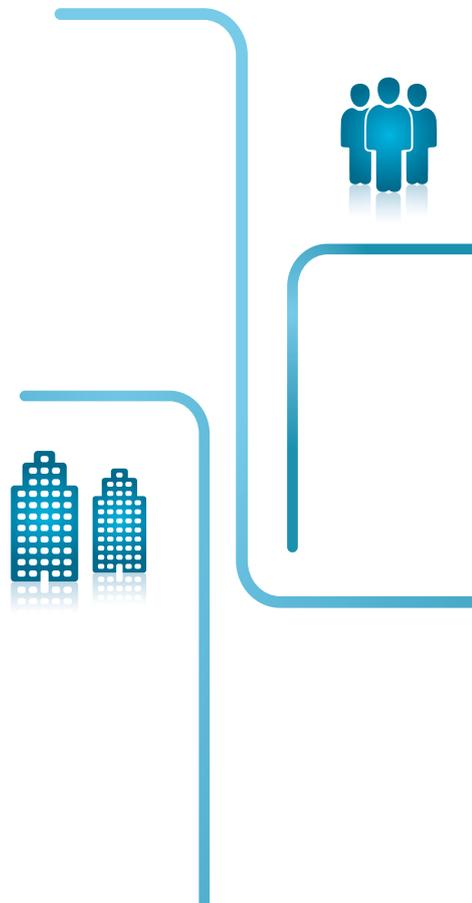
SURVIVING THE NEXT CRISIS –
A RISK MANAGEMENT PERSPECTIVE

MICHEL DACOROGNA
Senior Scientific Advisor to the Chairman & Chief Executive Officer
SCOR SE

The financial crisis of 2008/09 is still in all minds, and some even think we are not yet through with it. It is thus interesting to see how, from a risk management perspective, we can learn the lessons brought by this crisis and prepare ourselves for such events. The financial crisis might seem like old news for some people, and that is why I would like first to remind you how serious it actually was.

Figure 1: The financial crisis of 2008/09

S&P index annual returns from 1791 to 2013

2008 was the 3rd worst year after 1937 and 1931 with -38.5%

After two years of recovery, 2011 showed -0.11% return for a year and 2012, 13.4% and 2013 29.6% !!! More than 6% this year until mid-year

What is next ???

We are here!

2009 showed a +23.5% return

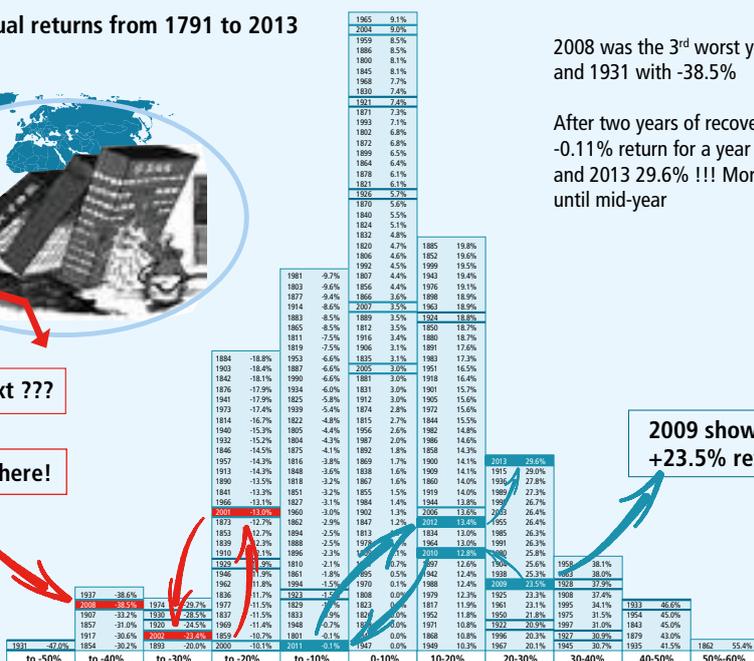| to -50%	to -40%	to -30%	to -20%	to -10%	0-10%	10-20%	20-30%	30-40%	40-50%	50-60%
	1937 -38.6%	1974 -29.7%	1884 -18.8%	1981 -9.7%	1965 9.1%	1885 19.8%	2013 29.6%	1908 37.4%	1933 46.6%	1862 55.4%
	2008 -38.5%	1930 -28.5%	1903 -18.4%	1803 -9.6%	2004 9.0%	1852 19.6%	1915 29.0%	1938 38.0%	1954 45.0%	
	1907 -33.2%	1920 -24.5%	1842 -18.1%	1877 -9.4%	1959 8.5%	1999 19.5%	1936 27.8%	1928 37.9%	1843 45.0%	
	1857 -31.0%	2002 -23.4%	1876 -17.9%	1914 -8.6%	1886 8.5%	1943 19.4%	1989 27.3%		1879 43.0%	
	1917 -30.6%	1893 -20.0%	1941 -17.9%	1883 -8.5%	1800 8.1%	1976 19.1%	1998 26.7%		1935 41.5%	
	1854 -30.2%		1973 -17.4%	1865 -8.5%	1845 8.1%	1898 18.9%	1955 26.4%			
1931 -47.0%			1814 -16.7%	1811 -7.5%	1968 7.7%	1963 18.9%	2003 26.4%			
			1940 -15.3%	1819 -7.5%	1830 7.4%	1924 18.8%	1985 26.3%			
			1932 -15.2%	1953 -6.6%	1921 7.4%	1850 18.7%	1991 26.3%			
			1846 -14.5%	1887 -6.6%	1871 7.3%	1880 18.7%	1980 25.8%			
			1957 -14.3%	1990 -6.6%	1993 7.1%	1891 17.6%	1900 25.6%			
			1913 -14.3%	1934 -6.0%	1802 6.8%	1983 17.3%	1925 23.3%			
			1890 -13.5%	1825 -5.8%	1872 6.8%	1951 16.5%	2009 23.5%			
			1841 -13.3%	1939 -5.4%	1899 6.5%	1918 16.4%				
			1966 -13.1%	1822 -4.8%	1864 6.4%	1901 15.7%				
			2001 -13.0%	1805 -4.4%	1878 6.1%	1905 15.6%				
			1873 -12.7%	1804 -4.3%	1821 6.1%	1972 15.6%				
			1853 -12.7%	1875 -4.1%	1926 5.7%	1844 15.5%				
			1839 -12.3%	1816 -3.8%	1870 5.6%	1982 14.8%				
			1910 -12.1%	1848 -3.6%	1840 5.5%	1986 14.6%				
			1929 -11.9%	1818 -3.2%	1824 5.1%	1858 14.3%				
			1962 -11.8%	1851 -3.2%	1832 4.8%	1900 14.1%				
			1836 -11.7%	1827 -3.1%	1820 4.7%	1909 14.1%				
			1923 -11.7%	1960 -3.0%	1806 4.6%	1860 14.0%				
	1977 -11.5%			1862 -2.9%	1992 4.5%	1919 14.0%				
	1969 -11.4%			1888 -2.5%	1807 4.4%	1944 13.8%				
	1859 -10.7%		1833	1813 -2.5%	1856 4.4%	1902 13.6%				
	2000 -10.1%			1896 -2.3%	1866 3.6%	2006 13.6%				
	1893 -20.0%			1810 -2.1%	1889 3.5%	1834 13.0%				
				1861 -1.8%	1812 3.5%	1964 13.0%				
				1994 -1.5%	1916 3.4%	2012 13.4%				
				1923 -1.5%	1906 3.1%	2010 12.8%				
				1948 -0.7%	1835 3.1%	1897 12.6%				
				2011 -0.1%	2005 3.0%	1988 12.4%				
				1947 0.0%	1881 3.0%	1979 12.3%				
					1831 3.0%	1817 11.9%				
					1912 3.0%	1952 11.9%				
					1874 2.8%	1971 10.8%				
					1815 2.7%	1868 10.8%				
					1987 2.0%	1949 10.3%				
					1892 1.8%					
					1869 1.7%					
					1970 0.1%					
					1808 0.0%					
					1823 0.0%					
					1801 0.0%					

Sources: globalfinancialdata.com

In Figure 1, we present the return history of the New York stock market since its very beginning in 1791. Historians have rebuilt the Standard&Poors (S&P) 500, which actually started in 1928, up to the opening of the New York Stock Exchange in 1791. I have constructed a histogram based on 10% slices of yearly returns. This graph covers more than 200 years. Let us concentrate on what happened at the beginning of our 21st century. We moved from 2000 where we had a loss of 10% in the year, to 2001 where the loss was about 13%. After this, we had the Internet bubble in 2002, which terminated in -23%. Then at the end of 2008, we had, with -38.5%, the third worst movement in the S&P 500 in more than 200 years. Only two years, in the last 200 years, were more serious than 2008: 1931 and 1937.

People forget about this bad outcome because in 2009 the market went up 23.5%, but 23% up after a 38% fall is not the is not mathematically symmetric, because you start from a lower value. We had a 13% rise in 2012 and a 29.6% rise in 2013, so all of a sudden it feels like the good old days are back. A risk manager is bound to ask: what is next?

In May 2008, before the bankruptcy of Lehman Brothers, more than USD 384 billion were lost by the hundredth largest bank in the world. Some of the largest US investment banks have lost respectively, USD 43 billion, USD 39 billion and USD 37 billion.

Twenty years ago, I was invited to the Federal Reserve of New York to talk about extreme risk in the foreign exchange market. I suggested building a warning system, that would detect instabilities in the financial system by analyzing volatilities at various frequencies. I was told it was too expensive. The OECD countries lost 2% GDP during this time in the last quarter of 2008 and 2.1% in the first quarter of 2009. This is a very serious loss of wealth, and for the first time, at a global level.

When facing a crisis like this, you are bound to ask what is the reason for such turmoil. People come up with the traditional post-crisis themes of insufficient regulations, real estate bubbles, excessive leverage and capital flows, lax monetary policies, etc. All of these were part of the cause, but do not offer a sufficient explanation. Actually crises are very common in the history of mankind. There are many examples of this. Since 1825, we have seen:

• Mount Vesuvius erupting nine times;

• Six volcanic eruptions causing more than 5,000 deaths;

• Ten earthquakes with 50,000 fatalities; and

• Seven tsunamis with 25,000 deaths.

Crises are part of life. In the meantime, there have been ten years when more than 20% was lost on the S&P 500. As a risk manager, history shows that there have been many crises and it is likely that there will be many more to come. This is why I don't believe in forecasting crises, because if we could forecast crises, we would avoid them. Instead, it is all the more important as a risk manager and also as an insurance company, in order to be prepared for the future financial crisis. But to be prepared for a future financial crisis, the general mindset of companies has to change.

What are the real causes of crises?

There are three major reasons for a crisis. Being aware of these could help to build early warning systems. Here are the three ingredients found in most financial crises:
- A significant negative surprise
- Irresponsibly high risk appetite, increased by high leverage
- Excessive concentration of aggregated risk in highly leveraged financial institutions

The problem in our modern economies is that they are strongly interconnected. In times of crisis some of these interconnections will become important. The surprise in the present financial crisis was the weak links in an immensely complex system. It was not the decline of real estate prices, and the fact that subprimes were the first to be affected by this. It was the related distress of many parts of the financial system, even those very distant from the subprime market itself. The data was available to recognize the problem, but reality is immensely complex with millions of potential weak links. *Ex-post* it's relatively easy to point out the connection that was causing the problem, but *ex-ante* is much more difficult because we have so many of these connections. They can change suddenly from irrelevant to very important. This change in paradigm from irrelevant to critical links triggers massive uncertainty and unleashes destructive flights to quality. Surprises that have the potential to trigger a severe financial crisis are not simply *bad realizations* within a *known probabilistic* environment. They are rather *changes in the environment* itself.

In 2008, the Federal Reserve and the Treasury decided to let Lehman Brothers go bankrupt. At the same time, intervened in the AIG situation because they were worried about their huge position in credit default swaps. What they did not take into account was that the Money Market Fund had part of its assets invested in Lehman Brothers bonds. At that time, the money market fund was considered to be extremely safe, so it experienced during the years 2007/2008 an increasing investment of USD 850 billion, 34% more assets than mid-2007 because of the subprime crisis. All of a sudden Lehman Brothers fell and people started to panic. The week following Lehman's default, there were redemption orders amounting to USD 169 billion, from total invested assets of USD 3.4 trillion (5%), as well as a large shift from prime funds towards fund investing exclusively in government debt. This is what I mean by negative surprises that people don't expect. It wasn't the bankruptcy of Lehman Brothers in itself that was a problem, but the link with the Money Market Fund.

Aggregate risks

Aggregate risk is also a major cause of instability. Very few people know that, just before the crisis, 85% of bank assets were held in securitized form, mostly senior tranches of structured products. These tranches rely on the protection by the junior tranche of the structured product in order to reduce the risk of default. Unfortunately, this protection is based on the law of large numbers, so the probability of many bad events happening together is small, but this is only true in normal conditions. When crisis erupts, the law of large numbers no longer holds.

During the crisis, structured products were downgraded by five to six notches on average. During the crisis on the corporate bond market in 2001/2002, the downgrade was only 1.8 notches on average. Corporate bonds have a lot of idiosyncratic risks, while with structured products, the structure of the product itself creates the aggregated risk. They are in fact an amplifier of the big market movements. The systemic consequence of this risk was that highly leveraged institutions were *bearing more aggregate risks* than would have been thought from simply observing the average ratings of their assets. Having the financial sector holding such a risk with respect to aggregate surprise proved to be a recipe for disaster.

Preparing the company for the next negative surprise

In times of crisis, small effects can generate a huge impact, and they are mainly driven by human behaviour. What you see in those situations are:

- Lack of leadership: management fails to do a systematic landscape monitoring

- Lack of analysis of the situation: after the crisis errupted, anyone who took the trouble to connect the dots could, in principle, have foreseen what might happen

- Lack of initiative: sitting on cash cows instead of proactively evaluating future risks

- Lack of level-headedness: we have seen harsh and disproportional reactions from market participants

The main failure was not understanding that relatively "small effects" could generate huge impacts and create a confusion across the entire system. Surprises quickly trigger a chain of unexpected events from the panic they engender. Neither element is going to disappear anytime soon. Despite all attempts, our economy will be subject to shocks in the future. It is the role of Risk Management to prepare the organization for the occurrence of such crises and to make sure that the company can survive them. Rather than trying to predict the crisis, risk managers should integrate the occurrence of crises with a reasonable probability into their models. This is the only way an organization can be prepared to face a major disruption of the financial system.

What is the level of risk appetite? Trying to schematize this, you could think of three business models.

1 Firstly, there are companies that opt for low financial leverage, which is the preferred business model of the regulators. Such companies would have a relatively low expected Return On Equity (ROE), but also low volatility of the results.

2 Next, going up in terms of leverage there would be a medium sized company with uncertain volatility and a higher expected ROE than the first model.

3 Finally, a high financial leverage company that will of course have a high expected ROE but with a high volatility in results and a high risk of bankruptcy due to irresponsibly high risk appetite.
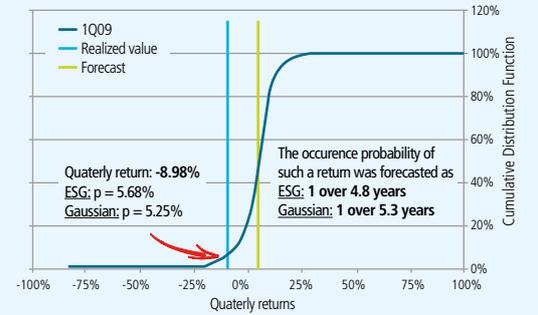

Figure 2: **A controlled risk appetite reduces the ruin probability**
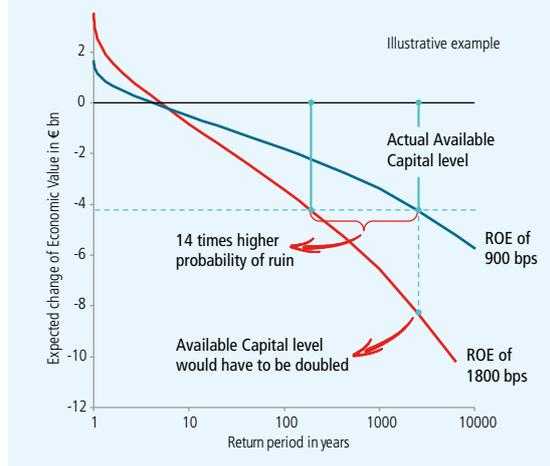
In Figure 2, we draw the Cumulative Probability Distribution (CDF) of SCOR value one year after the crisis. During the preparation of our three-year plan, we were asked to look at the consequences for the company of doubling of the target profit, which at that time was 900 basis points above the risk-free rate. They asked us to do the computation in our internal model and see what would happen if we choose 1 800 basis points instead. Here the red curve is the one with the double target expected return, with a higher risk of course, but the consequences of that are particularly striking. Keeping the same capital and doubling the ROE would mean multiplying the risk of bankruptcy for the company by a factor of 14! It is highly non-linear and it is what I call irresponsible risk appetite. This is based on our internal model, which integrates the risk of crisis as we will see in the next example.
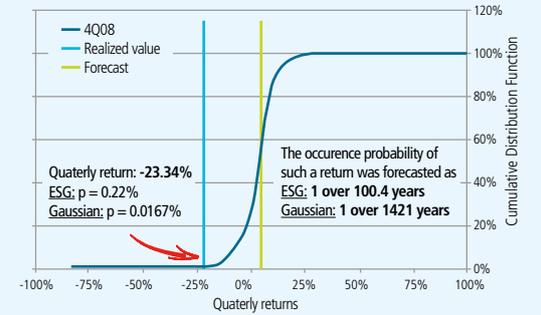
In the graphs of Figures 3a and 3b, we show an output of our economic scenario generator. This is the CDF for the US equity index as predicted by our model in June 2007 for the third and the fourth quarter of 2008. Our economic scenario generator is not a crystal bowl but simply a way to look at the risk. You can see that the expected value has completely missed the -8.98% of the real performance. The real question from a risk management perspective is the predicted probability of what actually happened. The probability in our distribution was 6.9%, which is about 1-over-4 years, so not very serious. What is much more serious is what happened for the fourth quarter of 2008.

Figure 3a: Empirical CDF of quarterly returns of USD Equity index (GDDLE15X)

Legend:
- 1Q09
- Realized value
- Forecast

Quarterly return: -8.98%
ESG: p = 5.68%
Gaussian: p = 5.25%

The occurence probability of such a return was forecasted as
ESG: **1 over 4.8 years**
Gaussian: **1 over 5.3 years**

Figure 3b: Empirical CDF of quarterly returns of USD Equity index (GDDLE15X)

Legend:
- 4Q08
- Realized value
- Forecast

Quarterly return: -23.34%
ESG: p = 0.22%
Gaussian: p = 0.0167%

The occurence probability of such a return was forecasted as
ESG: **1 over 100.4 years**
Gaussian: **1 over 1421 years**

In the fourth quarter of 2008, the probability of the realized value in the distribution we were predicting a year and a half before was, in our model, 1-over-100 years. But look at the probability of this in the rating agency and according to their model, such an event bank model, 1-over-1 400 years (cf Figure 3b). Basically, should not happen during our own lifetime. What is very important is that our model integrates the risk of an extreme event and assigns to it a reasonable probability. This is the only way we can really prepare our companies for such events.

Reinsurers and banks as risk bearers

Banks are essentially bearers of credit risks and market risks. Most other kinds of risk are born by insurance and reinsurance. Insurance companies generally hold very high risks in their portfolio and want to unload them on the reinsurer. Crises are thus part of our business, they are almost in the DNA of reinsurance.

In Figure 4, we present a summary of the insurance losses due to natural catastrophes in the US as reported by Swiss Re since 1985. We can see that the 2005 series of catastrophes stand out. Katrina, Rita and Wilma cost the reinsurance industry USD 50 billion, compared to the total amount of premium (USD 160 billion) that was ceded to reinsurance in 2005. Nevertheless, there was only one bankruptcy, a retrocessionnaire, out of 125 reinsurers at the time, a relatively mild consequence due to the fact that reinsurers are prepared for crisis. This example shows that society as a whole could prepare itself for this kind of outcome and be able to handle it.

In stark contrast, the financial system suffered one of its most severe crisis originating from the subprimes. Before the financial crisis, it is estimated that this market in the US represented a value of about USD 700 billion, which is a considerable amount. However, it should be compared to the total value of the real estate market at that time in the US, which was estimated to be USD 11 000 billion. Such a small market representing only 6.4% of the total real estate market in the US triggered immense turmoils in the whole world, while a loss of more than 30% of the entire industry premium in 2005 was a non-event for reinsurers. I like to think that good risk management should help us better weather financial crisis as it does in the case of reinsurance.

Figure 4: Worldwide Insured Natural Catastrophe Losses

all in 2005

Source: Swiss Re Sigma
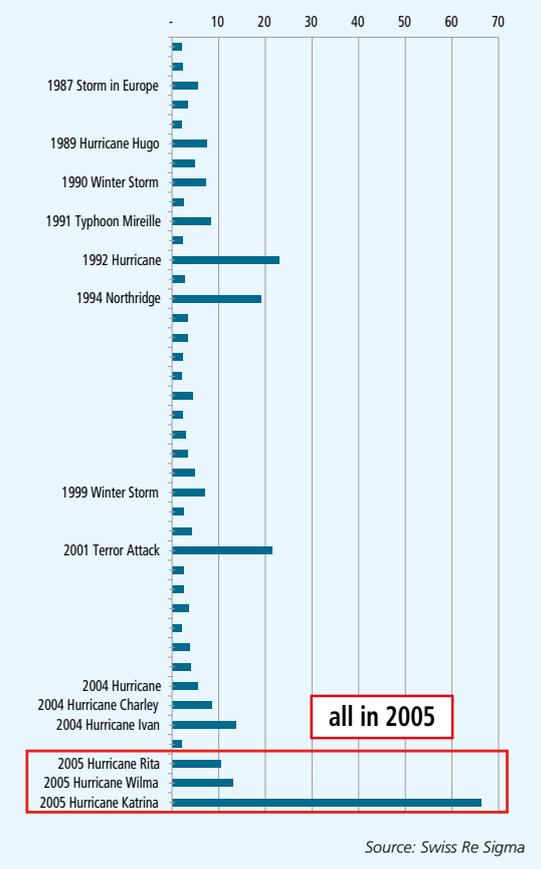
Risk management is crucial to survive a crisis

Here are some basic risk management rules we should apply in our organization to be prepared in case of crisis:
- Set realistic profit targets and solvency ratio
- Include crisis scenarios in the evaluation of risk capital
- Foster a risk culture throughout the company

- Track the main exposures of the portfolio
- Set limits for major risks and make sure that they are respected
- Be prepared for major disruptions to the financial system

Consequences of financial crises on insurance capital requirements

We are living in this new risk-based capital requirement environment which will probably have a lot of consequences in terms of the way our industry reacts to crises.

We have to think about regulation in times of crisis, before it actually erupts. In times of crisis, it is too late to correct the errors of the system. It is thus very important to adapt the solvency rules to the new situation and restore confidence in the system. In 2009, the stress tests that the Federal Reserve required the banks to undergo really helped get out of the banking crisis. Positive answers to the stress tests restored confidence in the system. With Solvency II, we are preparing to have risk models, and good risk models during crisis would reflect the increased risk of the situation and thus come up with higher risk-adjusted capital than in quieter times. Requiring companies to keep the same level of security than before the crisis would require a significant increase in capital. This will accentuate the lack of liquidity in the market, which is the main characteristic of a financial crisis. The question is whether this is reasonable.

Figure 5: **Government Yield developments**

Historical 10Y Government Yields
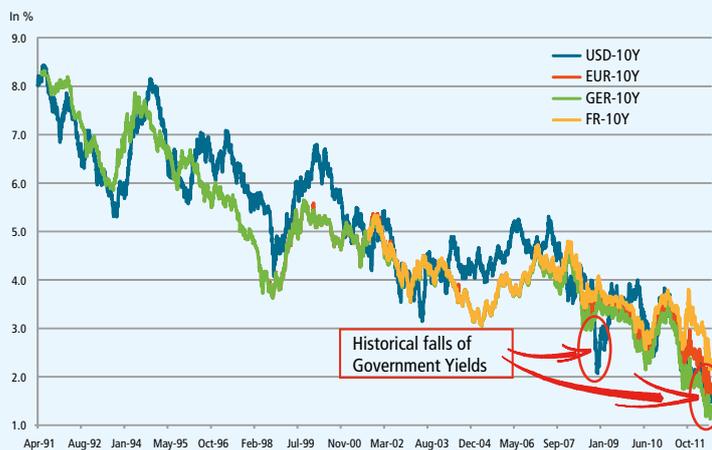
Some risks are directly linked to the fall of interest rate:

SCOR's life model required 17% more capital for mortality due to the drop of interest rate.
This translated in a 10% more capital for the whole portfolio.

Using the same yield curve as before the crisis would have increased the risk bearing capital by 15%.
This weakening of the risk bearing capital is due to the drop of the benefit of discounting P&C reserves.

Source: Bloomberg 06 Aug 12

In Figure 5, we present an example of the impact of the sudden decrease in yield during the crises of 2008/09 on SCOR's portfolio. This is an overview of the historical ten-year yield government bonds for the major economies since April 1991. Some people say that the constant decrease in government yield is one of the reasons behind the crisis. The risk-free rate has not ceased to decrease, but during the crisis, it decreased much more. What are the consequences of those decreased interest rates on SCOR's model?

In 2007, SCOR's top management had anticipated the crisis. We had already decided at that time to decrease the risk of our investment portfolio and to build up cash. As a consequence, we somehow disconnected liabilities from assets. The natural hedge in interest rates between assets and liabilities was less efficient. In addition, SCOR's portfolio is very large and is, by nature, very sensitive to interest rates. It is not just sensitive in terms of value, but also in terms of its risk.

The consequence of this on SCOR's Life portfolio was that the Life model required, on a standalone basis, 17% more capital for mortality due to the fall in interest rates, which translated into 10% more capital for the whole portfolio of SCOR. At the same time, because we had this policy of building cash, SCOR's available capital went down by 15%. The result of this was a drop of 30% in the solvency ratio of the company! It tells what happens. This demonstrates the volatility of results when performing economic evaluation. This is the practical impact of such a situation on the capital requirement, measured with a risk model.

Figure 6: Examples of increased risks: inflation

Empirical density function of 1 year returns of the CPI for USD
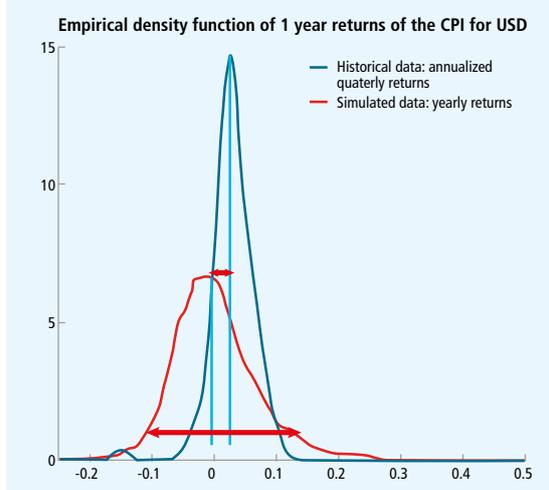
Another example of increased risk is given in Figure 6 where we look at the risk of inflation through the Consumer Price Index (CPI) for the US. The blue curve is the empirical distribution of the inflation as it was historically seen in our database, and the red curve is the distribution forecasted by our economic scenario generator at the time of the crisis. At that time, people feared inflation, and that is exactly what this model shows. The model was predicting a lower inflation for the next year, which turned out to be right. What is interesting here though is not the change in expectation, but the fact that the uncertainty was much greater. The result of this is that SCOR's internal model increased the capital it needed for inflation.

Most people are aware of these effects. They call this the pro-cyclical nature of risk-based capital. So insisting on having the same rules at all times for the internal model will require higher capital for all companies when the markets experience strong turbulence. At the same time, this would immobilize a huge amount of supplementary capital, which in turn would pointlessly increase the cost of protection at a time when good protection is needed. It would dry up capital on the market, where already not much cash is available.

Moreover, it would dry out the scarce liquidity available for the rest of the economy, further weakening non-financial companies, which would in turn reduce the quality of the asset portfolio of insurers and reinsurers, thereby reinforcing the vicious circle.

Several proposals have been put forward as solutions to the dilemma of pro-cyclicality, but most of these proposals are, to my opinion, not good because they tend to relax the rules of economic valuation. In other words, it is like breaking the thermometer when you have fever. Changing the interest rate because you don't like it will not help you if you need to sell your portfolio, because the people who buy it will use market interest rates and not those chosen by the regulators for discounting. The contract boundaries idea is also not a solution. It is very unrealistic to think that you can increase premium of life policies in times of crisis. If you do this, it is very likely that you will increase the lapse rate in very big proportions, thus reinforcing your problems.

This is not the best way to tackle the problem. The very obvious and most simple way to tackle it is to reduce the need for capital when measuring solvency during the crisis. This is very simple to do. We keep hearing that we want to measure capital using the value at risk at 99.5%. Why 99.5%? The first reason is that you want to be in the tails and you want to be more prudent than the banks. Yet, the choice of threshold is arbitrary. Actually, the system has to be dynamic and contingent to what happens. We cannot insist that a ship does not tip during a storm. We have to make sure that it doesn't capsize, which is not the same thing.

A natural proposal is would be to reduce the requirement for solvency capital in times of crises. I made the calculation for SCOR: using a 99% threshold instead of 99.5% would have required the same capital in the middle of the crisis as before the crisis. It would not have reduced it, but it would not have increased it as it did during the crisis. This does not mean that you would have no capital. It just means you wouldn't increase it at a time when you should not. After all, capital is here to be used from time to time.

The proposal thus is to change the threshold at which the capital is measured. We know that this is a difficult time, but we will measure the solvency on a weaker scale. Of course, the question is who is going to decide on that and how are we going to make it? The regulators should not be allowed to decide on this in the middle of the crisis, because this will increase the crisis. However, if prepared in advance, you have rules that make sense and you don't need to think, and simply follow them. In my opinion we should better decide on the rules beforehand and have a trigger that says from now on until a certain period of time, say a year, the regulator will measure the solvency at

the 99 percentile instead of 99.5. A year later, if the volatility is below this index, the regulators would then re-establish the 99.5% threshold and ask companies to refurbish their capital to comply with this.

Such a rule would allow insurance and reinsurance to use part of their capital to face up to the unfavourable economic situation without running the risk of becoming insolvent for liabilities they would have to pay in the distant future.

But what could be the trigger? The difficulty here is that everybody knows we are in a crisis, but it is very hard to measure. A Gross Domestic Product (GDP) measure could be used, but unfortunately such a measure will let you know that you are in a crisis a year after it started! So another trigger is welcomed, that will take the temperature of the market. There are of course various ways to measure this, and on Figure 7 we propose a possible solution.

Figure 7: Yearly volatility of US stock market since 1870

Source : IMF (2009)
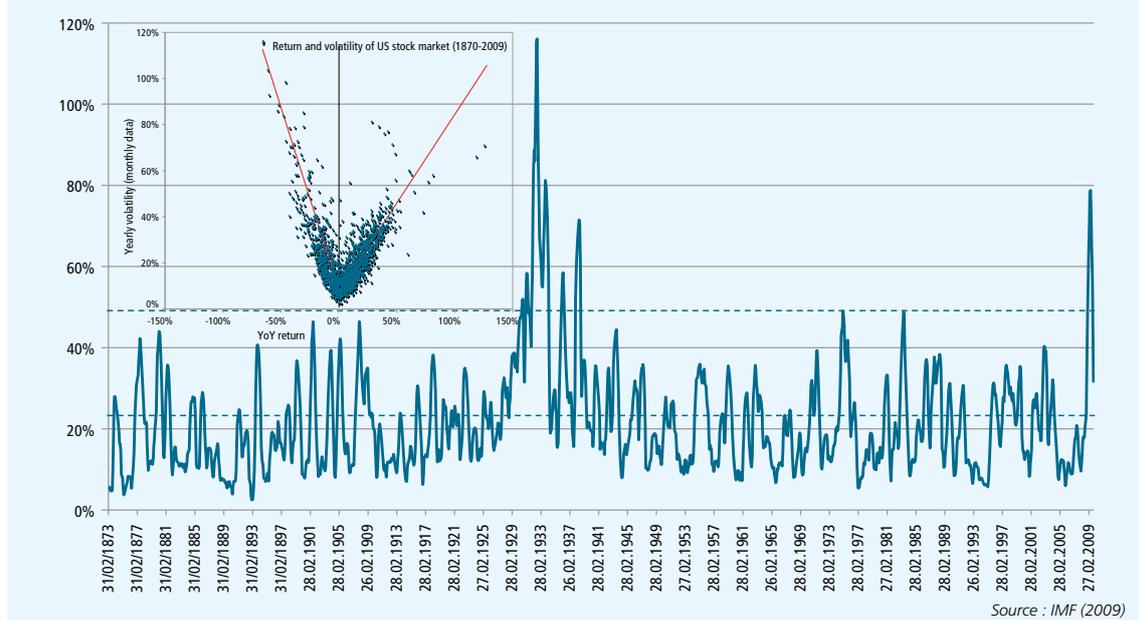
In Figure 7, we display the yearly volatility of the S&P 500 since 1870. On the top left-hand side of the graph, the volatility measured with positive movements and the volatility measured with negative movements are shown. The red line, which represents the correlation between volatility and returns, has a stronger slope for negative movements than for positive movements. This indicates that volatility increases faster when the market is in turmoil. We thus know that when measuring very high volatility, it is usually when things go bad. Thus volatility is a good measure for market turmoil. The average yearly volatility is about 20%. Now if we take twice this average yearly volatility, which is about 40%, it is represented by the dotted line on the graph. During

the period starting in 1870, the rule would have been triggered only twice; during the 1929 crisis and in 2008. The yearly volatility can be computed every day and relatively quickly.

Why not put into the law that the rules change if the volatility of the stock market hits twice the average yearly volatility? Then for a year, the regulator would look at the solvency of the company at the 99 percentile instead of the 99.5 percentile. Giving this flexibility to the system combines three advantages:
- It works against the famous pro-cyclicality.
- It reduces the need to lock up useless extra capital.
- It is transparent by recognizing an objective situation.

Conclusion

In conclusion, let us remember that there will always be crises and we will always be surprised by them. We undoubtedly need to learn the lessons of the last one, to reduce the risk of the same causes producing the same effects. We have to prepare ourselves for the next one to come. As risk managers, we need to

integrate into our models a reasonable probability of a crisis happening, and be ready for this. The Romans used to say *si vis pacem para bellum* (if you want peace, prepare for war), which I will paraphrase by: if you want to survive a crisis, you have to be prepared for it.

12

# REINSURANCE – A STRATEGIC CAPITAL MANAGEMENT TOOL

VICTOR PEIGNET
Chief Executive Officer
SCOR Global P&C

(Re)insurers are all increasingly subject to the cumulative effects of globalisation: be it economic, financial, or regulatory. Yet, at the same time, they face increasing pressure to be locally rooted with in-depth knowledge of local and regional issues: again, be it from an economic, financial or regulatory standpoint. By way of example, taking the regulatory environment: in order to operate and play a major role in a foreign country, companies must now be registered in and subject to the regulations of that country, as well as being obliged to invest capital locally and pay local taxes. Combined, the global nature of the reinsurance business and the multiplication of international and national regulations have increased the complexity of capital management.

Being able to be global AND local are two concurrent pressures that apply to reinsurers, forcing them to become increasingly multi-domestic and capital-driven.

These changes can be a source of opportunities for sophisticated global reinsurers able to leverage on their own experience to the benefit of their clients. We believe indeed it is a source of competitive differentiation which has been at work for several years now, and will increasingly act as a strategically discriminatory factor.

This is a major reason behind SCOR's positioning as a capital-driven company. Over the past 10 years, we have given the definition of a risk appetite framework and the consequential choice of a risk/return trade-off play a critical and strategically important role. This is a message SCOR shares continuously, and engages with its Board of Directors and all its stakeholders: clients, shareholders, regulators, rating agencies, employees...
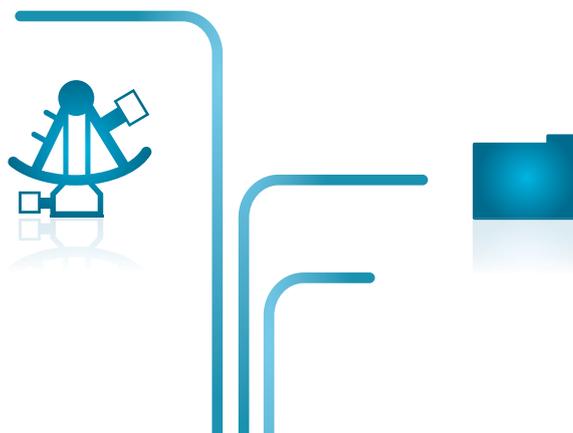
(Re)insurers are increasingly forced to become capital-driven companies, under the pressure of capital stakeholders

Since mid-2007, companies have witnessed an increasing number of disturbances and shocks, including financial, economic and political instability. Within this unstable environment, the failure of the banking system has created a temptation to strengthen regulations at a local level, including for (re)insurance, despite a track record of being resilient throughout the crisis. Recent regulatory developments have explicitly demanded additional layering of regulatory frameworks at a local level, leading to regulatory fragmentation, protectionism and nationalism. This "re-regulation" has followed a long period of "de-regulation" which acted as an engine to globalisation. The "re-regulation" trend, to the contrary, led to a fragmentation, which is such that today's playing field is no longer levelled.

On the one hand, at a local level we can observe:

- **Branch supervisions:** an IAIS paper (International Association of Insurance Supervisors) recommends more capital control, localized capital add-ons and the transformation of branches into subsidiaries

- **Solvency II:** where EU supervisors are adopting increasingly fragmented approaches with local biases

It is important to note that the inappropriate fragmentation of supervision poses a real threat to the capital management and organizational structure of all (re)insurers: capital becomes less and less fungible, and fragmentation slows down the mutualisation principle that is at heart of the (re)insurance business.

Alongside increasing local regulations, international initiatives have also been, taken with:
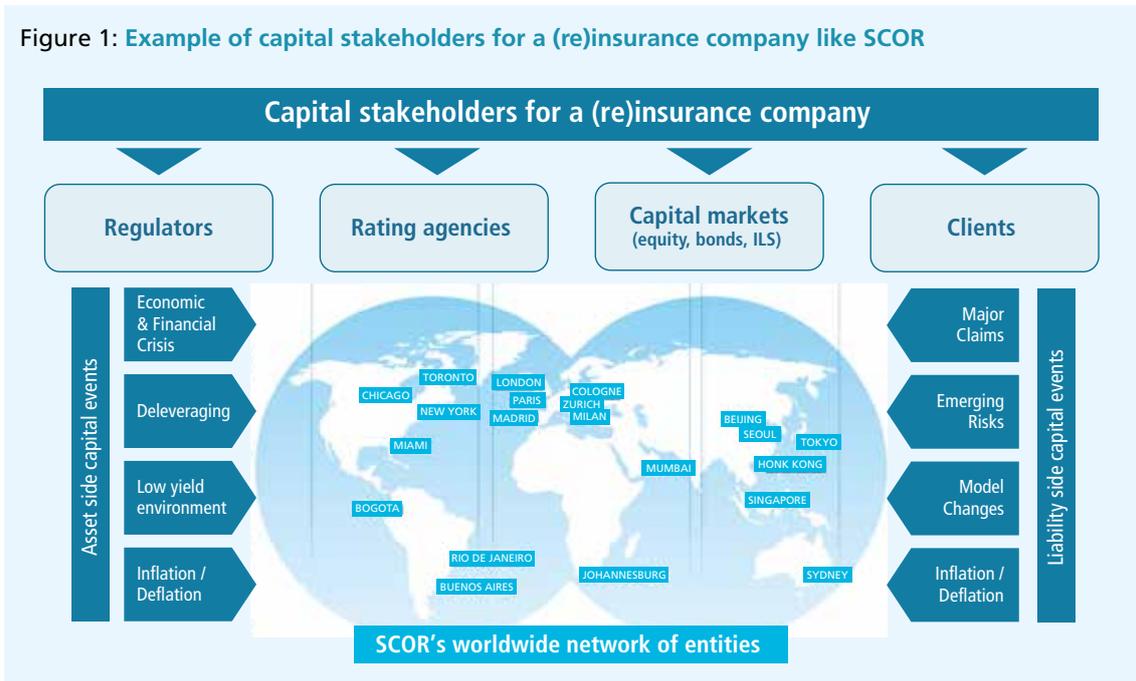
- The IAIS currently working on a Common Framework (ComFrame) for the Supervision of Internationally Active Insurance Groups (IAIGs), with the intention of:

- enhancing cooperation and coordination among supervisors

- improving the comparability of IAIG regulation and supervisory processes

ComFrame could be a positive milestone, notably for levelling the playing field and the recognition of group-wide supervision, unless it adds an extra layer on top of local regimes and supervision, or if the global standard is too generic and misrepresents (re)insurance risks

- The EU/US dialogue designed to reduce collateral postings and develop transatlantic business

In this context, whether they are for or against these changes, and whether they are local, regional, international or global players, (re)insurers are *de facto* increasingly impacted by in regulatory scrutiny. This scrutiny applies first and foremost to (re)insurers' capital. The notion of "capital" is actually more complex than what it seems at a first glance, and gets even more complex in proportion of the global nature of a (re)insurer's business (see Figure 1).

Capital stakeholders for a (re)insurance company

| Regulators | Rating agencies | Capital markets (equity, bonds, ILS) | Clients |

Asset side capital events

- Economic & Financial Crisis
- Deleveraging
- Low yield environment
- Inflation / Deflation

Liability side capital events

- Major Claims
- Emerging Risks
- Model Changes
- Inflation / Deflation

TORONTO, CHICAGO, NEW YORK, MIAMI, BOGOTA, RIO DE JANEIRO, BUENOS AIRES, LONDON, PARIS, MADRID, COLOGNE, ZURICH, MILAN, JOHANNESBURG, BEIJING, SEOUL, HONK KONG, TOKYO, MUMBAI, SINGAPORE, SYDNEY

SCOR's worldwide network of entities

As can be seen in the graph above, the capital stakeholders include regulators, rating agencies, capital markets and clients. None of these stakeholders is new in the overall equation, but their sophistication when looking at (re)insurers' "capital" has significantly increased in the recent years. Those stakeholders' attention has been particularly focused on both (re)insurers' assets and liabilities' side related events: taken on their own, and in conjunction with one another. A good example of a capital event is the economic and financial crisis of 2007 and 2008, which led to deleveraging and created a low yield environment as well as inflation/deflation, resulting in liabilities' coming under pressure.

In this context, SCOR acted early-on on its asset mix, and severely reduced its asset risk, acknowledging the fact that a reinsurer's primary goal is to take liability (not asset) risk, and refocusing its risk taking on its core activity in a stressed environment.

HOW TO BEST MANAGE OPTIMISE AND MANAGE UNDER CONSTRAINTS?

The role of a management team is to define a strategy which respects a given risk appetite, and fully acknowledges a key principle: there is no return without risk, and there is no margin without risk. This principal is at the heart of both the insurance and the reinsurance businesses: it is underpinning our value proposition to our customers, and is at the same time a source of returns to our shareholders, provided we indeed operate within this well-defined risk appetite framework approved by the Board.

The question then becomes: how can insurers and reinsurers best operate under these constraints? Being "capital-driven" is not about maximising any of the three key factors, being growth, profitability or solvency. It is about optimising and managing under constraints.

The first constraint is "capital", a notion that is more complex than what it first looks like, and does not necessarily represent the same thing for all stakeholders:

1. **For shareholders,** "capital" is a source of risks and profits, an investment to be remunerated. Its optimum level is "not too high", otherwise, profitability drags…

2. **For regulators,** "capital" is considered as a cushion to absorb shocks in order to protect policyholders. Its optimum level is "as high as possible" as regulators seek to maximise policyholders' security.

3. **For rating agencies,** "capital" is a cushion to pay bondholders and policyholders. Its optimum level is a subtle combination of the two above, and can be summarized as "sufficiently high", i.e. including notions of efficiency of capital and capital flexibility to have access to the markets in good conditions if ever required.

The second constraint is the ability to remunerate this capital, in order to make a (re)insurance company an attractive proposition to capital providers.

These two constraints (capital and ability to remunerate it at adequate level) drive SCOR's only two targets: Solvency, and Profitability. One of the business teams' goals is to maximise growth within these two targets, and find the optimal point between Solvency, Profitability and Growth. Optimising under constraints can simplistically be represented as the below triangle.

Figure 2: **Managing a fine balancing act: an equation with 3 key factors**
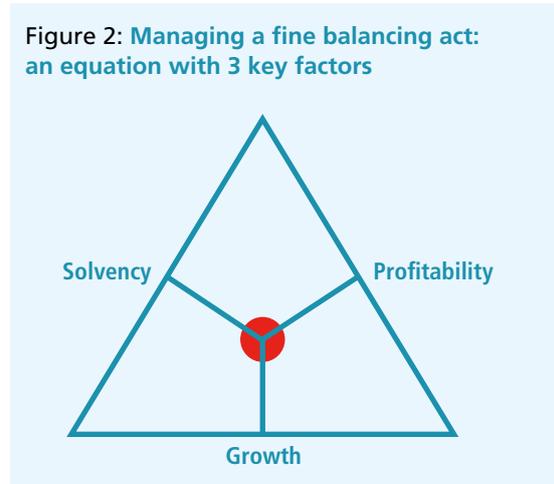
THE STARTING POINT: A GOOD DEFINITION OF A RISK APPETITE FRAMEWORK

Risk tolerance at SCOR has been publicly communicated since 2005. SCOR started to design an internal model in 2003 and began to use it in 2005, the year it won back an A rating from Standard & Poor's. When SCOR bought Converium (2007), it appropriated and expanded on their capital model, which has now been in use since 2010. This model has been submitted to the French regulator and its application for approval is due to be filed in Spring 2014. SCOR uses it in its management of the company and now publishes its solvency levels according to this model.

The starting point of any capital-driven company is therefore for a (re)insurer's executive management to precisely define the company risk appetite framework, which will operate almost like a philosophy, and to have it approved by the board of directors of the company.

Secondly, more practical aspects have to be defined: the definition of risk preferences and the creation of a set of quantum by defining risk tolerances, i.e. the maximum risk tolerance, how much risk exposure can be accepted and the length of time for which you will accept exposure to the maximum possible risk (see Figure 3).

Figure 3: **SCOR's risk appetite framework**
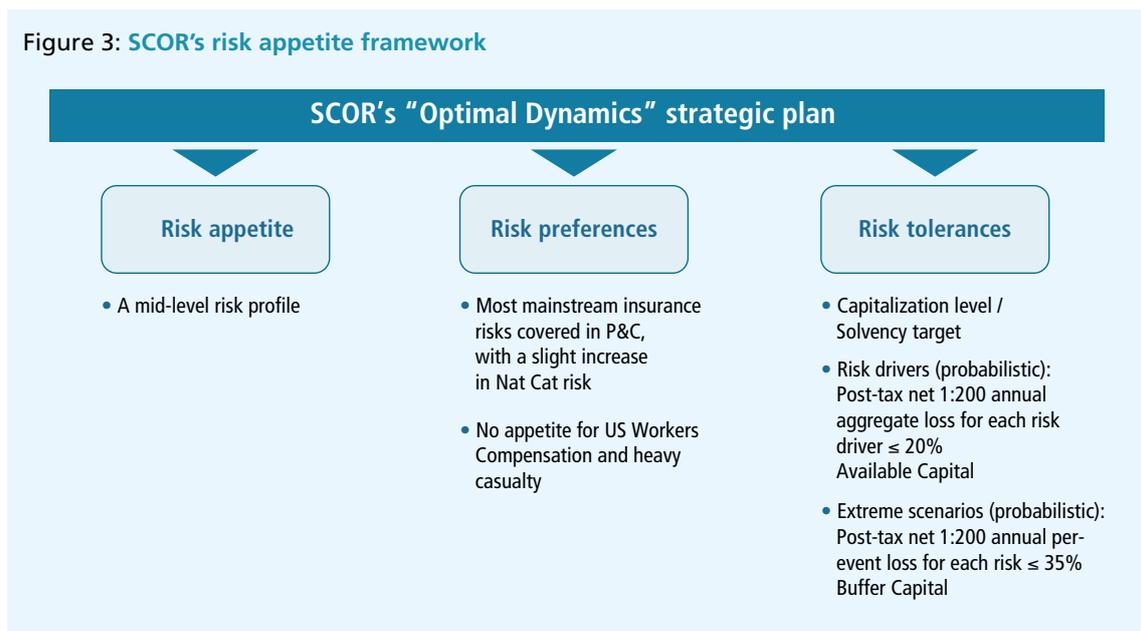
Once you have defined what your capital stakeholders can expect from the company, the next step relates to the choice of a risk/return trade–off:

a) The quantum of profit required to remunerate the capital. As shown by the curve in Figure 4, the more risk you take, the more Return on Equity (ROE) you are expected to deliver.

b) Beyond the quantity of profit required, its desired stability needs to be set as well. The SCOR model, chosen in 2005 and still in use today, focuses on earnings' stability, with low double-digit returns. What is characterised as a "mid-level risk appetite".

Figure 4: **Risk/return trade-off of SCOR's model**
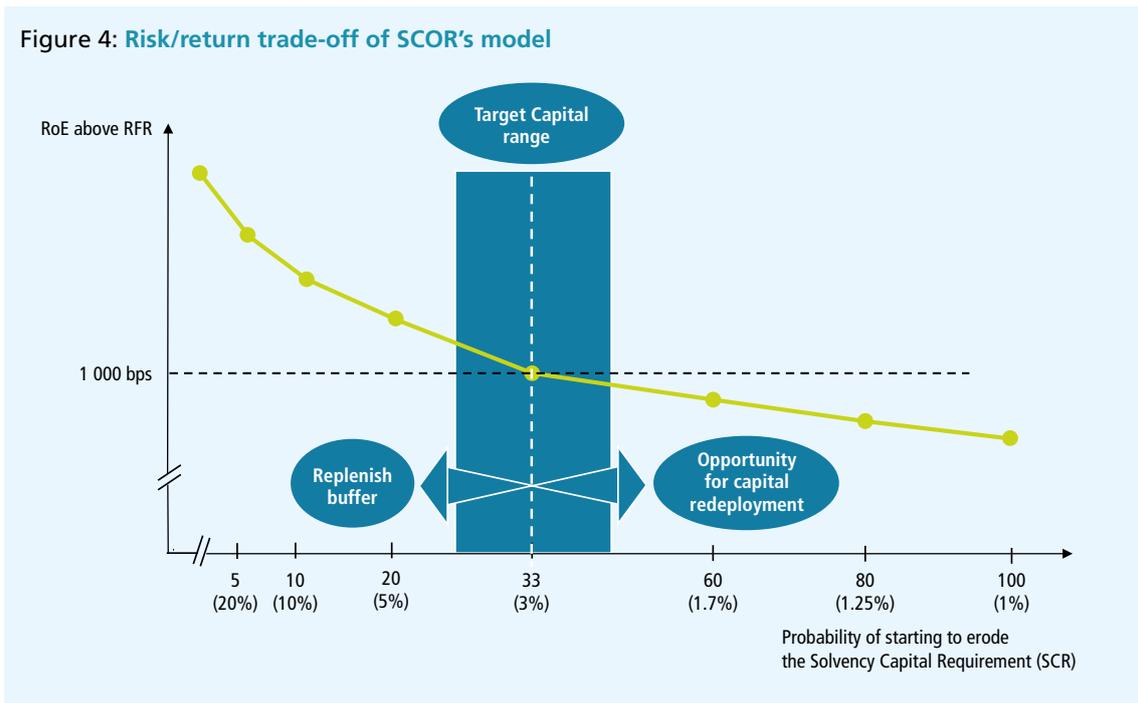
What is the reasoning behind the choice of a "mid-level risk appetite"? SCOR regained its A rating in 2005 through a very simple requirement: to win the challenge to be profitable every quarter in a cyclical business with a high inherent volatility. With this sort of requirement, earnings' stability becomes a key goal.

SCOR decided on stability at around 10% ROE, with a very low standard ROE deviation. If you look at the 2005 to 2014 period, SCOR has the lowest profits' standard deviation and the highest stability in the industry (Figure 5).
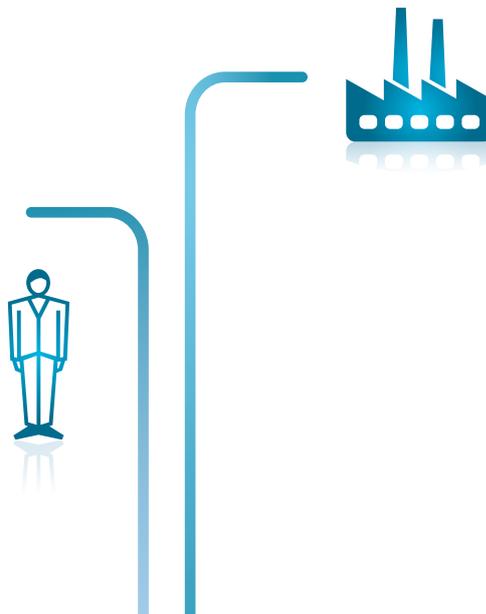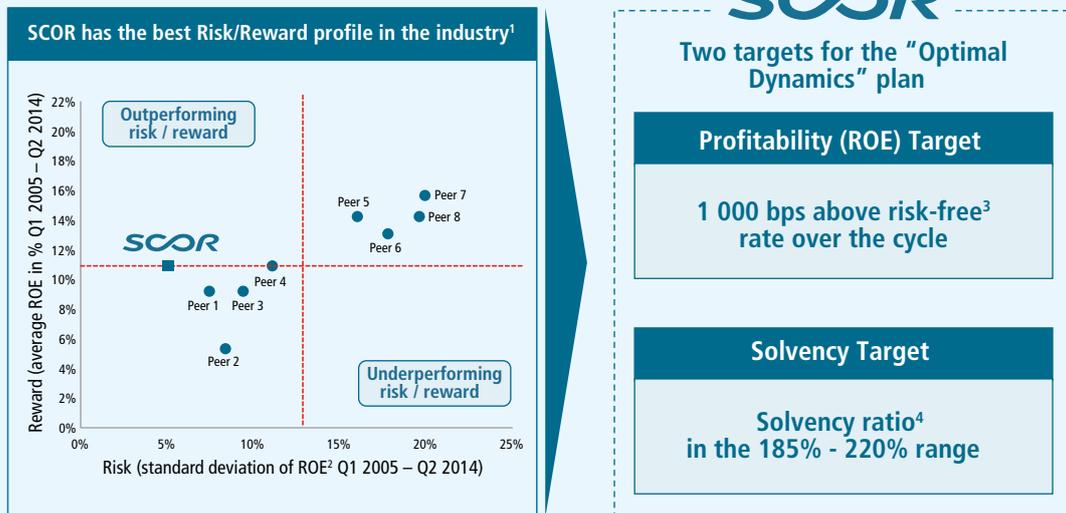
Figure 5: **SCOR has the best risk/reward profile in the industry**

SCOR has the best Risk/Reward profile in the industry[1]

Reward (average ROE in % Q1 2005 – Q2 2014)

Outperforming risk / reward

Underperforming risk / reward

Risk (standard deviation of ROE[2] Q1 2005 – Q2 2014)

SCOR

Peer 1   Peer 2   Peer 3   Peer 4   Peer 5   Peer 6   Peer 7   Peer 8

Two targets for the "Optimal Dynamics" plan

Profitability (ROE) Target

1 000 bps above risk-free[3] rate over the cycle

Solvency Target

Solvency ratio[4] in the 185% - 220% range

1) Source: company reports, peers in Alphabetical order: Axis, Everest Re, Hannover Re, Munich Re, Partner Re, Renaissance Re, Swiss Re and XL Re
2) Annualized quarterly ROE
3) "Risk-free rate" is based on 3-month risk-free rate
4) As per the Group Internal Model; it is the ratio of Available Capital over SCR (Solvency Capital Requirements)

In 2005, SCOR's model was not so warmly welcomed by the financial market, as earnings' stability was not a major consideration at the time. In a "good year", investors were expecting returns of 25% and they were ready to accept much more volatility, including the need for capital to be replenished in very bad years. SCOR was going against the trend at that time, but nine years on this model is highly appreciated: in a world that has become more risk averse, subject to an ever expanding universe of risks, (re)insurance companies' stakeholders have increasingly valued predictability and stability. When running a company over the long-term, top executives should believe that their model is a valuable one, even if its popularity fluctuates at certain times in the cycle. To sell to the market, consistency, transparency and continuity are key.

Reinsurance, a strategic tool in the capital management toolbox of insurance companies

By defining a structured and thorough capital shield strategy, (re)insurers create a range of protection mechanisms. As an example (see Figure 6), SCOR's capital shield strategy ensures efficient protection for its shareholders thanks to stacked protection layers:

- Traditional retrocession
- Capital market solutions
- Solvency buffer
- Contingent capital facility

Figure 6: **Structure of SCOR's capital shield strategy**

Size of loss

Contingent capital facility

Solvency buffer

Capital markets solutions

Traditional retrocession

Retention

SCOR's capital shield strategy ensures efficient protection of the Group's stakeholders, thanks to different protection layers. Very early on, SCOR sealed business with a combination of traditional retrocession partners and alternative capital providers, in order to strengthen its relationships with counterparts who understand its business and the risks underwritten. Consequently, strong relationships have been established with them over many years, through the boom and bust of many disasters. Continuity of purchase is extremely important in any relationship and it must drive price.
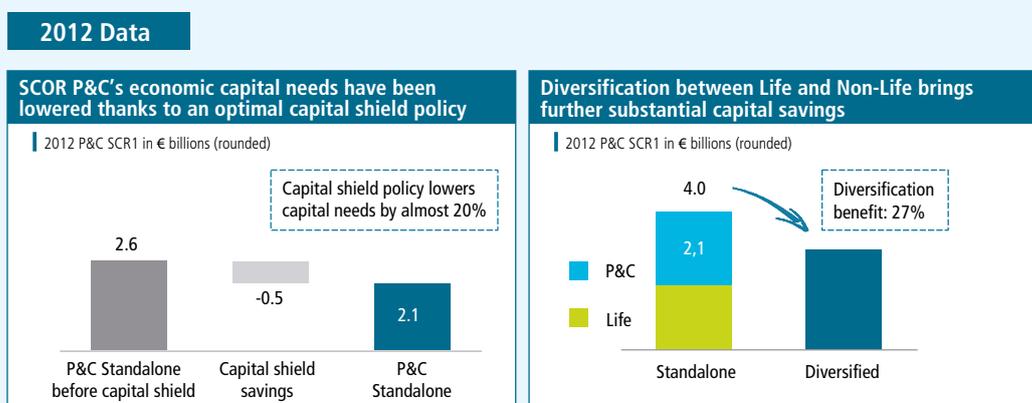
Separately, when building a capital shield strategy, (re)insurers must endeavour to optimize their own internal capital flows and deployment, in order to maximize capital "fungibility". Moving capital is extremely difficult in a regulated environment. It is therefore crucial to design an internal capital mobility grid that allows the Group to manage capital at multi-local levels, guaranteeing maximum fungibility and full capital optimization. To this effect, SCOR uses a strong capital management process through three capital pools (Europe, Americas and Asia), which support local solvency and ensures capital fungibility across the Group; it has also reduced the numbers of its subsidiaries. The efficiency of this structured approach and the capital fungibility between subsidiaries are ensured through the combination of various tools:
• Internal retrocession
• Collateral posting (deposits, letters of credit (LOC)) to reduce regulatory solvency requirements
• Other actions such as internal loans/portfolio transfers, capital transfers, etc.

Through an efficient branch set-up, facilitated by the Societas Europaea structure, supervision has been integrated at the parent company level. SCOR communicates with a limited number of regulators, with whom it can share its global strategy in a privileged manner, while mutualizing diversification benefits under Solvency II.

Taking such an articulated step by step approach genuinely allows reinsurance to become a strategic tool in the capital management toolbox of insurance companies. Using SCOR as an example, this approach allows the Group to save close to 30% of its capital. Figure 7 shows data from 2012: SCOR Global P&C had a standalone capital requirement of EUR 2.6 billion before retrocession. After retrocession, the capital required to run the P&C business is EUR 2.1 billion. For the Life reinsurance business of the Group, the capital required to run the business is EUR 1.9 billion. But the capital required to run the combined P&C and Life reinsurance businesses is EUR 2.9 billion: this is a lower figure than the sum of the two businesses (Life and P&C) taken individually (EUR 4 billion). The data showed in the table below for 2012 is still valid today, with Life/Non-Life diversification savings still at around 28%.

Figure 7: **The P&C capital shield policy and high diversification between P&C and Life both contribute to SCOR's tireless efforts to optimize its capital needs**

2012 Data

SCOR P&C's economic capital needs have been lowered thanks to an optimal capital shield policy

2012 P&C SCR1 in € billions (rounded)

Capital shield policy lowers capital needs by almost 20%

2.6   -0.5   2.1

P&C Standalone before capital shield | Capital shield savings | P&C Standalone

Diversification between Life and Non-Life brings further substantial capital savings

2012 P&C SCR1 in € billions (rounded)

4.0

Diversification benefit: 27%

2,1

■ P&C
■ Life

Standalone | Diversified

Conclusion

To conclude, managing a (re)insurance company is all about managing under capital and profitability constraints, and maximizing business within these two constraints. This translates into very concrete requirements in our day to day life:

- Satisfying clients through claims payment

- Bringing value to our clients through effective know-how sharing

- Capitalizing on our long-term experience and business partnerships

- Complying with accounting

- Complying with regulations

- Satisfying rating agencies

- Having a risk adjusted return that satisfies your shareholders

- Financing your growth

At SCOR, all the growth has been self-financed. In certain areas reinsurance / retrocession can help to finance growth. But SCOR has used retrocession for risk management purposes, not growth financing. SCOR has financed its growth with accumulated profits, while distributing a sizeable portion of its annual profits to the shareholders through an active dividend policy. SCOR is a company with over EUR 5 billion in shareholder's equity, and a target ROE of 10% above the risk free rate. This gives a target return of more than EUR 500 million every year, half of which is being distributed to the shareholders; the retained 50% of the profits feed into the capital that will finance growth for the next year. SCOR has managed to double the size of the company in 9 years!

Insurance and reinsurance companies share a number of features when it comes to managing their capital, and we view our own capital management track-record and standards as a source of value for our clients. Key steps to managing and optimizing (re)insurance companies' capital can be summarised as follows:

1. Define your two targets:

a) Solvency
 i. Define your risk appetite and tolerance framework
 ii. Optimize (but preserve) a strong capital position – solvency is essential
 iii. Maximize fungibility – you need the margins to respond to changes in regulations, adapting your business plan and underwriting policies when necessary
 iv. Maximize financial flexibility

b) Profitability: set a shareholders' remuneration consistent with your risk appetite, acknowledging that there is no return without risk, and there is no margin without risk

2. Maximise growth within the respect of these two targets

Reinsurance represents a flexible and efficient strategic capital management tool for insurance company executives when solving the solvency/profitability/growth equation (remember Figure 2). In terms of solvency, it acts as a balance sheet protection tool. For profitability it can reduce the volatility of earnings. For growth, although this applies more to Life at the moment, it can help finance growth by monetizing future business value, creating a cash flow that can be used to expand business.

BIOGRAPHIES

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Davide Canestraro is an Italian actuary; he holds a degree in Statistics and a Master in Actuarial Science from the University of Florence, as well as a PhD in Actuarial Science from the Sapienza - University of Rome. He joined the Financial Modelling and Risk Analysis team of SCOR in Zurich in 2009. Since 2005, he is a member of the National Council of Italian Actuaries. He has been awarded the SCOR Actuarial Prize in Italy in 2006 and the prize for the best scientific presentation by a young actuary at the first European Congress of Actuaries in 2012.

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Michel Dacorogna, is scientific advisor to the Chairman of SCOR. He conducts research in the field of insurance mathematics, capital management and risks. He is also involved in presenting to management and to customers SCOR models and capital management techniques. Member of the board of the SCOR Science Foundation and of the joint Research Center on Insurance Risk with the Nanyang Technical University of Singapore, he makes sure that SCOR sponsorship is well put in use and known in the academic world and recognized by the industry. Until July 2013, Michel was deputy group CRO in charge of Solvency II and the internal model. He was at the origin of SCOR's internal model, which he developed for more than 10 years.

Author and co-author of more than 70 publications in refereed scientific journals, he is often invited to present his results in international conferences and specialized seminars. His work is referenced in many publications. One of the papers he co-authored was the most quoted paper over 5 years in the Journal of Banking and Finance. He also lectures at the ETH and University of Zurich, at the University Ca'Foscari in Venice (Italy) and at the University of Turin (Italy) in their master of finance programs.

He received his Habilitation, Ph. D. and M. Sc. in Theoretical Physics from the University of Geneva in Switzerland and did a post-doc at the University of California in Berkeley.

CHRISTIAN DINESEN

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Christian Dinesen is a director and founder of the independent management consultancy Dinesen Associates Ltd, and has 29 years' experience of the insurance and capital markets. Dinesen Associates provides management consultancy debt strategy, debt investor relations and rating advisory to insurance companies, advises investors in, and managers of, insurance assets and executive coaching to senior financial services executives.

Christian was for ten years a Managing Director and the European insurance credit analyst for Bank of American Merrill Lynch, as well as the Head of International Credit Research.

Previously he headed the Standard & Poor's European insurance practice. Before that Christian was a partner in a management consultancy for ten years and manager of Texaco's European insurance company, having started his career as a Lloyd's reinsurance broker.

Christian has the rare, combined experience of both insurance and capital markets. He has an extensive network within the senior management of European insurers and financial fixed income investors.

Christian holds a MSc in Economic History from LSE and a BA in Modern History, Economic History and Politics from Royal Holloway College. He is Danish, but has lived in London for 30 years.

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Stuart McMurdo is the Head of Reinsurance for Santam Limited, South Africa's largest short term insurer. His responsibilities include both the buying of reinsurance and the writing of inwards reinsurance from selected territories in the world. Before joining Santam, Stuart was a General Manager of one of South Africa's leading retail brokerages after spending 11 years with the Hannover Reinsurance Group in various senior management roles both in South Africa and Germany.

He obtained a Bachelor of Accounting Science and Honours from UNISA and is a Certified Financial Accountant.

VINCENT FOUCART

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Vincent Foucart, a French citizen born in 1978, is a graduate of the *École Nationale Supérieure de Techniques Avancées* (ENSTA), the *Centre des Hautes Études d'Assurance* (CHEA), and the HEC Executive MBA. In addition he is a certified financial analyst and actuary. After working on the reorganization of Société Générale's business in Asia, in 2001 he joined the French insurer AGF as Investor Relations Manager, later also taking on the role of Director of the AGF Chairman's office. In this capacity, he worked with the Executive Committee and the Board of Directors of AGF and the Management Board of Allianz. As of 2006, he also headed the Long-Term Investments division. Following the success of the Allianz takeover bid on AGF at the beginning of 2007, he became Managing Director of the Tocqueville Finance asset management company.

He joined SCOR in 2009 as the Head of Chairman Office and then managed the General Secretariat during 5 years. In 2014 he joined SCOR Global P&C and took over The "Alternative Solutions" initiative, which is set out in the "Optimal Dynamics" plan, aiming to provide the Group's insurance and corporate clients with a wider range of hybrid reinsurance solutions for the transformation, financing and transfer of risks.

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Professor Karel Van Hulle studied law at the KU Leuven and at the Marquette University Law School in Milwaukee (Wisconsin). He served as Head of Insurance and Pensions at the European Commission until 1 March 2013. He now lectures at the Economics and Business Faculty of the KU Leuven and at the Economics Faculty of the Goethe University in Frankfurt where he is attached to the International Centre for Insurance Regulation. He is a member of the Insurance and Reinsurance Stakeholder Group of EIOPA and a member of the Public Interest Oversight Board.

DENIS KESSLER

Chairman & Chief Executive Officer – SCOR SE – vperinguet@scor.com

Denis Kessler is a French citizen, he is a graduate of HEC business school (*École des Hautes Études Commerciales*) and holds a PhD in economics as well as advanced degrees in economics and social sciences. He has been Chairman of the *Fédération Française des Sociétés d'Assurance* (FFSA), CEO and Executive Committee member of the AXA Group and Executive Vice-President of the MEDEF (*Mouvement des Entreprises de France*). He joined SCOR as Group Chairman and Chief Executive Officer on 4th November 2002.

FRIEDER KNÜPLING

Chief Risk Officer – SCOR SE – fknuepling@scor.com

Frieder Knüpling, a German citizen, holds degrees in Mathematics and Physics from the Universities of Göttingen and Freiburg. He worked as a lecturer and research assistant at the University of Fribourg and several other colleges, until he received a PhD in Economics based on research into the econometric modelling of macroeconomic and financial data. From 1999 to 2002 he worked for Gerling-Konzern Globale Rückversicherungs-AG and its UK subsidiary, dealing with pricing and valuation. As of 2003 he headed the Corporate Actuarial & Treasury department of the former Revios Group. Since 2007 Frieder Knüpling has headed SCOR's Corporate Actuarial Department, reporting to the Chief Risk Officer. He has been appointed Deputy Chief Risk Officer of SCOR in December 2008. In July 2010 he was nominated Deputy Chief Executive Officer (CEO) of SCOR Global Life SE and member of the SCOR Group Executive Committee (Group Comex). On 1st October 2012 he was appointed Deputy Group Chief Risk Officer of SCOR. On 17th January 2014 he was appointed Chief Risk Officer or SCOR. Frieder Knüpling is a fellow of the Deutsche Aktuar Vereinigung (DAV) and a Chartered Enterprise Risk Analyst (CERA).

DOUG LACOSS

Head of Reserving – SCOR Global P&C – dlacoss@scor.com

Doug is the Chief Reserving Actuary for SCOR Global P&C. Prior to his current role, he was the Head of Pricing for SCOR London for 6 years. He has over 20 years of experience in the insurance industry, having worked in New York and London for the St Paul Companies before joining SCOR in 2001. Doug is a Fellow of the Casualty Actuarial Society and has spoken at conferences in the US and UK.

TONY NEGHAIWI

Head of Actuarial Pricing – SCOR Global P&C – tneghaiwi@scor.com

Tony Neghaiwi joined Converium as Chief Actuary in 2006 and became in 2008 Chief Pricing Actuary and member of senior management of SCOR Global P&C with responsibilities of all P&C pricing and modelling operations. He has more than 23 years of experience in the insurance/reinsurance industry. He worked notably for Aetna Life & Casualty and Liberty Mutual in the United States, Zurich Financial Services and XL in Switzerland. He held a Master of Science in Applied Mathematics from University of Tennessee and completed post graduate studies in Mathematics from University of Houston and is a Fellow of the Casualty Actuarial Society.

PAUL NUNN

Head of Risk Modelling and Global Natural Hazards – SCOR Global P&C – pnunn@scor.com

Paul Nunn is responsible for pricing catastrophe risk on inwards business, and accumulation of catastrophe loss potential for natural hazard perils globally. A key aspect of the role is the provision of analytics and data for internal and external stakeholders including SCOR's internal capital model, rating agencies, regulators and retrocessionaires alongside. Paul is also responsible for directing strategic Cat platform system development to facilitate more efficient deployment of capital to support the catastrophe risk SCOR is exposed to. Before joining SCOR Global P&C, Paul was Head of Exposure Management at Corporation of Lloyd's responsible for all aspects of accumulation and concentration risk at Lloyd's. Paul has held many senior level positions in catastrophe management having also worked for ACE European Group and Applied Insurance Research Ltd. Alongside his role at SCOR Global P&C, Paul is a director of the non-profit Oasis Loss Modelling Framework company.

VICTOR PEIGNET

Chief Executive Officer – SCOR Global P&C – clegac@scor.com

Victor Peignet, Marine & Offshore Engineer graduated from the *École Nationale Supérieure des Techniques Avancées* (ENSTA), joined SCOR's Facultative Department in 1984 from the offshore contracting industry. He has more than 15 years underwriting and managing experience in Energy & Marine insurance with SCOR. He was at the head of the Corporate Business Division of the Group (SCOR Business Solutions) since its formation in 2000, as Executive Vice President and as Managing Director from April 2004.

Since July 2005, he has been the Chief Executive Officer of SCOR Global P&C that is one of the two operational entities of the Group and that manages the Group non-life business worldwide. He is member of the Group COMEX.

EVA SCHLÄPFER DE MONTMOLLIN

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Eva Schläpfer de Montmollin is a senior Risk Consultant in the Group Financial Modelling and Risk Analysis team at SCOR. She is responsible for the coordination between group and legal entities internal model topics and is participating in several legal entity related projects in areas of quantitative risk management and solvency regulations. Before taking on this role, she has led the BeSolvent initiative at SCOR to advise customers on reinsurance, and has also significantly contributed to the implementation of an integrated quantitative risk management system at SCOR.

Prior to joining SCOR she held various actuarial roles at Zurich Financial Services where she has been leading a team of actuaries developing pricing methodologies and implementing a widely used pricing platform. She holds a PhD and a MSc in Mathematics from the University of Fribourg in Switzerland. She is a fully qualified actuary (SAV, DAV).

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